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WESTERN SOCIETY OF WEED SCIENCE

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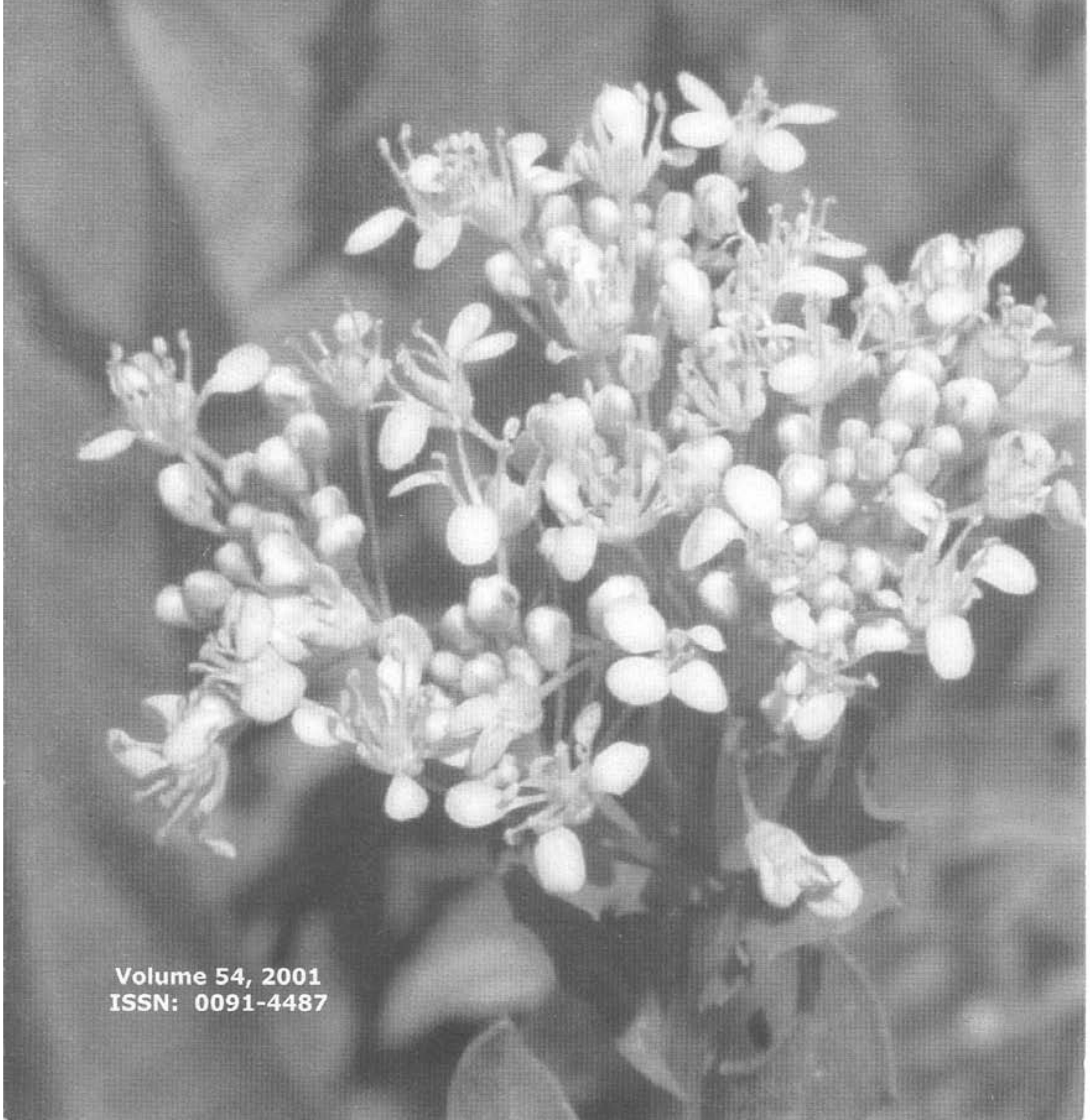

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2001

PROCEEDINGS

OF

THE WESTERN SOCIETY OF WEED SCIENCE

VOLUME 54

PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 12 TO 15, 2001

COEUR D'ALENE RESORT

COEUR D'ALENE, IDAHO

PREFACE

The Proceedings contain the written summary of the papers presented at the 2001 Western Society of Weed Science Annual Meeting plus summaries of the research discussion groups and of the business transacted by the Executive Board. Authors submitted either abstracts or full papers of their presentations.

In these Proceedings, herbicide application rates are given as acid equivalent or active ingredient unless otherwise specified. Chemical names of the herbicides mentioned in the text are given in the herbicide index. Botanical names of crops and weeds are given in the appropriate index and are not repeated in the text unless their omission may cause confusion. Common and botanical names follow those adopted by the Weed Science Society of America as nearly as possible and *Hortus* third.

Copies of this volume are available at $15.00 per copy from Wanda Graves, WSWS Business Manager, P.O. Box 963, Newark, CA 94560.

Cover photo Hoary cress, *Cardaria draba* (L.) Desv., by Timothy Prather. Other photography by Jack Schlesselman.

Proceedings Editors: Joan Campbell and Donn Thill

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POSTER SESSION

CONTROL OF SALTCEDAR USING THE BURCH™ WET-BLADE MOWER. James S. Votaw[1]*, Ann L. Hild[2], and Thomas D. Whitson[3], Graduate Research Assistant, Assistant Professor, and Professor [1,2]Department of Renewable Resources, University of Wyoming, Laramie, WY 82071 and [3]Department of Plant, Soil, and Insect Science, University of Wyoming, Laramie, WY 82071.

Abstract. Saltcedar, introduced to the United States during the early 1800s, has become naturalized along many waterways of the western United States. It has been implicated in lowering water tables, reducing wildlife diversity, increasing soil salinity, and displacing native plant species in infested areas. Traditional mechanical and chemical control methods have often proven to be ineffective or too costly. The Burch™ Wet-Blade Mower may provide effective control at reduced cost by applying a computer regulated amount of herbicide to the cut surface of plants. Concentrating herbicide on the target may reduce application rates and exposure to non-target species. In the spring of 1999, a study was established to test the Burch™ Wet-Blade Mower for effective control of saltcedar. Imazapyr was applied at 0.32 lb ae/A alone and tank mixed with glyphosate and trichlopyr at 2 lb ai/A and 1.5 lb ae/A; respectively, along with a mowing only and untreated control. Each treatment was applied in June and August to determine timing differences. First year results indicate that no treatment significantly reduced density ($P>0.05$) although the fall applied treatments killed and injured some plants. Second year results will be obtained in 2001. A subsequent study to compare resprout to whole-plant treatment was initiated during the spring of 2000. Treatments (0.25, 0.5, and 1 lb ae/A imazapyr, mow only, and untreated control) were applied in August to either resprouts or entire plants. Treatments will be evaluated in August 2001. [Paper Number 1]

THE BEGINNING OF CLASSICAL BIOLOGICAL CONTROL AGAINST MEDUSAHEAD RYEGRASS. Sforza R* [1], Blank B [2], Kashefi J [3], Quimby P.C[1]. [1]European Biological Control Laboratory, USDA-ARS Campus International de Baillarguet, CS90013 Montferrier sur Lez, 34988 St-Gely du fesc Cedex FRANCE;[2] USDA-ARS 920 Valley road, Reno, NV 89512, USA. [3]European Biological Control Laboratory, USDA-ARS, Tsimiski 43, 54623 Thessaloniki, GREECE.

Abstract. Medusahead ryegrass is the common name of Taeniatherum caput-medusae sub. asperum (L.) Nevski (previously Elymus caput-medusae L.). It is a member of the Triticeae tribe of the grass family. This weed is invasive across millions of acres of large semi-arid areas of intermountain rangelands in western U.S. states, especially those sites that have high clay content soils. It is considered that this grass has not reached its ecological limit. This winter annual has its origins in areas bordering the Mediterranean sea and has been introduced into the US in the late 1880s. Two subspecies are known: sub. caput-medusae in West Mediterranean basin in Italy, France, Spain, North Africa, and also in the colder climate of Siberia; sub. asperum is present in all the Mediterranean basin, in Hungary through Ukraine, Tadzhikistan up to Iran. Both subspecies of medusahead are known in the South of France from Menton to Perpignan. This grass is rare and found in relatively dry areas. Until now, no records are available on specific phytophagous insects or mites and nematodes. The objectives are to identify countries of origin of medusahead, and determine some sites of interest for collecting plant and insect material, to observe and collect candidate biological control agents and conduct host range testing. All types of agents will be investigated. No study on classical biocontrol by natural enemies has been done before. Based on literature, investigations will be actively carried out on shoot and root pathogens. The paradigm for biological control has been that exotic invasive species lack the web of predatory organisms that co-evolved in native habitats. This new program includes a global approach of biological control. Alternative mechanisms to explain invasiveness are often excluded. In that view, we will collect soil samples in different European areas to determine if soil composition may have an impact on spreading and competitiveness. The hypothesis is that soil fertility levels may be robust in predicting an alien plants invasiveness. In this scenario, an alien plant can alter soil processes including soil microflora and microfauna to make more available plant nutrients to itself and perhaps capture these plant nutrients more efficiently than the native vegetation it is replacing. Studies on enzyme activities, extractable nutrient levels, and N mineralization potentials will be conducted on soil samples. Maps of the distribution of the plant and the potential for finding future biocontrol agents will be presented and discussed. [Paper Number 2]

EVALUATING IMPACTS OF HERBICIDE TREATMENTS ON THE ROOT SYSTEM OF LEAFY SPURGE USING MINIRHIZOTRON TECHNOLOGY. Summer P. Alger*, Tom D. Whitson, Research Assistant and Extension Weed Specialst, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071

Abstract. Leafy spurge is a perennial noxious weed which infests almost 2.5 million acres in North America, with over 60,000 acres in Wyoming alone. The shallow root mass (upper 2-3 ft of soil) of leafy spurge is critical to the horizontal spread of this invasive and should be targeted for observation and control. Currently, the most effective control methods include grass competition, biocontrol and herbicides; the latter accounting for the most use. How root control is correlated to foliar control of leafy spurge is unknown. The non-destructiveness of minirhizotron use, in situ, provides an effective means of examining potential impacts of integrated control on the roots of leafy spurge. Research studies located at Devils Tower National Monument, WY, wre established in 1998 and 1999 to apply minirhizotron technology primarily to examine and record impacts of herbicide treatments of 2,4-D (1 lb ai/A), picloram (0.5 lb ai/A), imazapic (0.16 lb ai/A), and glyphosate (1.5 lb ai/A) on the root system of leafy spurge. Subsequent objectives will be to determine which area of the rhizosphere is impacted greatest by herbicide applications and their long-term effects. Preliminary results from root counts of the 1998 study were determined from the differences of May 1999 pre-counts and May 2000 post-counts analyzed against three soil levels (top: 8-16 in; middle: 16.5-24 in; lower 25-33 in). A significant decrease in root intercepts in the top level was exhibited by both 2,4-D and imazapic. Picloram exhibited no real difference in root intercepts among the three depths. Glyphosate exhibited significant increases in root intercepts for both the top and middle layers. [Paper Number 3]

INCREASED LEAFY SPURGE CONTROL WITH HERBICIDE MIXTURES. Katheryn M. Christianson* and Rodney G. Lym, Plant Sciences Dept. North Dakota State University, Fargo, ND 58105.

Abstract. Herbicide mixtures often provide greater control of perennial weed species than the single components alone. For example, picloram plus 2,4-D provides a 20 to 30% increase in long-term leafy spurge control compared to either herbicide applied alone. Timing of herbicide application also affects herbicide efficacy on leafy spurge. For instance imazapic fall-applied provides 80 to 90% leafy spurge control 1 yr after treatment, but only 20 to 30% control when the same treatment is applied in the spring. The purpose of this research was to evaluate long-term leafy spurge control with several herbicide mixtures applied either alone or with diflufenzopyr an auxin transport inhibitor. The first study evaluated leafy spurge control by imazapic applied in the spring (or fall) followed by picloram plus 2,4-D in the fall (or spring), picloram plus 2,4-D applied in the spring (or fall) followed by imazapic in the fall (or spring), and all three herbicides applied tank-mixed together in the spring (or fall). The three herbicide mixture of picloram plus 2,4-D plus imazapic applied at 280 + 1120 + 70 g/ha once in the spring provided the best long-term control and averaged 98% 24 MAT (months after treatment) compared to less than 60% when the herbicides were applied alone. The same three herbicide treatment applied in the fall only averaged 15% control 24 MAT. The best split treatments were picloram plus 2,4-D applied in the spring followed by imazapic in the fall and imazapic fall-applied followed by picloram plus 2,4-D in the spring. These treatments averaged 85 and 61% control in August of 1999 and 2000, respectively. No grass injury was observed following any of the rotational treatments. [Paper Number 4]

FOOD QUALITY PROTECTION ACT: IMPLICATIONS FOR U.S. AGRICULTURE. Dudley Smith*, Soil and Crop Sciences Dept.,Texas A&M University, College Station, TX, Rick Melnico, University of California, Davis, CA, and Leonard Gianessi, National Center for Food and Agricultural Policy, Washington, DC.

Abstract. The 1996 Food Quality Protection Act mandated new regulatory requirements for the US EPA. Currently labeled and new chemicals are subjected to complex dietary and non-dietary, occupational, and environmental considerations, with less importance placed on the economic benefits of pesticides. Since numerous weed, disease,

and insect pests limit productivity of agronomic and horticultural crops, the retention of current pesticides and availability of new products are important to sustain profitability. Five crops account for nearly 60% of all pesticide use in the US but another 75 'minor crops' are grown on 50% of the crop land. For example, although sugar beet acreage in the U.S. approaches 1.4 million acres, commercial firms are not particularly interested in this pesticide market due to high costs of development, geographic diversity in the U.S. industry, and regulatory requirements. While cultural, biological, and other means of non-chemical means are used to control weeds and other pests, pesticide development is still essential to sustain dietary diversity and health. The IR-4 program works with EPA, agricultural groups, chemial firms, and others to facility new tolerances for pesticides for minor crops, with numerous sucesses benefiting production agriculture. [Paper Number 5]

WEED CONTROL WITH FLUMIOXAZIN AND SULFENTRAZONE IN PACIFIC NORTHWEST POTATO PRODUCTION Rick A. Boydston*, Pamela J. S. Hutchinson, Corey V. Ransom, Len L. Welch, and James J. Knabke, USDA-ARS, Irrigated Agriculture Research and Extension Center, Prosser, WA 99350; University of Idaho, Aberdeen, ID 83210, Malheur Experiment Station, Oregon State University, Ontario, OR 97914; Valent USA Corp, Hood River, OR 97031; FMC Corp, Clovis, CA 93611.

Abstract. Sulfentrazone and flumioxazin were tested in Russet Burbank potatoes for crop tolerance and weed control at three locations in 2000 representing major potato growing regions in Idaho, Oregon, and Washington State. Trials were conducted under sprinkler irrigation on a Delco silt loam soil with 1.4 % organic matter, pH 8.1 in Aberdeen, ID, Owyhee silt loam soil, 1.5 % organic matter, pH 7 in Ontario, OR, and on a Quincy sand soil, 0.5 % organic matter, pH 7 near Paterson, WA. In all three trials herbicides were applied after the final hilling and prior to potato and weed emergence. Flumioxazin applied at rates ranging from 0.05 to 0.13 lb ai/a controlled hairy nightshade and common lambsquarters in late June from 85 to 91% and redroot pigweed from 63 to 80% in Idaho trials. Common lambsquarters and redroot pigweed control were lower in July, but hairy nightshade control remained above 85% with flumioxazin at 0.09 and 0.13 lb/a. Flumioxazin did not control tame oats. In Oregon, flumioxazin controlled redroot pigweed in early June from 56% to 85% and control increased as flumioxazin rate increased from 0.05 to 0.13 lb/a. Early season common lambsquarters and hairy nightshade control ranged from 75 to 100%. Flumioxazin failed to control barnyardgrass. In Washington, flumioxazin controlled redroot pigweed, common lambsquarters, and hairy nightshade for the entire season at rates from 0.05 to 0.13 lb/a. Flumioxazin failed to control large crabgrass, which was controlled well by a postemergence application of clethodim. Little or no potato injury was observed when treating with flumioxazin in Idaho and Oregon trials. Flumioxazin at the 0.13 lb/a slightly visually injured potatoes in Washington, but potato yield was not reduced compared to a hand weeded check or potatoes treated with a herbicide standard. Combining flumioxazin with dimethenamid-P or S-metolachlor improved control of redroot pigweed, barnyardgrass, and large crabgrass and did not injure potatoes or reduce potato tuber yield at all three locations. Tank mixes of flumioxazin with EPTC or pendimethalin in Oregon did not improve control of redroot pigweed, but did improve control of barnyardgrass compared to flumioxazin applied alone. Combining flumioxazin with pendimethalin in Idaho slightly improved control of redroot pigweed and tame oats, but control was not commercially acceptable. Flumioxazin combined with metribuzin in Idaho controlled all annual weeds well. In Idaho, sulfentrazone applied alone from 0.06 to 0.13 lb/a controlled common lambsquarters, redroot pigweed, and hairy nightshade greater than 95 %. Tame oats were not controlled well by sulfentrazone. In Oregon trials, sulfentrazone applied alone from 0.09 to 0.25 lb/a controlled common lambsquarters, redroot pigweed, and hairy nightshade greater than 90 %. Sulfentrazone controlled barnyardgrass greater than 90% at 0.188 and 0.25 lb/a. In Washington, sulfentrazone controlled hairy nightshade, and sparse populations of common lambsquarters, and redroot pigweed greater than 99% at rates ranging from 0.09 to 0.25 lb/a but failed to control large crabgrass. Sulfentrazone tank mixed with metribuzin or pendimethalin visually injured potatoes in early June in Idaho trials, but injury was transient and potato tuber yield was equal to hand weeded checks. Sulfentrazone visually injured potatoes in June at rates of 0.19 lb/a or more in Oregon and Washington, but potato tuber yield was not reduced compared to potatoes treated with herbicide standards or hand weeded checks. Tank mixes of sulfentrazone at 0.09 or 0.19 lb/a with S-metolachlor, dimethenamid-P, EPTC, or pendimethalin, controlled annual broadleaf and grass weeds well and did not reduce potato tuber yield at all three locations compared to hand weeded checks or potatoes treated with standard herbicide treatments. Both sulfentrazone and flumioxazin controlled hairy nightshade, a

common weed in potato. These two herbicides may also provide control of triazine resistant broadleaf weeds in potato rotations and provide growers new options for weed control in metribuzin susceptible potato varieties. [Paper Number 6]

INFLUENCE OF ROOT-KNOT NEMATODES AND TUBER SIZE ON EMERGENCE AND DEVELOPMENT OF VIABLE REPRODUCTIVE STRUCTURES OF YELLOW NUTSEDGE AND PURPLE NUTSEDGE AT EARLY-SEASON TEMPERATURES. Brian J. Greenfield[1], Jill Schroeder[1], Stephen Thomas[1], Leigh W. Murray[2], Jackie Fuchs[1], and Kenneth F. Brown[2], Research Assistant, Professor, Professor, Professor, Research Specialist, and Graduate Student. [1]Department of Entomology, Plant Pathology, and Weed Science, [1]Department of Experimental Statistics, New Mexico State University, Las Cruces, NM 88003

Abstract. Previous research conducted at New Mexico State University indicated that purple nutsedge and yellow nutsedge tubers collected in June, approximately 6 to 8 weeks after emergence, were higher in tuber weight and tuber number when grown in soil infested with root-knot nematodes (*Meloidogyne incognita* (Kofoid &White) Chitwood) relative to tubers from non-infested soil. These results did not identify whether the differences were due to the influence of root-knot nematodes, initial tuber size, or both variables. Therefore, a study was conducted during the winter to early-summer months of 2000 to determine the influence of root-knot nematodes and initial tuber size on purple nutsedge and yellow nutsedge emergence and tuber development. Tubers were sized by weight into three weight categories per nutsedge species. For purple nutsedge, the weight categories were 0.1 to 0.3 g, 0.51 to 0.71 g, and 0.92 to 1.12 g. For yellow nutsedge, the weight categories were 0.02 to 0.04 g, 0.07 to 0.09 g, and 0.14 to 0.18 g. At the New Mexico State University Plant Science Research Center, five tubers of similar size, nutsedge species, and root-knot nematode exposure (tubers produced in the presence or absence of root-knot nematodes) were planted into 15-cm azalia pots containing a sand/soil mix and were entrenched near a field. Four pots of each nutsedge-nematode-tuber size combination were harvested at 21, 28, 35, and 42 days after emergence. Emergence was defined as at least one shoot in at least 60% of the pots. Purple nutsedge and yellow nutsedge pots were harvested at different times because of differing emergence dates. Yellow nutsedge daughter-tuber count and fresh weight were significantly greater when mother tubers were grown in the presence of root-knot nematodes. Yellow nutsedge tuber weight and count were also significantly greater in pots planted with tubers weighing 0.14 to 0.18 g. Results indicate an interaction in which increasing mother tuber weight and presence of root-knot nematodes increased daughter tuber weight and count. Purple nutsedge daughter-tuber count and fresh weight were significantly greater in pots planted with medium and large mother tubers. Interactions occurred in which purple nutsedge mother tubers grown in the presence of root-knot nematodes and later harvest dates increased daughter tuber fresh weight. Purple nutsedge mother tubers developed in the presence of root-knot nematodes, later harvest dates, and increasing mother tuber size increased daughter tuber counts. No significant differences for any independent variable on root-knot nematode egg count, egg count per gram of dry root, or log of egg count per gram of dry root were observed on either yellow nutsedge or purple nutsedge. These preliminary results indicate that both tuber size and presence of root-knot nematodes may enhance early season nutsedge development. The study will be repeated in 2001. [Paper Number 7]

PURPLE NUTSEDGE MANAGEMENT IN CHILE PEPPERS WITH HALOSULFURON. Jill Schroeder*, Philip A. Banks, and Cheryl A. Fiore, Professor, New Mexico State University, Las Cruces, NM 88003; President, Marathon Consulting, Las Cruces, NM 88005; and Research Assistant, New Mexico State University, Las Cruces, NM 88003.

Abstract. Field studies were conducted in 1999 and 2000 on an Agua loam soil (pH 8.1, 1.3% O.M.) near Rincon, NM to assess chile pepper response and purple nutsedge control with halosulfuron, GWN-3060. Chile peppers were direct seeded in beds separated by furrows and managed according to local practices. Furrow irrigation was used. In 1999, halosulfuron was applied at preemergence, postemergence, and preemergence followed by postemergence timings at 0.023, 0.032 or 0.047 lb ai/A. All postemergence treatments included the nonionic surfactant, AG-98, at 0.125% v/v. Chile pepper injury from preemergence treatments ranged from 12 to 40%; however, postemergence treatments caused 85% in late August after postemergence treatments of > 0.032 lb ai/A. Preemergence treatments

of halosulfuron did not control the purple nutsedge. In 2000, halosulfuron was applied as a postemergence-directed treatment to chile at the 3 to 4 leaf stage of growth at 0.032 or 0.047 lb ai/A alone or followed by a sequential treatment at the same rate of application. Methylated seed oil plus CMR Embrace Plus at 1% v/v plus 2.5% v/v were included in all treatments. Purple nutsedge control was excellent but chile injury from the postemergence-directed treatment was 20 to 40%. Yields were unaffected by treatment, however. An additional study was conducted to determine the effect of the adjuvents on chile response to halosulfuron. The same rates of halosulfuron were applied as postemergence or postemergence-directed treatments to 5 to 12 inch tall chile. The adjuvent treatments were AG-98 or methylated seed oil plus CMR Embrace Plus. Halosulfuron plus methylated seed oil plus CMR Embrace Plus applied postemergence caused up to 30% injury compared to [Paper Number 8]

CONTROL OF YELLOW NUTSEDGE WITH HALOSULFURON IN BELL PEPPERS. W. Thomas Lanini* and Ernie Roncoroni, Extension Weed Ecologist and Staff Research Associate, University of California, Davis, CA 95616.

Abstract. A field study was established on the Vegetable Crops Farm at Davis California to evaluate the control of yellow nutsedge in bell peppers. Six week-old bell peppers transplants, variety 'Bonita', were transplanted at one-foot intervals onto 30-inch beds. Halosulfuron treatments were made at 0.036 or 0.053 kg ai/ha as a single treatment, or as repeat treatments 21 days apart. Initial halosulfuron treatments were applied on June 18, 2000, using a CO2-powered backpack sprayer, equipped with 8004 flat fan nozzles, and a final spray volume of 373 l/ha. Applications were made by directing the spray toward the base of the pepper plants, avoiding spray contact with the top of the plants. At the time of treatment, yellow nutsedge had 3 to 5 true leaves. Halosulfuron provided 80 to 90% yellow nutsedge control at six weeks after treatment (WAT), compared to the untreated check. Single treatments were just as effective as multiple treatments. At 11 WAT, yellow nutsedge control declined by 6 to 29%. Yellow nutsedge regrowth at the end of the season was minimal on halosulfuron treated plots (less than 18% cover) compared to the untreated plots (greater than 80% cover). Bell pepper injury from the halosulfuron application ranged from 5 to 19% at 6 WAT, with most of the injury symptoms occurring on the lower leaves, which came into contact with the spray solution. By harvest, bell pepper injury symptoms had disappeared. At the first harvest, on August 1, 2000, the weights of grade 1 bell peppers did not differ among treatments, with the average being about 4000 kg/ha. However, plots that received a double application of halosulfuron at the 0.053 kg/ha rate had more grade 2 bell peppers, by weight, than did untreated plots (3000 to 4000 kg/ha vs. 1000 kg/ha). At the second harvest, September 8, 2000, yield of grade 1 bell peppers was greatest on plots that received double applications of halosulfuron at the 0.036 kg/ha rate (2000 kg/ha vs. 1000 kg/ha). The weight of grade 2 and culls did not differ among treatments at the second harvest. As with bell pepper weight, the number of grade 2 bell pepper fruit was slightly greater in plots that received a double application of halosulfuron at the 0.053 kg/ha rate at the first harvest. At the second harvest, the number grade 1 bell pepper fruit was greater on plots that received a double application of halosulfuron at the 0.036 kg/ha rate. The overall weight of bell pepper fruit produced was greater on all halosulfuron treated plots (14,000 to 21,000 kg/ha vs. 7,000 kg/ha for untreated). [Paper Number 9]

EFFECTS OF FIELD APPLICATIONS OF NONSELECTIVE, POSTEMERGENCE HERBICIDES IN ORNAMENTAL BULBS. Timothy W. Miller and Carl R. Libbey*, Extension Weed Scientist and Agricultural Technologist, Washington State University Mount Vernon Research and Extension Unit, Mount Vernon WA 98273.

Abstract. Tulip, narcissus, and bulbous iris are grown on about 2200 acres annually in western Washington. These bulb crops are poor competitors with winter annual weeds that germinate continually from September through July in the mild maritime climate of this region. Residual herbicides are currently fall applied, since they do not adequately control emerged weeds. Fall-applied herbicides, however, lack the soil persistence necessary for season-long weed control. If nonselective herbicides could safely be applied after emergence of bulb foliage, emerged weeds would be killed and the application of residual herbicides delayed until February, thus lengthening the period of weed control through bulb harvest. Glyphosate, sulfosate, glufosinate, carfentrazone, and paraquat were applied to ornamental bulb foliage at several timings in late winter. Weed control 30 DAT for all treatments except carfentrazone exceeded 90%. Glyphosate or sulfosate applied to tulips emerged up to 1inch, and to narcissus and iris

up to 6 inches, was generally safe to foliage and did not significantly reduce total bulb number, total bulb weight, or average bulb weight. Number and height of tulip flowers were reduced by glyphosate at this timing. Glufosinate caused minor foliar injury to tulips up to 1 inch, while carfentrazone and paraquat caused moderate to severe injury. No contact herbicide reduced narcissus or iris bulb yield parameters, but tulips treated at 2 or more inches tall produced fewer and lighter bulbs than nontreated tulips. [Paper Number 10]

RANKING WEED RESPONSE TO ADDED NITROGEN AND PHOSPHORUS. Robert E. Blackshaw*, Randall N. Brandt, and Henry H. Janzen, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada T1J 4B1.

Abstract. A controlled environment study was conducted to determine the growth response of twenty common weeds of the Northern Great Plains to increasing levels of nitrogen and phosphorus. Wheat and canola were included as check species. Separate experiments were conducted for each nutrient and all experiments were repeated. Plants were grown in soil that was naturally low in fertility and nutrients were applied at doses approximating field doses of 0 to 125 kg/ha for nitrogen and 0 to 60 kg/ha for phosphorus. Other macro- and micro-nutrients were maintained at adequate levels. Shoot and root dry weight of each species was determined after six weeks of growth. Results indicated that weeds varied considerably in their growth response to these nutrients, with many weeds exhibiting a greater growth response to added nitrogen or phosphorus than that of wheat or canola. Redroot pigweed and round-leaved mallow were highly responsive to both nitrogen and phosphorus. Wild mustard responded greatly to nitrogen but not to phosphorus. Russian thistle was among the least responsive weeds to both nutrients. Differences in crop and weed responses to soil fertility may allow development of fertilization methods and cropping systems that stimulate crop growth over that of weeds. [Paper Number 11]

BROADLEAF WEED CONTROL IN SPRING-SEEDED ALFALFA WITH POSTEMERGENCE APPLICATIONS OF AC 299-263 AND IMAZETHAPYR APPLIED ALONE OR IN COMBINATION.
Richard N. Arnold* and Dan Smeal, Pest Management Specialist and Agricultural Specialist, New Mexico State University Agricultural Science Center at Farmington, Farmington, NM 87499.

Abstract. Alfalfa is New Mexico's leading cash crop, accounting for approximately 20% of the state's crop income. Weeds compete vigorously with spring-seeded alfalfa for light, nutrients, and moisture. Some weeds, when harvested with alfalfa, may reduce quality. Hay quality, particularly protein content, is an important consideration in feed rations in some markets, such as the dairy and horse racing industries. A field experiment was conducted in 2000 at Farmington, NM to evaluate the response of alfalfa (var. Legend) and annual broadleaf weeds to postemergence applications of AC 299-263 and imazethapyr applied alone or in combination. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 30 psi. Treatments were applied on June 12 when alfalfa was in the second trifoliolate leaf stage and weeds were small. Black nightshade, redroot and prostrate pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were light throughout the experimental area. Plots were evaluated on July 12. Alfalfa was harvested on August 1, using a self-propelled plot harvester. No crop injury was observed in any of the treatments. Buctril applied at 0.25 lb/A gave poor control of redroot and prostrate pigweed. Russian thistle control was good to excellent with all treatments except AC 299-263 and imazethapyr applied at 0.032 and 0.047 lb/A and the check. Common lambsquarters and black nightshade control were good to excellent with all treatments except the check. The weedy check had significantly higher yields as compared to herbicide treatments. This is possibly attributed to the high weed content when harvested. All treatments had a significantly higher protein content than the check. [Paper Number 12]

IMAZAMOX A NEW POSTEMERGENCE HERBICIDE FOR ALFALFA. Mick Canevari*, Farm Advisor, University of California Cooperative Extension, Stockton, CA, Don Colbert, Field Biologist, BASF Corporation, Lodi, CA, Steve Orloff, Farm Advisor, University of California Cooperative Extension, Yreka, CA.

Abstract. Imazamox is a new short soil residual imidazolione herbicide being developed by BASF Corporation for use in alfalfa. Early Postemergence application of the herbicide controls a broad spectrum of grasses and broadleaf weeds. Rates from .032 to .047 lb/A have demonstrated excellent control of mustards, filaree, burning nettle and cheeseweed. Imazamox has also shown excellent control of wild barley, ripgut brome, Italian ryegrass and canarygrass. Imazamox shows good crop safety to seedling alfalfa in the second trifoliolate leaf stage or larger. It may also be applied in established alfalfa for winter weed control or between cuttings for summer grass control. [Paper Number 13]

MALT BARLEY RESPONSE TO FENOXAPROP-P ALONE AND IN TANK MIXTURES. Michael G. Particka* and James A. Mickelson, Research Associate and Assistant Professor, Montana State University, Southern Agricultural Research Center, Huntley, MT 59037.

Abstract. A new formulation of fenoxaprop-p (Puma) has recently been approved for use in barley. This formulation contains a new crop safener. Therefore, experiments were conducted to evaluate malt barley response to fenoxaprop-p applied alone or in tank mixtures. Two experiments were conducted near Huntley, MT in 2000. Crop response to fenoxaprop-p and tralkoxydim alone and to fenoxaprop-p tank mixed with MCPA ester, bromoxynil+MCPA ester, thifensulfuron, fluroxypyr+MCPA ester, clopyralid+2,4-D, fluroxypyr, and propiconazole was evaluated on a current malt barley variety (Moravian 22). Each treatment was applied to 3 and 6 leaf barley. No injury was observed following applications to 6 leaf barley. Crop injury was observed 11 days after treatment of 3 leaf barley and ranged from 0 to 16%. Crop injury was reduced when fenoxaprop-p was tank mixed with a broadleaf herbicide. At 21 days after treatment no injury was observed in any treatment. No differences in barley yield or quality were detected among treatments. A second experiment compared crop response of a current malt barley variety (Moravian 22) to an experimental variety (Moravian 37). Treatments included fenoxaprop-p alone and tank mixed with bromoxynil+MCPA ester, and tralkoxydim alone applied to 3 leaf barley. Fenoxaprop-p+bromoxynil+MCPA ester was also applied to 6 leaf barley. Maximum crop injury was observed 11 days after treatment of 3 leaf barley and 7 days after treatment of 6 leaf barley and ranged from 0 to 23%. Fenoxaprop-p alone was most injurious but by 21 days after treatment no injury was observed in any treatment. Injury to Moravian 37 was slightly less than injury to Moravian 22. No differences in barley yield or quality were detected among treatments. [Paper Number 14]

GLYPHOSATE SUPPRESSION AND INTERCROPPING KENTUCKY BLUEGRASS TO MAINTAIN SUBSEQUENT BLUEGRASS SEED YIELD. Jerry B. Swensen, Janice M. Reed, and Donald C. Thill*, Plant Science Division, University of Idaho, Moscow, ID 83844-2339

Abstract. Experiments were established in fields of four Kentucky bluegrass varieties ('Rhonde', 'Kenblue', 'NuBlue', and 'Palouse') to determine whether suppression with a spring application of glyphosate, followed by no-till planting of an intercrop of lentil, pea, or oat, can sustain Kentucky bluegrass production cycles in subsequent crop years, and whether high or low post-harvest residues impact this reaction. Glyphosate, applied at 1 lb/A from 2 to 6 weeks prior to planting the intercrop, suppressed Kentucky bluegreass stands from 0 to 93%, depending on variety and timing, with earlier application resulting in less suppression. Kentucky bluegrass seed yield in the year following suppression was 120 to 250% greater than the untreated check regardless of intercrop species, priovided that bluegrass suppression was less than 80%. Kentucky bluegrass seed yield ranged from 150 to 477 lb/A as post-harvest residue remaining in the field ranged from 3200 to 500 lb/A, respectively. [Paper Number 15]

PERFORMANCE OF CYHALOFOP-BUTYL ALONE AND IN COMBINATION WITH PROPANIL IN CALIFORNIA WATER-SEEDED RICE. Alan E. Haack*, Richard K. Mann, and Roger E. Gast. Dow AgroSciences LLC, Indianapolis, IN, 46268.

Abstract. Field trials were conducted in the Sacramento Valley of CA during 1997-2000 in water-seeded rice culture to investigate the effect of application rate and timing on the efficacy and rice tolerance of cyhalofop-butyl alone and in combination with propanil. Treatments were targeted to early watergrass growth stages at either 2-3 leaf, 4-6 leaf, or 2-3 tiller stage with cyhalofop-butyl applied at rates of 70, 140, 210, 280 and 560 g ai/ha. Cyhalofop-butyl (210 g ai/ha) tank-mixed with different propanil (3360 g ai/ha) formulations (aqueous suspension and EDF) was also evaluated. Bearded sprangletop was present in most trials and was usually 1-2 leaf stages behind in development compared to that of early watergrass. Water was lowered or completely removed to expose foliage at the 2-3 leaf timing and maintained at a 5-10 cm level for the later timings. Commercial formulations of propanil (aqueous suspension) at 3360-6720 g a/ha and fenoxaprop-ethyl (resolved isomer) at 38 and 76 g ai/ha were included as reference treatments. Cyhalofop-butyl at 210 g ai/ha provided greater than 90% control of both 2-3 leaf and 4-6 leaf early watergrass. Propanil at 3360-4480 g ai/ha provided 81% and 70% control of 2-3 leaf and 4-6 leaf early watergrass, respectively. Fenoxaprop-ethyl at 38 g ai/ha provided 71% and 68% control of 2-3 and 4-6 leaf early watergrass, respectively. Bearded sprangletop control of greater than 90% was achieved by cyhalofop-butyl at 140 g ai/ha at the 2-3 leaf stage and 210 g ai/ha at the 4-6 leaf stage. Fenoxaprop-ethyl at 38 g ai/ha provided 82% and 85% control of 2-3 and 4-6 leaf bearded sprangletop, respectively. Control of bearded sprangletop with propanil ranged from 25-57%. Cyhalofop-butyl at 280 g ai/ha, fenoxaprop-ethyl at 76 g ai/ha and propanil at 6720 g ai/ha provided equivalent initial control (86-90%) of 2-3 tiller early watergrass. Cyhalofop at 210 g ai/ha and fenoxaprop at 76 g ai/ha resulted in greater than 95% control of 1-3 tiller bearded sprangletop; propanil provided 45% control. Cyhalofop-butyl at 210 g ai/h tank mixed with propanil at 3360 g ai/h (aqueous suspension, or EDF) provided greater than 95% control of 4-6 leaf and 2-3 tiller early watergrass and bearded sprangletop. Cyhalofop-butyl at rates up to 560 g ai/ha caused little or no visual rice injury (0-5%) in all studies. Propanil caused slight rice injury (9-15%) 1-2 weeks after treatment. Fenoxaprop-ethyl at 38 g ai/ha caused significant injury to rice when applied to rice in the pre-tiller stages of growth. These studies indicate that cyhalofop-butyl, at rates ranging from 140-280 g ai/ha, depending on grass species and growth stage at application, will provide equal or better annual grass control than propanil or fenoxaprop-ethyl with significantly less potential for rice injury. [Paper Number 16]

WEED CONTROL IN SUNFLOWER WITH HERBICIDES AND ALTERNATIVE PLANTING ARRANGEMENT. Troy M. Price* and Phillip W. Stahlman, Assistant Scientist, Kansas State University-Northwest Research and Extension Center, Colby, KS 67701 and Professor, Kansas State University-Agricultural Research Center, Hays, KS 67601.

Abstract. Weeds are a major problem in sunflower, in part because few herbicides are registered for use in sunflower. An integrated approach potentially could be used to improve weed control in sunflower. Field studies were conducted at Colby, Kansas in 1999 and 2000 to evaluate the effects of planting arrangement and herbicide treatment on weed control and sunflower yield. Planting arrangement consisted of planting sunflower at similar populations in paired rows 30 cm apart with a 48-cm spacing between paired rows compared with planting in equidistant rows 76 cm apart. Herbicide treatments in 1999 consisted of sulfentrazone at two rates applied preemergence. In 2000, herbicide treatments consisted of sulfentrazone and pendimethalin alone and in combination and S-metolachlor, each at two rates, applied 15 days preplant (DPP) and preemergence. Weeds present in both experiments were pigweed species and puncturevine. Broadleaf weed control was up to 20 percent higher in paired row sunflower than in equidistant row sunflower in 1999, but sunflower yields did not differ. The trend was similar in 2000, though differences were less and yields did not differ between planting arrangements. The better weed control in paired-row sunflower was attributed to 2-week earlier canopy closure. Sulfentrazone and sulfentrazone plus pendimethalin controlled puncturevine and tumble pigweed better when applied 15 DPP compared with preemergence application, whereas pendimethalin provided better control when applied preemergence. Weed control with S-metolachlor was similar between timings. [Paper Number 17]

A COMPARISON OF THE COMPTETIVE ABILITY OF GLYPHOSATE RESISTANT CANOLA VERSUS GLYPHOSATE NON-RESISTANT CANOLA. David L. Esplin*1, Larry S. Jeffery1, Dennis L. Eggett2, Steven R. Eskelsen3, Thomas Nickson3, and Michael J. Horak3, Graduate Research Assistant, Professor of Agronomy, Associate Professor of Statistics, Research Agronomist, Director, Plant Ecologist, 1 Department of Agronomy and Horticulture, 2 Statistics Department, Brigham Young University, Provo UT 84604 and 3 Ecological Technology Center, Monsanto Company, St. Louis, MO 63198.

Abstract. A possible risk of genetic engineering is an increase in the competitive ability of the transformed plant. The objective of this experiment was to determine if the competitive ability of glyphosate resistant canola (*Brassica napus*) is greater than non-modified canola. An addition series experiment was conducted during the 1999 and 2000 growing seasons at Walla Walla, WA. Five densities of wild mustard (*Sinapis arvensis*) were planted in all combinations with either five densities of the non-modified canola hybrid, 'Hyola 401' or five densities of the modified canola hybrid '357RR.' The fifty treatments were replicated four times in a randomized complete block design. 'Hyola 357RR' and 'Hyola 401' are hybrids and differ only by the glyphosate resistant transgenes inserted into the parental lines of 'Hyola 357RR'. Total plant biomass and the number of plants of each species in each plot was measured. Analysis of covariance suggests that the per plant biomass of wild mustard in plots of glyphosate resistant canola was no different than per plant biomass of wild mustard in plots of non-glyphosate resistant canola (p=.6442). The per plant biomass of glyphosate resistant canola was not significantly different than per plant biomass of non-glyphosate resistant canola (p=.2484). This suggests that the competitive ability of glyphosate resistant canola is the same as the competitive ability of the non-glyphosate resistant canola. [Paper Number 18]

CONTROL OF FIELD BINDWEED IN GENETICALLY MODIFIED CORN. Larry S. Jeffery, Professor of Agronomy, Brigham Young University, Provo, UT 84602.

Abstract. Field bindweed, *Convolvulus arvensis* L., is a persistent perennial weed that is extremely difficult to control in many agricultural lands of the Western United States. Its extensive and deep penetrating root system makes it very competitive for water and nutrients plus its viny nature cause serious crop harvesting losses. A study was initiated on adjacent plots in 1999 and 2000 in a field heavily and uniformly infested with field bindweed to compare the efficacy of glufosinate, glyphosate and 2,4-D for the control of field bindweed in corn. The experiment was established in a randomized complete block design with three replications in 1999 and four in 2000. The entire research area was treated with a preemergence application of cyanazine + alachlor to control annual weeds. Glufosinate, glyphosate and 2,4-D were applied over-top of the genetically modified corn cultivars '4016LL' and 'DK493RR'when corn was in the 6 to 7 leaf stage. Weedy and weed-free checks were included for each cultivar. Ratings of field bindweed control made prior to corn harvest each year were 95 to 100% for glyphosate, 55 to 78% for glufosinate and 73 to 88% for 2,4-D. The control of field bindweed improved corn yields compared to the weedy check and the herbicide treatments did not reduce yields compared to the weed free check. The preemergence application of cyanazine and alachlor probably prevented same season reinfestation of the plots by germinating field bindweed seedlings. None of the herbicide treatments reduced corn yields when compared to the weed-free check. The degree of field bindweed control obtained in corn in 1999 was also apparent in wheat planted in 2000 over the 1999 plots and grown during the summer of 2000. In this study glyphosate gave excellent control of field bindweed in genetically modified glyphosate resistant corn that had received a preemergence application of cyanazine plus alachlor. [Paper Number 19]

FACTORS AFFECTING SUNFLOWER TOLERANCE TO SULFENTRAZONE. Gregory W. Kerr, Phillip W. Stahlman*, and J. Anita Dieleman, Kansas State University, Hays and Manhattan.

Abstract. Weed control in reduced tillage and no-tillage sunflower cropping systems is limited by a lack of effective herbicides that do not require incorporation. Sulfentrazone received Section 18 Specific Exemption registration in 1999 and 2000 for use in reduced tillage, conservation tillage, and no-tillage sunflower fields to control kochia. Numerous occurrences of sunflower injury in 1999 were related to one or more factors including time of herbicide

application, excessive herbicide rate on some soils, environmental factors, and seeding depth. A greenhouse study was conducted at the KSU Agricultural Research Center, Hays, KS and two field studies were conducted at the Northwest Research-Extension Center near Colby, KS in 2000 to evaluate the effects of herbicide rate, time of application, and seeding depth on sunflower tolerance to sulfentrazone. In the greenhouse study, sulfentrazone was applied preemergence at 0, 140, 210, or 280 g ai/ha and sunflower were seeded 2 or 4 cm deep. Sunflower plant dry weights were determined as a percentage of the untreated control 21 days after planting. In one field study, sulfentrazone was applied 45, 30, or 15 days preplant or preemergence and sunflower were seeded 3 cm deep, whereas in an adjacent study sunflower were seeded 1.9 or 3.2 cm deep and sulfentrazone was applied preemergence. Sulfentrazone rates in both field studies were 105, 140, 158, and 210 g/ha. Sulfentrazone stunted sunflower plants in all studies; however, sunflower plants in both field studies recovered and seed yields did not differ between sulfentrazone rates. Sunflower plant dry weights as a percent of the untreated control decreased in the greenhouse study and visible injury generally increased in field studies with increasing sulfentrazone rate. Averaged across herbicide rates, increased seeding depth increased plant dry weights in the greenhouse and reduced stunting in the field. Increased seeding depth also increased sunflower yield averaged across herbicide rates. Early preplant application of sulfentrazone reduced sunflower stunting compared with preemergence application, but less injury achieved with preplant application did not result in higher seed yield. These studies indicate that lowering use rate, applying sulfentazone 15 to 45 days preplant rather than preemergence, and increasing sunflower seeding depth can lessen risk of sunflower injury to sulfentrazone. Early preplant application and deeper seeding lessen the need to reduce use rate. [Paper Number 20]

WHEAT VARIETAL RESPONSE TO FENOXAPROP. Brian L. S. Olson*, Todd A. Baughman, Alan Fritz, and David Worrall. Postdoctoral Research Associate and Assistant Professor, Department of Soil and Crop Sciences, Texas A&M Research and Extension Center, Vernon, TX 76385. Assistant Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506. Co-manager of North American AgriPro Wheat Breeding, Vernon, TX 76385.

Abstract. Fenoxaprop (Silverado) and fenoxaprop plus a safener (Puma) are herbicide treatments used to control wild oat in North Central Texas. Fenoxaprop is normally applied after wheat tillering but before jointing in this area. In the past, there has been a few reports of possible wheat injury from fenoxaprop applications. Field studies were conducted at the Chillicothe Research Station in 1997-98, 1998-99, and 1999-2000 and the Vernon Research Center in 1997-98 to assess possible wheat injury. Treatments consisted of a factorial arrangement of fenoxaprop at 0.094 kg ai/ha with or without the safener, no herbicide, and liquid foliar nitrogen or water as the carrier. These treatments were applied to 11 regionally adapted wheat varieties prior to jointing: Custer, 2137, Hickok, Jagger, Lockett, Ogallala, TAM 202, TAM 301, TAM 302, TAM W-101, and Tomahawk. Wheat response to fenoxaprop was minimal with the maximum wheat injury of 6 % observed 3 weeks after treatment (WAT) at Vernon in 1997-98 when fenoxaprop was applied with no safener and water as the carrier. No wheat injury at any location was observed 5 WAT. Visual ratings of wheat stunting across locations 3 WAT also indicated that fenoxaprop with no safener and water as the carrier stunted wheat more. At harvest, wheat height was dependant upon a location by herbicide treatment interaction. Fenoxaprop decreased wheat height by 4.5 cm at Chillicothe in 1997-98; however, no reduction in wheat height was observed at Chillicothe in 1998-99 or 1999-2000. Due to poor growing stands at Vernon in 1997-98, no wheat height or wheat yield were taken. Wheat yield was unaffected by fenoxaprop application at the different locations with only a wheat varietal response observed. [Paper Number 21]

THE EFFECT OF HERBICIDE APPLICATION TIME ON WILD OAT CONTROL IN WHEAT. Traci Rauch*[1], Joan Campbell[1], Mike Hubbard[2] and Donn Thill[1], Research Support Scientist, Research and Instructional Associate, Private Consultant and Professor, [1]Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339 and [2]Kootenai Valley Farm and Research, Bonners Ferry, ID 83805.

Abstract. Application timing can greatly affect wild oat herbicide efficacy. Studies were established near Potlatch and Bonners Ferry, Idaho in winter and spring wheat, respectively, to determine the effect of wild oat herbicide (imazamethabenz, fenoxaprop, tralkoxydim, clodinafop, and flucarbazone-sodium) application time on wild oat

control. In winter wheat at Potlatch, clodinafop, flucarbazone-sodium and tralkoxydim each controlled wild oat equally when applied at the one to two, three to four, and five leaf growth stages. However, control usually was best with clodinafop and flucarbazone-sodium (89 to 100%), compared to tralkoxydim (81 to 91%). Wild oat control with fenoxaprop/safener was best when applied at the three to four and five leaf stages (95 to 100%), while control with imazamethabenz was best at the three to four leaf stage (76%). In one experiment in spring wheat, all herbicides controlled wild oat equally at the one to three and five to seven leaf growth stage, except flucarbazone-sodium, which controlled larger wild oat plants better than smaller plants. In a second study, wild oat plants usually were controlled best when each herbicide was applied to six to seven leaf wild oat plants compared to one to three or four to five leaf plants. [Paper Number 22]

SPLIT APPLICATION OF REDUCED HERBICIDE RATES FOR WILD OAT CONTROL IN HARD RED SPRING WHEAT. Sam J. Lockhart* and Kirk A. Howatt, Graduate Research Assistant and Assistant Professor, North Dakota State University, Fargo, ND 58105.

Abstract. Interference from wild oat (*Avena fatua* L.) is a major problem in North Dakota hard red spring wheat (*Triticum aestivum* L.) production. Early emerging wild oat plants are the most competitive with the wheat crop, so both early and full season control of wild oat is critical for reducing wild oat interference to hard red spring wheat. Field experiments were conducted at Fargo and Grandin, ND, in 2000 to evaluate CGA-184927, fenoxaprop, flucarbazone, and tralkoxydim at labeled and reduced rates for wild oat control and wheat yield. Each herbicide was applied once at 25, 33, and 100% of the labeled wild oat rate to 2-true-leaf wild oat plants. Split-applied treatments totaled 50% and 67% of the full rate, divided into two equal applications, and were applied at the 2-true-leaf wild oat stage and 10 days later. Fenoxaprop and flucarbazone as single treatments at 25% and 33% rates did not provide consistent wild oat control. Excellent full-season wild oat control was obtained with two reduced-rate treatments of CGA-184927, flucarbazone, and tralkoxydim. Wild oat control was significantly less than the full rate with single reduced-rate treatments of CGA-184927, tralkoxydim, flucarbazone, and fenoxaprop. Tralkoxydim or CGA-184927 split-applied at 25% and 33% rates provided wild oat control equal to labeled rates. Fenoxaprop and flucarbazone split-applied at 33% rate provided control equal to labeled rates. Wheat yields were similar following treatment with CGA-184927 and tralkoxydim when applied either once at the labeled rate or split-applied at 25% or 33% rates (total equaled 50% and 67% of full rate). [Paper Number 23]

WILD OAT (*AVENA FATUA*) COMPETITION IN BARLEY IS INFLUENCED BY BARLEY VARIETY AND SEEDING RATE. J. T. O'Donovan*, K. N. Harker, G. W. Clayton, and R. N. Pocock, Agriculture & Agri-Food Canada, Lacombe-Beaverlodge Research Centre, Alberta; D. Robinson and J. C. Newman, Alberta Research Council, Vegreville, and L. M. Hall, Alberta Agriculture, Food and Rural Development, Edmonton.

Abstract. Field experiments were conducted at Vegreville and Lacombe, Alberta to determine the influence of barley variety and seeding rate on interference of wild oat with barley. Barley variety and seeding rate affected barley plant density, seed yield, and wild oat shoot dry weight and seed yield, in most experiments, but there were no variety x seeding rate interactions. As expected, the semi-dwarf varieties, Falcon and CDC Earl, were the shortest. Barley seedling emergence and subsequent plant densities varied among varieties, locations and years. The hull-less varieties Falcon and CDC Dawn had the poorest emergence, in most cases, while AC Lacombe and Seebe had the highest emergence. Wild oat shoot dry matter and seed production were highest in the Falcon, CDC dawn, and CDC Earl plots, suggesting that these were the least competitive with wild oat. Barley yield loss from wild oat interference also tended to be highest in these varieties. Poor emergence of Falcon and CDC Dawn and the shorter stature of Falcon and CDC Earl, likely contributed to their relatively poor competitiveness with wild oat. Increasing the seeding rate improved the competitiveness of all varieties as evidenced by reduced wild oat shoot dry matter and seed production and, in some cases, improved barley yields. The study identifies barley varieties that would be most appropriate for situations where weed control options may be limiting such as organic or low-input farms, or fields where herbicide resistant wild oat is a problem. The varieties AC Lacombe and Seebe consistently reduced wild oat seed production most effectively, and would be most suitable for these situations. The study also emphasizes the

need for effective weed control in the less competitive hull-less and semi-dwarf barley varieties to obtain maximum yields. Hull-less varieties such as Falcon were particularly sensitive to weed competition due to both the semi-dwarf stature and relatively poor seedling establishment. [Paper Number 24]

A SUSTAINABLE APPROACH TO NEMATODE AND NUTSEDGE MANAGEMENT IN CHILE USING NEMATODE-RESISTANT ALFALFA AS A ROTATION CROP. C. Fiore*[1], L. Murray[2], I. Ray[3], J. Schroeder[1], S. Thomas[1], Research Assistant, Professor, Professor, Professor, [1]Department of Entomology, Plant Pathology and Weed Science, [2]Department of Economics and International Business, and [3]Department of Agronomy and Horticulture, New Mexico State University, Las Cruces, NM 88003.

Abstract. New Mexico, on average, harvests 27,000 hectares of chile in spite of heavy losses from a variety of pests. Slow emergence and growth rate contribute to chile's inability to compete with these pests. Southern root knot nematodes (RKN) and the perennial weeds, yellow (YNS) and purple (PNS) nutsedge are among the most difficult pests to manage in chile, in part, because of a lack of effective control measures. Research indicates that tubers of both nutsedge species and crops traditionally rotated with chile also host RKN. However, a few non-dormant cultivars of alfalfa, a very competitive crop, are RKN resistant. The objective of this four-year rotational study is to determine if RKN-resistant alfalfa in rotation with chile is an effective, sustainable approach to RKN and nutsedge management. The experiment was designed as a split-plot, randomized complete block with four replications and five treatments. Alfalfa cultivars Magna 8 (RKN resistant) and Doña Ana (RKN susceptible) were planted at a high and low seeding rate in September 1997. Cotton, the least RKN susceptible row crop traditionally planted in rotation with chile, was used as a moderately susceptible control. Acala 1517 cotton was planted in the spring of each planting season from 1998 to 2000. Alfalfa was harvested five times each growing season with no significant yield differences among cultivars or seeding rates. Seven days after each harvest, yellow and purple nutsedge biomass was estimated by sampling four 0.25 meter quadrats in each alfalfa plot. Within the same quadrats, four 20-cm deep soil cores were obtained to evaluate RKN populations. No detectable levels of RKN were observed consistently from either cultivar during the three growing seasons. The 2000 growing season was the third and final year in the alfalfa rotation. Overall YNS and PNS biomass has been significantly reduced in all alfalfa plots since 1998. YNS has been reduced by approximately 86%, while PNS has been reduced by 81%. Variety by seeding rate analysis indicates that the alfalfa variety, Doña Ana, planted at the low seeding rate has maintained more nutsedge biomass than the other treatments. In the cotton plots, YNS and PNS biomass has not significantly changed, while RKN counts have increased over the three years. Chile will be planted in all plots in 2001 to determine the extent to which RKN, YNS and PNS have been controlled by crop rotation with different alfalfa cultivars. [Paper Number 25]

GROWTH CHARACTERISTICS OF SULFONYLUREA-RESISTANT AND -SUSCEPTIBLE DOWNY BROME BIOTYPES. Kee-Woong Park*[1], Carol A. Mallory-Smith[1], George W. Mueller-Warrant[2], and Daniel A. Ball[3], Graduate Student, Associate Professor, Research Agronomist, and Associate Professor, [1]Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002, [2]USDA-ARS, National Forage Seed Production Research Center, 3450 SW Campus Way, Corvallis, OR 97331-7102, and [3]Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, OR 97801.

Abstract. Sulfonylurea-resistant (AR) and -susceptible (AS) downy brome seeds were collected from two different Kentucky bluegrass fields in Athena, Oregon. Sulfonylurea-resistant (MR) and -susceptible (MS) downy brome seeds were harvested in the same field at Madras, Oregon. The AR biotype was highly resistant to sulfonylurea herbicides (primisulfuron, sulfosulfuron, and BAY MKH 6561), but slightly resistant to the imidazolinone herbicide, imazamox. The MR biotype was five to ten times more resistant than the MS biotype to both sulfonylurea and imidazolinone herbicides. Above-ground dry weight and plant height were greater for the MS biotype than the MR biotype. However, there were no differences between MR and MS biotypes in leaf area and tiller number. There also were no differences between AR and AS biotypes in any growth characteristics measured. This study suggests that the MS biotype is more fit than the MR biotype but the AR biotype is as fit as the AS biotype under noncompetitive conditions. The maximum cumulative germination percentage was 4.4% greater for the AR than AS biotype at 5 C. The AR biotype germinated 28 h and 4 h faster than the AS biotype at 5 and 25 C, respectively. The speed of

germination was higher for the AR than the AS biotype at all temperatures. The greatest differences in germination between the AR and AS biotype were observed at 5 C. However, no differences in germination were observed between the two Madras biotypes at any temperature. [Paper Number 26]

WEED CONTROL AND SUNFLOWER TOLERANCE OF AZAFENIDIN AND SULFENTRAZONE. Paul E. Hendrickson*, Brian M. Jenks, Michael T. Edwards, Christopher M. Mayo, and James D. Harbour, Research Agronomist, North Dakota State University, Carrington Research Extension Center, Carrington, ND 58421; Weed Scientist, North Dakota State University, North Central Research Extension Center, Minot, ND 58701; Field Technology Representative, DuPont Crop Protection, Broomfield, CO 80020; Field Technology Representative, DuPont Crop Protection, Grand Island, NE 68803; and Field Technology Representative, DuPont Crop Protection, Fargo, ND 58104

Abstract. Trials were established at Carrington and Minot, ND; Blunt, SD; Goodland, KS; and Wellington, CO to evaluate weed control and sunflower response to azafenidin and sulfentrazone applied alone or in combination with pendimethalin and quizalofop-P-ethyl. Azafenidin and sulfentrazone were applied as preplant incorporated (PPI) and preemergence (PRE) treatments at Carrington, Minot and Blunt. At Goodland, all treatments were applied PPI, while at Wellington, all treatments were applied PRE. Plots were arranged in a randomized complete block design with three replicates. Weeds evaluated were redroot pigweed, common lambsquarters, wild buckwheat, toothed spurge, kochia, yellow foxtail, green foxtail, and barnyardgrass. Azafenidin and sulfentrazone generally provided good to excellent (80 to 100%) control of redroot pigweed, common lambsquarters, wild buckwheat, kochia, and barnyardgrass. Green foxtail control was less than adequate at Goodland, but was good to excellent at Wellington. The addition of pendimethalin generally did not increase weed control. Sunflower was tolerant to azafenidin and sulfentrazone. [Paper Number 27]

EVALUATION OF IN-CROP, PRE-HARVEST, AND POST-HARVEST APPLICATIONS TO CONTROL CANADA THISTLE. Brian M. Jenks, Kent R. McKay*, Denise M. Markle, and Gary P. Willoughby. Weed Scientist, Extension Agronomist, Research Specialist, and Research Specialist, North Dakota State University, North Central Research Extension Center, Minot, ND 58701.

Abstract. We initiated a study in 1998 to determine the influence of in-crop and pre/post-harvest herbicide applications on long-term Canada thistle control. The number of Canada thistle plants present in each plot was determined before the herbicides were applied. Glyphosate was applied either pre-harvest or post-harvest following selected in-crop treatments. In 1999, Canada thistle plants in each plot were counted before any spring tillage operation. In spring 1999, we imposed similar herbicide treatments to those in 1998. For example, we applied 2,4-D at the 5-leaf wheat stage (in-crop) followed by glyphosate pre-harvest to the same plots in 1998 and 1999. Some in-crop treatments differed slightly between 1998 and 1999, but the pre-harvest and post-harvest applications generally stayed the same. In spring 2000, we again counted the Canada thistle in order to make comparisons with initial densities in 1998. The pre-harvest and post-harvest Roundup applications were very effective in 1998. Both application timings generally reduced Canada thistle densities, whereas, densities increased with in-crop treatments of 2,4-D, dicamba + 2,4-D, tribenuron + 2,4-D, or bromoxynil&MCPA (i.e., were not followed with fall application). Canada thistle densities did not increase where clopyralid&2,4-D was applied. The pre-harvest applications were also effective in 1999. The 1998 post-harvest applications were effective in reducing Canada thistle densities, however, there was insufficient Canada thistle regrowth in fall 1999 for an effective post-harvest application. [Paper Number 28]

CONTROL OF MONOCOT AND DICOT WEEDS IN DRY EDIBLE BEANS USING IMAZAMOX.
Charles Finley*[1], Fred Taylor[1], Paul Ogg[2], and Donald Colbert[2], Commercial Development[1] and Field Biology[2], BASF Corp., 26 Davis Drive, Research Triangle Park, NC 27709.

Abstract. Research indicates that postemergence application of imazamox to dry edible beans provides excellent control of many important weeds with minimal crop rotation restrictions. A request for Section 3 registration of imazamox (RAPTOR[R]) for herbicidal usage in dry edible legumes was submitted to the EPA in December 1999 and was granted "reduced risk" status in January 2000. A request for concurrent review by the California DPR was also made. Registration approvals are anticipated in late 2001 with product launch planned in 2002. Imazamox was granted Section 18 emergency exemption status by the EPA during 1999 and 2000 at the request of several states where dry beans are grown. Studies were conducted using imazamox applied as a postemergence spray to dry beans in the one to three trifoliate growth stages at 0.032 LB AE/A in combination with an agricultural spray additive. Depending on local conditions non-ionic surfactants, crop oil concentrates, and/or UAN fertilizer solutions may be recommended as spray additives. The spectrum of dicot weeds controlled by imazamox in these studies includes important weeds such as velvetleaf, redroot pigweed, common ragweed, common lambsquarter, jimsonweed, and black nightshade. The spectrum of monocot weeds controlled includes key grass weeds such as barnyardgrass, giant foxtail, foxtail species, Bromus species, shattercane, and volunteer cereals (non-Clearfield™ wheat). The spectrum of monocot and dicot weeds controlled or suppressed by imazamox is improved by sequential applications with soil applied herbicides such as pendimethalin or postemergence tank mixtures with herbicides such as bentazon. Research data has shown that under normal growing conditions some 20 or more crops may be planted 9 months after the use of imazamox for weed control in dry beans. Soybeans, edible legumes, CLEARFIELD™ canola, and CLEARFIELD™ wheat may be planted at any time following application of imazamox to dry beans. [Paper Number 29]

EVALUATION OF WILD MUSTARD RESISTANCE TO ACETOLACTATE SYNTHASE INHIBITING HERBICIDES. Todd R. Wehking*, Kirk A. Howatt, and Michael J. Christoffers, Graduate Research Assistant, Assistant Professor, and Research Scientist, North Dakota State University, Fargo, ND 58105.

Abstract. Wild mustard (Brassica kaber L.) is a problematic weed in many crops grown in North Dakota. Interference from wild mustard can lead to reduced yields and harvest problems for farmers. Wild mustard that survived previously lethal acetolactate synthase (ALS) -inhibiting herbicide treatments has recently been observed in North Dakota. Greenhouse and DNA analysis experiments were established to confirm and evaluate the level of resistance to ALS-inhibiting herbicides in wild mustard. A resistant wild mustard biotype was analyzed in the laboratory to determine if a resistance mutation was present. The resistant wild mustard contained a point mutation inferring leucine in place of tryptophan in the ALS enzyme sequence. This point mutation is known to confer ALS resistance in kochia, waterhemp, and common cocklebur. In greenhouse experiments, thifensulfuron, ethametsulfuron, triflusulfuron, imazamethabenz, imazamox, imazethapyr, flumetsulam, cloransulam, and flucarbazone at labeled rates were applied to 2-to-4 leaf wild mustard known to be susceptible to ALS-inhibiting herbicides and to the resistant wild mustard. All herbicide treatments controlled the wild mustard plants known to be susceptible to ALS-inhibiting herbicides. Dry weights of susceptible wild mustard plants were negligible four weeks after herbicide application. Herbicide treatments applied to resistant wild mustard failed to offer satisfactory control. Triflusulfuron injured the resistant wild mustard the most as indicated by significantly decreased dry weight of the ALS-resistant wild mustard plants. Greenhouse and DNA analysis experiments have therefore confirmed the field observed resistance of wild mustard to ALS-inhibiting herbicides in North Dakota including identification of the mutation likely responsible for the trait. [Paper Number 30]

MONITORING AND ASSESSING THE STABILITY OF WEED POPULATION DYNAMICS IN CROP ROTATIONS BASED ON ROUNDUP READY TECHNOLOGY. Jason Miller*, Philip Westra, and Scott Nissen, Graduate Research Assistant, Professor, and Associate Professor, Biological Sciences and Pest Management, Colorado State University, Ft. Collins, CO 80523-1177

Abstract. In 1998 an irrigated and a dryland site were established to determine if repeated use of glyphosate would cause a shift in weed species or the development of Roundup tolerant weeds. There are four weed management treatments that are fixed in location for the duration of the study. These treatments are a low rate of glyphosate, a high rate of glyphosate, glyphosate every other year rotated with another mode of action, and strictly non-glyphosate herbicides. Crops planted in 1998 were corn and soybeans; 1999 crops were corn, soybeans, and sugarbeets; 2000 crops were corn and soybeans. Systems built on sequential, post-emergence treatments resulted in the best weed control and highest crop yields. Use of soil residual herbicides generally resulted in late season weed flushes. Higher crop yields generally correlated with better weed control. Weeds that may increase under multiple year glyphosate applications include velvetleaf, toothed spurge, wild buckwheat, hairy nightshade, and lambsquarter. Soil samples taken annually will be used to correlate seedling populations with the soil cores from which weed seeds are extracted. [Paper Number 31]

BAY MKH 6561 DOSE RESPONSE, APPLICATION TIMING, AND MOISTURE STRESS EFFECTS ON WEEDS AND WINTER WHEAT. Lynn Fandrich*, Sandra K. McDonald, Scott J. Nissen, and Philip Westra. Graduate Research Assistant, Extension Specialist, Associate Professor, and Professor. Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523.

Abstract. The degree of differential sensitivity between jointed goatgrass and downy brome response to BAY MKH 6561 was quantified under greenhouse conditions. Experiments evaluated the effects of BAY MKH 6561 application timing and rate on jointed goatgrass, downy brome and winter wheat. Pre and postemergence applications from 11 to 180 g ai ha^{-1} with 0.25% non-ionic surfactant (NIS) (v/v) were made to weeds and winter wheat. Additionally, the effect of moisture stress was evaluated on jointed goatgrass postemergence applications. Shoots were excised 21 DAT, plant dry weights recorded, and GR_{50} values (rates that provided a 50% reduction in biomass) estimated using log-logistic analysis. Increasing BAY MKH 6561 rates improved weed response. Preemergence rates prevented downy brome emergence and reduced jointed goatgrass and winter wheat growth. Jointed goatgrass and winter wheat GR_{50} values were 7 and 31 g ai ha^{-1}, respectively. Postemergence applications reduced the growth of downy brome, jointed goatgrass and winter wheat by 50% at 8, 18, and 126 g ai ha^{-1}. The effect of high moisture stress on jointed goatgrass response to BAY MKH 6561 postemergence was significantly different from medium or no stress ($P = 0.05$). Jointed goatgrass GR_{50} values were 11, 23, and 18 g ai ha^{-1} at approximately 40, 60 and 100% field capacity, respectively. Preemergence applications were more efficacious than postemergence, and may provide a strategy for improving jointed goatgrass efficacy. [Paper Number 32]

SHOWY MILKWEED INTERFERENCE IN MALT BARLEY AND SUGARBEET. James A. Mickelson* and Michael G. Particka, Assistant Professor and Research Associate, Montana State University, Southern Agricultural Research Center, Huntley, MT 59037.

Abstract. Showy milkweed populations continue to increase in irrigated malt barley and sugarbeet fields of Montana. Managing milkweed in crop (barley or sugar beet) with selective herbicides is largely ineffective and management between crops (post-barley harvest) with herbicides is limited due to herbicide rotational restrictions associated with sugar beet. Therefore research is needed to determine if costly control strategies are justified and if research is needed to develop alternative management strategies. Field experiments were conducted in 2000 near Huntley, MT to quantify the effects of milkweed interference on barley and sugar beet yield and quality, and to determine if seed production and/or vegetative reproduction significantly contribute to the survival and proliferation of milkweed populations. At the barley site, there was a linear relationship between milkweed shoot biomass and

barley yield loss. As milkweed biomass increased, barley yield loss also increased up to a maximum of 47% yield loss at the highest milkweed biomass. Barley grain moisture, test weight, plumpness, and protein content were not affected by milkweed interference. At the sugar beet site, yield loss due milkweed competition was substantial, however, a clear relationship between milkweed biomass and beet yield loss was not well defined. Maximum sugar beet yield loss was 58 % at the highest milkweed biomass. Sugar beet percent sugar content was not affected by milkweed interference. No milkweed seeds were found in soil samples collected from within milkweed patches at each site. Also, no milkweed shoots originating from seed were found in either field. All shoots likely originated from rootstock buds. Depth of emergence of rootstocks varied form 4 to 20 inches deep in the soil. Data indicate that milkweed population increases within a field are likely due to vegetative reproduction, however, seeds may be partly responsible for establishment of new populations at uninfested sites. Results suggest that within milkweed patches, milkweed is very competitive and can greatly reduce yields in irrigated crop production. [Paper Number 33]

ROTATIONAL CROP RESPONSE TO MON 37500. Jason P. Kelley* and Thomas F. Peeper, Senior Agriculturist and Professor, Department of Plant and Soil Sciences, Oklahoma State University, Stillwater, OK 74078.

Abstract. Currently the MON 37500 label specifies that only wheat may be replanted for one year after treatment. After one year, a bioassay test should be performed to evaluate whether rotational crops will be injured. The objective of this research was to determine whether sensitive rotational crops would be injured if planted approximately 18 and 30 months after a MON 37500 application. Two field experiments were initiated in the fall of 1997 near Perkins and Enid, in North-central Oklahoma. MON 37500 was applied at 1, 2, and 4x rates of the labeled rate on November 18 or December 17, 1997. Experimental design was a randomized complete block with four replicates and 15 by 25-ft plots. Wheat growth stage at Perkins was four to six tillers and two to four leaves at Enid. MON 37500 at Perkins did not affect wheat yields. At Enid wheat yields declined as MON 37500 rates increased. This was attributed to small wheat growth stage and cold wet weather at application. After wheat harvest, plots were kept weed free by applying Roundup as needed during the summer of 1998. In May 1999, corn, grain sorghum, soybeans, and sunflowers were planted no-till. No injury was seen for any crop at Enid (Soil pH = 5.0, silt loam, OM%= 1.2), while grain sorghum and sunflower were injured by 2 and 4x rates of MON 37500 at Perkins (Soil pH = 6.4, sandy loam, OM%=0.7). No injury was seen for corn or soybeans at Perkins in 1999. Grain sorghum and sunflowers were planted no-till in May 2000 at both Perkins and Enid. In 2000, no crop injury was seen at either site. Rotational crop injury appeared to be influenced by soil properties. Since four times the labeled rate caused no injury at Enid, and the labeled rate caused no injury at Perkins, there is little likelihood that the labeled rate would cause injury to rotational crops seeded 18 months after treatment on a majority of soils in Oklahoma. [Paper Number 34]

CONTRASTING JOINTED GOATGRASS EMERGENCE PATTERNS UNDER UNIFORM FALLOW-TILLAGE ACROSS THE WESTERN UNITED STATES. John O. Evans, Daniel A. Ball, and Gail A.Wicks, Professor, Department of Plants, Soils, and Biometeorology, Utah State University, Logan, UT 84322, Associate Professor, Columbia Basin Agriculture Research Center, Oregon State University, Pendleton, OR 97801, and Professor, University of Nebraska, North Platte, NE 69101.

Abstract. These studies originated in response to a hypothesis that jointed goatgrass seedling emergence in a winter wheat-fallow-winter wheat rotation is significantly influenced by tillage timing performed at selected intervals near the start of the fallow season. Five tillage-timing treatments during fallow were selected to include two autumn tillage dates, two spring tillage dates, one treatment tilled at each of the four dates, and a no-till control. Similar experiments were conducted in three principal jointed goatgrass regions; Great Plains, Intermountain, and Pacific Northwest. Seedling jointed goatgrass emergence in the ensuing wheat crop was greatest with early autumn fallow tillage in Nebraska, but not in Utah nor Oregon. The number of jointed goatgrass seedlings in wheat in Utah was highest following no-till fallow and lowest when fallow tillage occurred at each of the four tillage dates. Uniform jointed goatgrass populations occurred in Oregon without correlation to fallow tillage date, tillage intensity, or no-

till. To date, jointed goatgrass has demonstrated a potential to respond differentially to tillage regimes across the western United States. [Paper Number 35]

SIMULATED HERBICIDE DRIFT IN SUGARBEETS. Charles A. Rice*, Stephen D. Miller. University of Wyoming, Laramie, WY.

Abstract. Greenhouse studies were conducted to evaluate sugarbeet response to sulfonylurea herbicide spray drift. The herbicides tribenuron and thifensulfuron/tribenuron were applied to sugarbeets at both the 2 to 4 and 4 to 6 leaf stages. Simulated spray drift rates of 0.01%, 0.05%, 0.1%, 0.15%, 0.25%, 0.5%, 0.75%, and 1.0% of the labeled rates were used. Biomass reduction, plant height, and visible herbicide injury were measured and compared to the controls. Plant injury symptoms occurred with both herbicides at all simulated drift rates over a five-week observation period following herbicide application. Biomass production was significantly less with thifensulfuron/tribenuron at drift rates greater than 0.05% and for tribenuron at drift rates greater than 0.1% when compared to the control. Biomass reductions with the drift rates were significant at both sugarbeet growth stages. [Paper Number 36]

COMPARISON OF WEED POPULATION DYNAMICS IN TWO DIFFERENT WEED CONTROL SYSTEMS: GLYPHOSATE VS PARAQUAT-GLYPHOSATE. Federico Trucco*, Philip Westra and Tim D'Amato, Graduate Student, Professor and Assistant, Bioagricultural Sciences and Pest Management Dept. Colorado State University, Fort Collins, CO 80523.

Abstract. The development of transgenic crops resistant to glyphosate and the many advantages of such a development have resulted in a significant change in weed control practices, namely, exclusive and continuous use of glyphosate. The sole use of one herbicide mode of action over time has previously been found to increase the speed at which a weed ecosystem changes toward populations that exhibit greater tolerance or increased resistance to that chemistry. The purpose of this study is twofold. In the first place, it is to evaluate whether a weed population shift occurs as a result of continuous glyphosate use, and in the second place, it is to evaluate whether adding a different mode of action in the weed management strategy decreases the speed at which weed shift occurs. A glyphosate resistant corn crop was subjected to two different weed control strategies. One treatment consisted of glyphosate applications both pre and post emergence, and the other treatment consisted of a paraquat application pre emergence and subsequent applications of glyphosate post emergence. Soil samples were collected prior to the establishment of the crop. These samples were elutriated to obtain weed seed counts. Weed counts in terms of number and species where obtained before and after each herbicide application. This information was used to evaluate changes in weed populations for each treatment. No significant difference was observed between the shift in weed population determined for one treatment and the shift determined for the other. Overall, no evidence of weed shift was found. This study is part of a long-term study evaluating weed shift dynamics in the two systems previously mentioned. [Paper Number 37]

CONTROL OF FIVE KOCHIA ACCESSIONS AT THREE GROWTH STAGES WITH FLUROXYPYR AND DICAMBA. David S. Belles*, Philip Westra, Scott J. Nissen, and Vanelle Carrithers, Graduate Research Assistant, Professor, Associate Professor, and Senior Research Biologist, Department of Bioagricultural Sciences and Pest Management. Colorado State University, Fort Collins, CO 80523 and Dow AgroSciences 28884 South Marshall Road, Mulino, OR 97042.

Abstract. A field study was conducted in Larimer County, Colorado to compare the efficacy of fluroxypyr and dicamba on kochia accessions exhibiting a high, medium, or susceptible response to dicamba. Fluroxypyr and dicamba were applied at 20, 39, 79, 157, 314, and 471 g/ha to six accessions of dicamba tolerant and susceptible kochia at three plant heights (15, 42, and 69 cm). An untreated control also was included. Kochia control was

evaluated 9 and 21 days after treatment. Kochia biomass and plant height were also measured. Control decreased as kochia size increased. Fluoxypyr sprayed on 42 cm kochia controlled some accessions 70 to 82% but only at rates greater than 314 g/ha. Both herbicides controlled large kochia less than 25%. The response of each accession when sprayed with each herbicide was regressed. Small kochia control was similar between all kochia lines. Fluroxypyr controlled kochia 78 to 95% at rates of 314 and 471 g/ha. Dicamba control varied more within each line and r2 values were lower when data was regressed. Henry was different than Sato when regression lines were contrasted. The biomass response of small kochia was also regressed. Biomass was less than 50 g at 314 g/ha when treated with fluroxypyr but only one accession was less than 50 g when treated with dicamba. Contrasts of lines showed differences in biomass between accessions 7710 and 9426 and Sato and Henry when treated with both herbicides. [Paper Number 38]

WEED POPULATION SHIFTS AND SEED SURVIVAL UNDER SEVERAL WHEAT ROTATIONAL SYSTEMS. D.W. Wilson, S.D. Miller and W.L. Stump, Dept. of Plant Sciences, University of Wyoming, Laramie, WY.

Abstract. The knowledge of the survival of weed seeds in soil coupled to various rotation schedules can exert pressures, which have major impacts, on weed seed population densities. Relating weed seed burial studies to applied rotations yields a clear picture of proper crop rotation implementation in wheat cropping systems. Ideal rotation combinations decrease weed seed bank populations as well as the number of fallow seasons. Additional benefits, of the rotational systems, include reduced soil manipulation, improved organic matter levels, increased crop production, improved nutrient cycling and higher water use efficiency. Based on seed survival information, four crop rotation systems were studied for their effects on weed seed population densities. Common wheat system monocot weeds studied include: jointed goatgrass, feral rye, wild oat, downy brome, and green foxtail. Common wheat system dicot weeds studied include: field bindweed, cutleaf nightshade, Canada thistle and kochia. Crops studied for rotation in spring and winter wheat fallow systems included proso millet and oilseed sunflower. Wheat fallow system crop rotation combinations included: Wheat/Fallow/Wheat, Wheat/Millet, Wheat/Sunflower/Fallow and Wheat/Sunflower/Millet/Fallow. The various rotations or successional order yielded dramatically different results on the weed populations studied. [Paper Number 39]

MICRO-RATE POSTEMERGENCE HERBICIDE APPLICATIONS FOR WEED CONTROL IN SUGAR BEET. Matthew J. West[1]*, Don W. Morishita[1], Corey V. Ransom[2], and Michael J. Wille[1], Graduate Student, Associate Professor, Assistant Professor, and Support Scientist, [1]Department of Plant Soil and Entomological Sciences, University of Idaho, Twin Falls, ID 83303-1827 and [2]Department of Crop and Soil Science, Oregon State University, Ontario, OR 97914-3344.

Abstract. In Minnesota and North Dakota, sugar beet herbicides applied with methylated seed oil (MSO) at rates lower than labeled rates effectively controlled weeds. Studies were established in Southern Idaho and Eastern Oregon to determine the effectiveness of various micro herbicide rates compared to a standard treatment, and compared MSO to other adjuvant efficacy with micro herbicide rates. The standard treatment contained ethofumesate, desmedipham, and phenmedipham + triflusulfuron + clopyralid ± quizalofop. Micro-rate and standard treatments were applied at the sugar beet cotyledon stage, followed by sequential applications at 5 to 7 day intervals. Sugar beet injury ranged from 0 to 40% 8 days after last treatment (DALT), but was minimal 33 to 36 DALT. All micro-rate treatments controlled hairy nightshade, redroot pigweed, and common lambsquarters 83 to 99% 33 to 36 DALT; which was equal to the standard treatment. Kochia control was variable with micro-rate treatments ranging from 40 to 90%, while control with the standard treatment was 94%. Kochia control was improved with the addition of ethofumesate or increasing the ethofumesate, desmedipham, and phenmedipham micro-rate at the third and fourth applications compared to using the same rate. Barnyardgrass control was equal among most micro-rate treatments compared to the standard treatment with control ranging from 77 to 92%. Adjuvants added to micro-rates of the standard treatment controlled all weed species equally. Sugar beet yield in all herbicide treated plots was 7 to 10 times greater than in the untreated plots, but usually did not differ among treatments. [Paper Number 40]

PEANUT INJURY BY DICLOSULAM IN WEST TEXAS. Peter A. Dotray*, Jarred R. Karnei, J. Wayne Keeling, Todd A. Baughman, Robert L. Lemon, and W. James Grichar, Associate Professor and Graduate Research Assistant, Department of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409-2122, Professor, Texas Agricultural Experiment Station, Lubbock, TX 79401-9757, Assistant Professor and Extension Agronomist, Texas Agricultural Extension Service, Box 2159, Vernon, TX 76384-2159, Associate Professor and Extension Agronomist, Texas Agricultural Extension Service, College Station, TX 77843, and Research Scientist, Texas Agricultural Experiment Station, Yoakum, TX 77995.

Abstract. Diclosulam (Strongarm), a new ALS-inhibiting triazolopyrimidine herbicide that was registered for use in peanut (*Arachis hypogaea*) in 2000, has broad spectrum weed control and good crop tolerance. Diclosulam has been reported to have excellent activity on Florida beggarweed (*Desmodium tortuosum*), eclipta (*Eclipta prostata*), tropic croton (*Croton glandulosus*), golden crownbeard (*Verbesina encelioides*), bristly starbur (*Acanthospermum hispidum*), common ragweed (*Ambrosia artemisiifolia*), and pigweed species (*Amaranthus* sp.), but is weak on sicklepod (*Cassia obtusifolia*). An important attribute of diclosulam is crop rotation flexibility with cotton (*Gossypium hirsutum*). Field experiments conducted in Texas from 1997 to 2000 evaluated diclosulam activity on numerous weed species in peanut. Diclosulam at 0.024 lb ai/A applied preemergence (PRE) controlled Palmer amaranth (*Amaranthus palmeri*), devil's-claw (*Proboscidea louisianica*), golden crownbeard, eclipta, and pitted morningglory (*Ipomoea lacunosa*) at least 80%. Visual peanut injury was first observed following excessive rates of diclosulam (0.046 lb/A). Injury was observed in West Texas in 1999 following diclosulam at 0.024 lb/A, but injury was not observed at the end of the season and was not reflected in yield. In the 2000 growing season, peanut injury was observed in many areas. Therefore a series of greenhouse experiments were established to better understand peanut injury. In six replication tests, diclosulam at rates from 0 to 0.048 lb ai/A were applied PRE to three peanut varieties (AT-201, Flavorunner 458, Georgia Green) grown in three peanut soils. Plants were observed for four weeks after application for emergence and visual injury. Fresh shoot and root weights will be recorded at the conclusion of this experiment. Diclosulam will be a valuable tool to Texas peanut producers, but questions regarding crop injury must be addressed. [Paper Number 41]

ASSESSING AQUATIC ECOLOGICAL EXPOSURE TO SECTION 18 PESTICIDES USING GENEEC.
Ronald D. Parker and Steve L. Foss(*), Environmental Engineer and Pesticide Information/Biopesticide Specialist, Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington DC and Washington State Department of Agriculture, Olympia, WA 98504.

Abstract. The Washington State Department of Agriculture (WSDA) has the authority to request an exemption from registration (Section 18) from the Office of Pesticide Programs (OPP) of the Environmental Protection Agency (EPA) that would allow limited use of an unregistered pesticide in an emergency situation, such as an outbreak of a new weed pest. In 2000, WSDA used EPA's GENeric Estimated Environmental Concentration (GENEEC) model to show that there was a low possibility of risk to aquatic organisms from four Section 18 herbicides classified as moderately toxic under EPA's hazard classification system. The calculated Risk Quotients (RQ) for use of pyridate and pendimethalin on mint, oxyflurofen on strawberries, and dimethenamid on sugarbeets were below 0.05 or the level of concern for endangered and non-endangered species. Based on this information, it was determined that additional label statements were not needed to mitigate for potential environmental risk to aquatic organisms from the use of these herbicides. The Environmental Fate and Effects Division (EFED) of the EPA/OPP is responsible for assessing the potential risk from pesticides to the environment. EFED assesses the exposure and the hazard posed by herbicides to non-target species and has designed GENEEC to mimic the more sophisticated PRZM (Pesticide Root Zone)/EXAMS (EXposure Analysis Modeling System) risk assessment models. The GENEEC model uses the same EFED "standard" agricultural field/farm pond scenario as used with PRZM/EXAMS simulations, but requires far fewer inputs (i.e. herbicide's basic use and application information, soil/water partition data, and degradation rate values) and much less time and effort to use. WSDA's initial evaluation of the Section 18 request is based on the toxicity (LC_{50}) of the pesticide. EPA and WSDA use GENEEC to calculate the estimated environmental concentrations (EEC) and predict the likelihood of no adverse effects on aquatic organisms from a particular pesticide under normal conditions of use. The calculated EEC is used to calculate a Risk Quotient (RQ),

which indicates whether adverse effects on non-target organisms are expected. If the risk quotient predicts no adverse effects from the Section 18 application, then WSDA does not impose additional label restrictions. When an applicant/registrant does not provide additional information (ie GENEEC assessment) to demonstrate that endangered species will be adequately protected, then WSDA imposes the default environmental hazard statements based on the toxicity of the pesticide to mitigate possible adverse effects. The default restrictions are available on the WSDA's web page in the Guide for Requesting Section 18 Emergency Exemption from Registration at http://www.wa.gov/agr/pmd/docs/rcw/sec18gui.pdf.

Table. Summary of herbicide's basic application information, aquatic toxicity, and Risk Quotients (RQ) values.

Herbicide	Pyridate	Pendimethalin	Dimethenamid	Oxyfluorfen
EPA Reg. No.:	100-880	241-337	7969-147	707-243
Crop	Mint	Mint	Sugarbeet	Strawberry
Maximum Application Use Rate (lbs. ai /acre):	0.9375	2.0	1.5	0.5
Maximum Number of Applications	2	1	2	1
Freshwater Fish				
LC_{50}[1](ppm)	> 1.2 [1]	0.52 [1]	2.6[1]	0.21 [2]
Risk Quotient (RQ)	0.0389	0.013	0.0213	0.0045
Freshwater Invertebrates[3]				
LC50 (ppm)- 48 hr	1.08	5.1	16	1.5
Risk Quotient (RQ)	0.043	0.001	0.0035	0.0008

[1] Rainbow trout
[2] Bluegill
[3] *Daphnia magna* . [Paper Number 42]

THE USE OF METABOLIC MARKERS AS AN INDICATOR OF SUSCEPTIBLE PLANT EXPOSURE TO CERTAIN HERBICIDES. William T Cobb[1], Kim A. Andersen[2] and Bob R. Loper[2], [1]Cobb Consulting Services, 815 South Kellogg, Kennewick, WA, [2]Environmental & Molecular Toxicology Department, Oregon State University, Corvallis, OR 97331

Abstract. The biochemical mode of action of the herbicide glyphosate blocks aromatic amino acid synthesis in susceptible plants by inhibiting the enzyme 5-enolpyruvlyshikimate -3-phosphate synthase (Steinrucken, et al 1980). This inhibition results in the accumulation of shikimic acid in susceptible plants exposed to glyphosate. The accumulation of shikimic acid is proportional to the rate of glyphosate applied (Andersen et al 2000) and shikimic acid is retained in susceptible plant tissue even after plant death (Singh and Shaner, 1998). Field experiments were conducted in 1999 and 2000 on Express spring wheat and Russet Burbank potatoes using sub-lethal rates of glyphosate; tissue samples were collected periodically during the course of the experiments and were analyzed for the presence of both glyphosate and its major metabolite in plant tissue, amino methylphosphonic acid as well as for shikimic acid. The data from these field experiments were supplemented with data collected from commercial glyphosate applications on winter wheat and alfalfa and glyphosate drift onto sweet cherries. Shikimic acid accumulated rapidly in susceptible plants exposed to glyphosate; in many cases it began to accumulate in less than 2 hours after exposure. Significant amounts of shikimic acid may accumulate before any visible plant symptoms are noticeable. The shikimic acid was analyzed in plant tissue by using a water extraction method followed by high-performance liquid chromatography, requiring no post-column derivatization; the detection limit is estimated at about 0.1 MU g/g. The shikimic acid method is more rapid and cost effective than analyzing for glyphosate directly and significantly reduces the potential for sample cross contamination. The use of other metabolic markers as indicators of susceptible plant exposure to other groups of herbicides has been investigated. [Paper Number 43]

THE DEVELOPMENT OF A WEB-BASED INFORMATION SOURCE ON WEED BIOLOGY AND MANAGEMENT. Alvin J. Bussan and Meghan A. Trainor*, Assistant Professor and Weed Extension Associate, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717.

Abstract. Delivery of research-based weed science information in a timely manner can be challenging, especially in a large and geographically diverse state such as Montana. Extension Specialists from land-grant universities may only be able to visit various areas within the state once or twice per year. Often, producers cannot attend field schools due to time constraints or location. The Internet offers a means of disseminating weed science information to county agents, producers, and other citizens across the state. The Weed Science web site at Montana State University (MSU) serves as a timely information source of weed biology and management. Visitors to the site can also access reports on current research at MSU within various weed science projects and other weed science-related topics. The site is organized into the following categories including crop weeds, cropping systems, weed physiology, range weeds, and weed ecology. This format has proven to be the most efficient and navigable for weed science website users. As the site continues to expand, goals include the development of descriptions of weed biology and ecology by species, management recommendations by crop, discussions on various weed management issues, and a herbicide recommendation section. Hyperlinks to the online versions of herbicide labels will be included for access to further detailed information. Furthermore, reprints of MSU-authored abstracts and papers are and will continue to be made available for download from the website. For instance, the practices and principles of crop rotation is just one of the many topics covered. The web site integrates several aspects of weed science in such a manner that it simulates having several specialists in the same room. The website user is able to access research-based knowledge from a cropping systems specialist and a crop weeds specialist all in the same place. The URL of the web site is http://weedeco.msu.montana.edu/weedgroup/home.htm . [Paper Number 44]

PREDICTING SUSCEPTIBILITY OF INVASIVE SPECIES USING GIS. John Gillham* and Tom Whitson, Graduate Student, Department of Renewable Resources, and Professor, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071

Abstract. Managing weed invasions has been a problem since the beginning of rangeland management. One of the biggest problems facing resource managers has been simply keeping track of where weed problems exist. Effectively focusing on the most vital areas can allow managers better control of weed infestations. Geographic Information Systems (GIS) can offer a credible solution to this problem. This project was initially performed in the Jack Morrow Hills Wilderness study area near Rock Springs, Wyoming. The project has developed a GIS based model to predict occurrence of five weed species within semiarid rangelands. The five species included in this ArcView extension were black henbane, hoary cress, leafy spurge, perennial pepperweed, and spotted knapweed. The predictive model associates risk of invasion by an individual weed species to its relative geographical location on the ground. These risks are based upon rankings of invasion susceptibility factors for each weed species. A database of these rankings was created in order to allow for easy expansion of additional species in the future. A "spread of known invasions" tool, also included in the model, uses already mapped invasions to predict spread throughout the future based on environmental and biological factors. As well, a report generator option is included within the extension to allow users to quickly develop statistical and control option reports for their invasions. This predictive model allows land managers to more easily and accurately predict invasions and to remotely assess resources of concern in order to better fight the war against noxious weeds. [Paper Number 45]

PHOTOSYNTHETIC INHIBITION AND AMMONIUM ACCUMULATION IN PALMER AMARANTH AFTER GLUFOSINATE APPLICATION. Elmé Coetzer and Kassim Al-Khatib, Graduate Student and Professor, Department of Agronomy, Kansas State University, Manhattan, KS 66506

INTRODUCTION

The glutamine synthetase/glutamine 2-oxo-glutarate aminotransferase (GS/GOGAT) pathway is the main route for the incorporation of ammonia into organic compounds in plants. Therefore, plants are very susceptible to potent GS inhibitors. Glufosinate is a nonselective postemergence herbicide that controls several grasses and broadleaf weeds including *Amaranthus* species (Ahrens 1994). Use of glufosinate was limited to vegetation management in noncrop areas, but advances in genetic transformation of plants have facilitated the development of glufosinate-resistant crops. Glufosinate is an analogue of L-glutamic acid and binds to the active site of GS as a reversible inhibitor in competition with glutamate. Phosphorylation of glufosinate by ATP produces an analogue that behaves as an irreversible inhibitor (Manderscheid and Wild 1986). This inhibition of GS in vivo by glufosinate causes a light dependent accumulation of ammonia (Lacuesta et al. 1990a) and inhibits the rate of photosynthesis in both C_3 and C_4 plants (Lacuesta et al. 1990b). Although inhibition of photosynthesis can be associated with an accumulation of ammonia (Larsen et al. 1981), indirect evidence indicates that inhibition of photosynthesis by glufosinate is not.

OBJECTIVE

This research was conducted to determine if the inhibition of photosynthesis coincide with the decrease in glutamine synthetase activity and the accumulation of ammonium after glufosinate application.

MATERIALS AND METHODS

Palmer amaranth plants were grown in the greenhouse. Greenhouse conditions were 23/20 C day/night temperatures and 16/8 h day/night periods.

Absorption and Translocation Study. Eight 1 μL droplets containing 740 Bq ^{14}C-glufosinate, 2.56 μL non-labeled glufosinate, and 0.5% by volume crop oil concentrate were applied uniformly across the adaxial leaf surface of the third leaf of plants at the six leaf stage. Plants were harvested 0.25, 0.5, 0.75, 1 1.5, 2, and 6 hours after treatment (HAT) and were separated into foliage above treated leaves, treated leaves, foliage below treated leaves and roots. The treated leaf was washed with 10 ml double distilled water for 30 s to remove unabsorbed herbicide.

Plant parts were air dried, oxidized and trapped $^{14}CO_2$ were quantified using liquid scintillation spectrometry. Absorption was computed by comparing the radioactivity recovered in the entire plant to the total amount applied. Herbicide translocation was computed as the amount of radioactivity recovered in a given plant part as a percent of the total radioactivity in the plant.

Glutamine synthetase inhibition and ammonium accumulation study. Glufosinate was applied at 410 g ha^{-1} to the plants at the seven- to nine-leaf stage. Untreated control plants were treated only with water. Foliage was harvested at 0.5, 1, 2, 6, and 24 HAT.

Glutamine synthetase was extracted from leaves as described by Elliott (1953). Leaves were homogenized in a medium of 0.03 M Tris(hydroxy-methyl)aminomethane, 0.003 M cysteine hydrochloride, and 10^{-4} M Na-EDTA (pH 7.2). The homogenate was centrifuged at 20,000 x *g* for 15 min at 2 C. One milliliter of supernatant was added to 3.4 mL medium containing 0.8 M Tris(hydroxymethyl)aminomethane, 0.5 M glutamate, 1 M $MgSO_4$, 1 M hydroxylamine, and 0.025 M adenosine 5-triphosphate (pH 7.2). The solutions were incubated for 20 min at 30 C. The reaction was stopped by the addition of 2 mL ferric chloride reagent (1:1:1: by volume mixture of 0.1M $FeCl_3$.6 H_2O in 0.2 N HCl: 0.24 M trichloroacetic acid: 50% (v/v) HCl). Samples were centrifuged at 1,500 x *g* for 5 min and absorbance was measured at 540 nm.

Ammonium (NH_4-N) content was determined as described by Franz et al. (1982). Leaves (0.6 to 1.3 g) were homogenized and ammonium was extracted with 5 mL of a 12:5:3 by volume mixture of methanol:chloroform:water and centrifuged at 20,000 x *g* for 15 min. Prior to centrifugation, 35 mL distilled water was added to the extract. The aqueous phase was used for rapid flow analysis to determine the ammonium concentration spectrophotometrically. Absorbance of the blue-green color, formed by the salicylic acid analog of indophenol blue, was measured at 660 nm.

Photosynthetic inhibition study. The plants were sprayed with water or 410 g ha^{-1} glufosinate. Photosynthetic rates and stomatal conductance were determined at 0.5, 1, 2, 6, and 24 HAT with a LI-6400 photosynthesis system on the fifth and sixth fully expanded leaves. Light-adapted chlorophyll fluorescence also was measured on the same leaves with a Hansatech Fluorescence Monitoring System. The fluorescence yield measurements were made at steady state of 2,000 μmol m^{-2} s^{-1} (Fs) and saturating state of 5,000 μmol m^{-2} s^{-1} for 0.7 sec when all of the Photosystem II (PSII) reaction centers were reduced. The temporary reduction of PSII photochemistry ensured that the maximal fluorescence yield in light (Fm') was achieved. The quantum efficiency of PSII (Φ_{PSII}) was calculated by dividing the difference of Fm' and Fs by Fm' (Genty et al. 1989).

Experimental design and data analysis. The absorption and translocation study was arranged in a completely randomized design. Treatments were replicated seven times, and the study was repeated twice.

The experimental design for the glutamine synthetase inhibition and ammonium accumulation study was a split plot with time as the main plots and herbicide treatments as the subplots. The treatments were replicated twice, and the study was repeated five times. Ammonium accumulation data were log transformed, and data are presented as such.

The photosynthetic inhibition study was arranged in a hierarchically blocked design with repeated measures. The study was blocked by experiment, day, and plant, with time as the treatment. Treatments were replicated five times, and the study was repeated five times.

All data were subjected to analysis of variance, and the least significant differences (LSDs) among means were tested at the P=0.05 level of probability. However, paired t-tests at P=0.05 were performed to determine differences between consecutive times in the photosynthetic inhibition study (Ramsey and Schafer 1997).

RESULTS AND DISCUSSION

Absorption and translocation study. Absorption of glufosinate was 17% at 0.25 HAT, increased to 42% at 0.5 HAT, and did not change until 6 HAT, when it increased to 64% (Figure 1).

Most of the absorbed glufosinate remained in the treated leaf throughout the experimental period (data not shown).

Glutamine synthetase inhibition and ammonium accumulation study. Glufosinate caused a rapid decrease in GS activity (Figure 2). At 0.5 HAT, GS activity was inhibited by 24%, and the inhibition continued to increase rapidly over time. At 6 HAT, inhibition of GS activity peaked at 77%. These results are similar to earlier reports showing that GS activity decreased rapidly in *M. sativa* (alfalfa; Lacuesta et al.1993) and *A. edulis* (grain amaranth; Lacuesta et al.1997) after PPT treatment.

Glufosinate was absorbed in adequate amounts at 0.5 HAT (Figure 1) to cause a decline in GS activity. Furthermore, inhibition of GS activity increased as glufosinate absorption increased. This inhibition of GS activity implied that less glutamine was formed and that glutamate and ammonium would accumulate in the plants.

The decline in GS activity after glufosinate treatment coincided with the accumulation of NH_4-N (Figure 2). However, the accumulation increased steadily and did not reach a plateau like inhibition of the GS activity. Accumulations were 10, 44 and 189% higher than those in the control plants at 0.5, 1, and 2 HAT, respectively. At 6 and 24 HAT, the ammonium contents of treated plants were 22 and 58 times higher, respectively, than those of untreated plants. An increase in ammonium levels above that in control plants was observed within 12 HAT in *Setaria viridis* (green foxtail; Mersey et al. 1990).

Photosynthetic inhibition study. Glufosinate slightly reduced photosynthetic rates at 0.5 and 1 HAT (Figure 3). However, at 2 HAT, glufosinate reduced the photosynthetic activity by 31%. Inhibition of the photosynthetic activity reached a plateau after 6 h when rates were decreased by 57% and remained at that level at 24 HAT. These results are in agreement with earlier research that showed a rapid decrease in photosynthetic rates during the first 6 h in *S. alba* (white mustard) leaves treated with PPT (Wild and Manderscheid 1984).

The photosynthetic inhibition coincided with the increase in glufosinate absorption, decrease in GS activity, and accumulation of ammonium. However, ammonium accumulation in Palmer amaranth was much greater and occurred at a faster rate than the inhibition in photosynthesis. The ammonium accumulation at 1 HAT exceeded those known to depress photosynthesis by uncoupling of photophosphorylation (Krogman et al. 1959).

The decrease in quantum yield (the ratio of light emitted to the amount of light absorbed) of electron transport of PSII (Φ_{PSII}) was similar to the decline in photosynthesis. No inhibition in Φ_{PSII} was measured within the first 2 HAT (Figure 3). At 6 HAT, Φ_{PSII} was inhibited by 64%, but no further reduction was measured.

The decrease in Φ_{PSII} indicates a decrease in the light emitted as fluorescence and that the PSII light-harvesting complex probably was maintained in an oxidized state because of high light levels that were absorbed (Murata and Satoh 1986).

Initial inhibition of stomatal conductance (C_s) was more rapid than inhibition of photosynthetic rates. At 2 HAT, stomatal conductance decreased by 41%. An additional increase in inhibition was observed at 24 HAT to the point where stomatal conductance was 19% of the control (Figure 3).

CONCLUSIONS

This study clearly showed that glufosinate application has an inhibiting effect on photosynthetic activity in *A. palmeri*. This inhibition coincided with the rapid decreases in GS activity and stomatal conductance and the increase in ammonium concentration.

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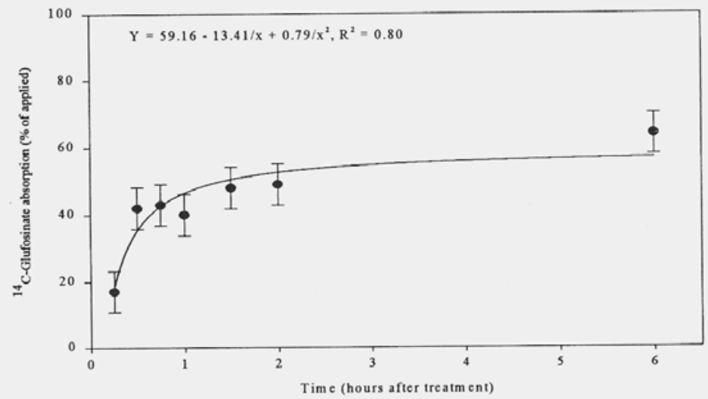

Figure 1. Absorption of ^{14}C-glufosinate in Palmer amaranth.

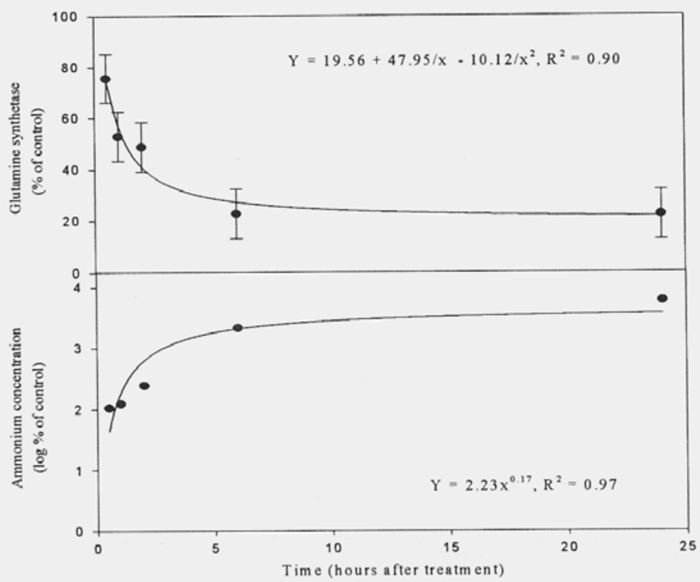

Figure 2. Glutamine synthetase activity and ammonium concentration in Palmer amarant as affected by glufosinate application.

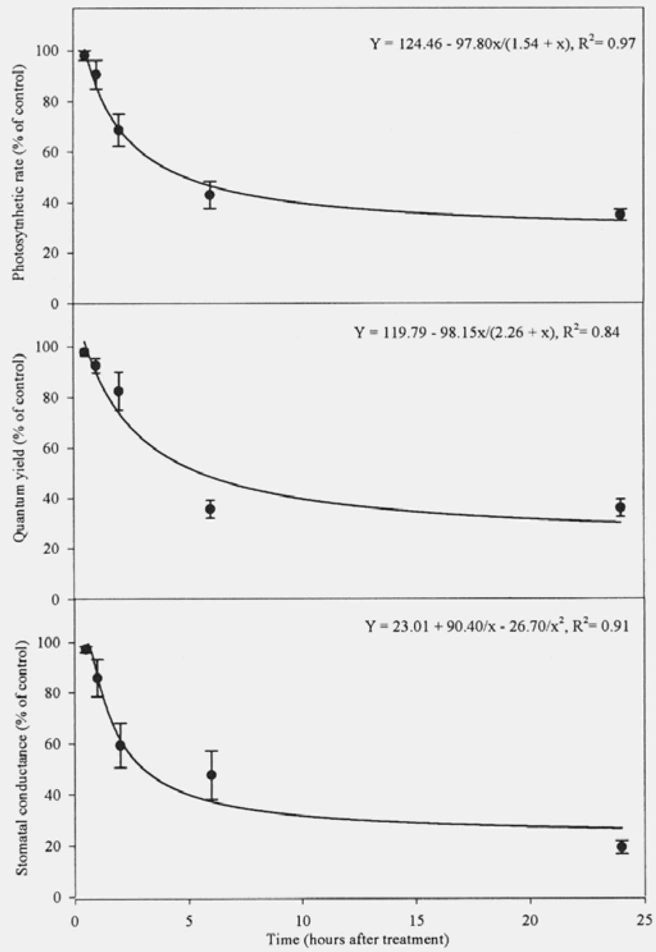

Figure 3. Photosynthetic rates, quantum yield of PSII, and stomatal conductance in Palmer amaranth as affected by glufosinate application.

INHERITANCE OF PICLORAM RESISTANCE IN YELLOW STARTHISTLE. Amber D. Vallotton[1*], Rob P. Sabba[2], Ian Ray[3] and Tracy M. Sterling[1], Research Assistant, Plant Physiologist, Associate Professor and Associate Professor, [1]Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces, NM 88003; [2]USDA-ARS, Northern Crop Science Lab, Fargo, ND 58105; [3]Department of Agronomy and Horticulture, New Mexico State University, Las Cruces, NM 88003.

Abstract. Yellow starthistle (*Centaurea solstitialis* L.) is spreading steadily on western rangelands, causing loss of grazing land carrying capacity as well as serious damage to non-grazed land and recreational areas. This noxious weed can be effectively controlled at the seedling stage by foliar application of 0.28 kg a.e. ha^{-1} picloram. Resistance to picloram in yellow starthistle was observed near Dayton, WA in 1988 and was confirmed in 1990. To determine the inheritance of this resistance, reciprocal F_1 crosses between susceptible and resistant plants were performed. Susceptible seeds of yellow starthistle (SCI-1) were collected from wildtype plants growing in Central Grade, ID. Resistant (RDW-1) seeds are second generation progeny of a plant (RDW) resistant to 0.56 kg a.e. ha^{-1} picloram from Dayton, WA. Progeny of this resistant plant was sprayed with 0.07 to 0.14 kg a.e. ha^{-1} picloram in the greenhouse and survivors were cross-pollinated to produce RDW-1 seed. Seed from reciprocal F_1 crosses was collected and grown under greenhouse conditions until seedlings were five weeks old. Half of the F_1 progeny from reciprocal crosses as well as RDW-1 and SCI-1 seedlings were sprayed with picloram at 0.28 kg a.e. ha^{-1} and half with clopyralid at the same rate. All SCI-1 seedlings and F_1 progeny died. Crosses to resistant and susceptible testers were then conducted among F_1 progeny, SCI-1 and RDW-1 plants. Selfing rates of individuals used in the crosses were less than 0.1% suggesting that all progeny were hybrids. F_2 progeny were screened with both herbicides and segregation ratios determined for the number of progeny surviving and dying. Chi square analyses of F_1, F_2, and testcross segregation data indicate that the resistant phenotype is recessive and conferred by a single gene with the original SCI-1 population being homozygous dominant for susceptibility. Picloram resistance as a recessive trait is consistent with the observations that while under no additional picloram selection pressure, resistance has not spread from where it was first identified and that no other picloram-resistant yellow starthistle populations have been identified. [Paper Number 47]

DIFFERENTIAL RESPONSE OF COMMON WATERHEMP BIOTYPES TO ACIFLUORFEN AND LACTOFEN. Kassim Al-Khatib, Neal Hoss, and Dallas E. Peterson*. Associate Professor, Graduate Research Assistant,and Professor. Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Abstract. Field and greenhouse experiments were conducted to determine the differential response of two common waterhemp biotypes to acifluorfen and lactofen. Seeds of acifluorfen-susceptible common waterhemp were collected in the fall of 1999 from the Kansas State University-Research Farm near Manhattan, Kansas (where no diphenyl ether herbicides were applied in the last several years). Common waterhemp seeds of a suspected acifluorfen resistance biotype were collected in the fall of 2000 from a soybean field near Sabetha, Kansas. Common waterhemp was planted in 11.4-cm containers filled with 500 g of soil. The greenhouse temperature was 26/23 C (day/night) with a 16-h photoperiod. Plants were treated at the 5-leaf stage with 0, 0.0625X, 0.125X, 0.25X, 0.5X, 1X, 2X, 4X, and 8X of the use rate of acifluorfen and lactofen. Herbicide use rates were 210 and 420 g ai/ha for lactofen and acifluorfen, respectively. Herbicides were applied with a bench-type sprayer calibrated to deliver 187 L/ha at 138 kPa. Herbicides were applied with 0.5% (v/v) crop oil. Two weeks after herbicide application, visible plant injury ratings and plant height were determined and plants were harvested. Plants were dried at 72 C for 48 hr. A dose response curve was established by plotting use rate vs. plant injury, plant height and dry weight. The rate required to cause 50% visible injury, height reduction and dry weight reduction was determined. The experiments were a completely randomized block design. The study was repeated four times with 9, 15, 30, and 35 replications. In addition, field experiment was conducted in a commercial field of 'Macon' soybean near Sabetha, Kansas with a heavy infestation of common waterhemp that was not controlled with repeated acifluorfen application. Lactofen and acifluorfen were applied when common waterhemp plants were at 10 to 30 cm height. Herbicide rates were 105, 210, and 420 g/ha for lactofen and 140, 280, and 560 g/ha for acifluorfen. Spray mixture included 0.25% of NIS and COC for acifluorfen and lactofen, respectively. One week after herbicide application, visible common waterhemp injury was rated from 0 (no injury) to 100 (mortality).The experiment was conducted as a randomized complete block design. Treatments were replicated three times. Growth of both common waterhemp biotypes was reduced by acifluorfen and lactofen. However, the reduction was more severe in common waterhemp plants from the field with

no history of acifluorfen application. The acifluorfen and lactofen rate required to cause 50% visible injury (GR50) were 147 and 78 g/ha for the susceptible biotype and 1902 and 1241 g/ha for the biotype from the field with a history of acifluorfen application. Common waterhemp height and dry weight reduction by acifluorfen and lactofen showed similar trends to visible injury. Lactofen and acifluorfen cause minimal injury on common waterhemp under field conditions. However, lactofen injured common waterhemp plants more that aciflourfen. At the use rate, visible injury rates were 13 and 23% with acifluorfen and lactofen, respectively. This level of common waterhemp injury is significantly lower than what would normally be expected This study showed that common waterhemp biotype collected from the field with a history of acifluorfen use is more resistant to acifluorfen and lactofen than plants from a field with no history of acifluorfen application. The ratios of GR50 of resistant to susceptible biotype were 13 and 16 for acifluorfen and lactofen, respectively. [Paper Number 48]

ANTIOXIDANT RESPONSE IN PROMETRYN-TOLERANT AND -SUSCEPTIBLE COTTON VARIETIES. Ismael Hernández-Rios* and Tracy M. Sterling, Graduate Student and Associate Professor, Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces NM 88003.

Abstract. Although approved as a preplant-incorporated treatment for weed control in cotton, prometryn injures Delta Pine 5415 (DP) (*Gossypium hirsutum* L.) at the recommended rate ($X = 1.34$ kg ha^{-1}), while Pima S7 (PS7) (*Gossypium barbadense* L.) can tolerate up to 10-fold that rate. Being a photosynthetic inhibitor, prometryn increases the cellular production of reactive oxygen species (ROS) that may induce oxidative stress in the plant by the reallocation of electrons and light energy to readily available molecular oxygen, O_2. Consequences of non-quenched ROS are lipid peroxidation, protein denaturation, and nucleic acid mutations which can eventually kill susceptible plants, whose antioxidant protective mechanisms are overwhelmed by excessive ROS. Since other mechanisms have failed to explain prometryn tolerance in cotton PS7, such a tolerance could be related to more efficient antioxidant machinery in this variety, keeping ROS at nondeleterious levels. To verify this hypothesis, DP and PS7 were preplant-treated with prometryn at 0X to 4X and grown under growth chamber conditions. Since prometryn-induced visual symptoms are detectable at ca. two weeks after emergence (DAE), leaf discs were taken at 11 DAE to determine lipid peroxidation and activity levels of the antioxidant enzymes catalase, ascorbate peroxidase, and glutathione reductase. Prometryn injuries were detected in DP but not in PS7, as shown by lipid peroxidation, an indicator of oxidative stress. However, the activity levels of antioxidant enzymes was unchanged between varieties at increased levels of prometryn. Possibly other protective enzymes not analyzed here, as well as antioxidants such as ascorbate, glutathione, and α-tocopherol play a major role in protecting PS7 from prometryn-induced damages. [Paper Number 49]

REMOTE SENSING OF SPOTTED KNAPWEED WITH A HYPERSPECTRAL IMAGING SPECTROMETER. Lass, L.W.*, D. C. Thill and T. S. Prather. University of Idaho, Moscow, ID 83844-2339

Abstract. Failure to detect weeds with current survey methods has contributed to their establishment and spread. Remote sensing using new technology with improved spatial and spectral resolution has the potential to automate weed surveys. The Probe 1 hyperspectral sensor, from Earth Search Sciences Inc., Kalispell, MT imaged Farragut State Park in Idaho on July 19, 1998. The instrument is an imaging spectrometer in the reflected solar region of the electromagnetic spectrum (440 to 2543 nm). The objective of this project was to accurately identify the location of spotted knapweed with remote sensing images. A spectral angle mapper algorithm (SAM) was used to classify the images. SAM separates classes using the angle created by a vector between a known value and the axis and the vector of an unknown value and the axis. Increasing the angle includes more pixels with similar values but will increase the commissional classification error. Infestations with 70 to 100% spotted knapweed cover and larger than 0.1 ha classify properly regardless of the classification angle. When spotted knapweed cover was below 70%, classification angles become important. Low angles (2 and 8°) did not completely define the extent of the infestation and the highest tested angle (20°) classified areas as infested that were not infested. Accuracy assessment showed the overall image errors as-well-as omissional and commissional errors for spotted knapweed

were the lowest (3%) when SAM angles were set to 10 or 11°. Areas with 1 to 40% spotted knapweed cover were detected with an omissional error of 1% greatly improving early detection of new spotted knapweed infestations. [Paper Number 49.5]

GENERAL SESSION

PRESIDENTIAL ADDRESS--WEED SCIENCE FROM MY POINT OF VIEW. Don W. Morishita, Associate Professor of Weed Science and Extension Specialist, University of Idaho, Twin Falls, ID 83303

INTRODUCTION

Welcome to the 54th meeting of the Western Society of Weed Science. I'm going to take the opportunity to talk a little about opportunities. One of the keys to success is taking advantage of these opportunities as they arise. Opportunities present themselves in various ways. Some opportunities may be as obvious as a sprayer skip in grain field and some opportunities may only be as obvious as jointed goatgrass in a wheat field. However obvious they are, its important to keep your eyes open to them. As my colleague and early weed science mentor, Donn Thill told me several years ago, there are never problems; only opportunities to challenge us.

It was twenty-one years ago that I had my first opportunity to attend a WSWS meeting. I was a young and innocent graduate student of Dr. Gary Lee. It was held at the Hotel Utah in Salt Lake City, the city chosen for our 2002 meeting. I was given the opportunity to present the results of some work we had done with DPX-4189, which later became known as chlorsulfuron.

There are two things I remember most about presenting my first paper at a professional meeting. The first thing was that I was afraid my knees were going to knock so loud, everyone would think there was a woodpecker in the room and nobody would be able to hear what I was saying. My other memory from that meeting was listening to weed scientists from all over the western United States present their research and being amazed at all of the weed science research that was taking place. I was even more amazed and impressed when I sat in on the discussion sessions and listened to the great exchange of information regarding various weed control topics.

In 1980, Project 1 was called Perennial Herbaceous Weeds. This discussion session addressed the topic "What is industry doing to help us solve our perennial herbaceous weed problem?" Gus Foster of Velsicol Chemical was project chair. Project 2 was called Herbaceous Weeds of Range and Forest, and Project 3 was Undesirable Woody Plants. Project 5, Weeds in Agronomic Crops, discussed the fundamentals of weed competition in annual and perennial agronomic crops and the relationship of these to short-term and long-term research projects. In this year's program the Agronomic Crops discussion session will focus on economic thresholds. An interesting point about the topics discussed at those meetings in 1980 is the continued relevance of each of those topics today. It should not be construed as an indication of the lack of progress made in weed science, but rather a tribute to the complexities of our discipline and the fact that solutions are not quick to come by.

Attending my first WSWS meeting in Salt Lake City was an opportunity I'll never forget and it certainly contributed to convincing me that I wanted to become a Weed Scientist. The fact that there were also several great hospitality suites at this meeting didn't hurt.

I'd like to offer some advice to graduate students or other individuals who are attending this meeting for the first time. Take advantage of the opportunity to meet and network with others at this meeting. It has been said many times before that one of the strengths of the WSWS is the friendliness and openness that provides many opportunities to interact with those involved in weed science. At this point in your lives, you've come to realize the importance of contacts. Use this meeting as an opportunity to network with other weed scientists, whether they are from private industry or the public sector.

I can't begin to name all of the members of this Society from whom I have had the opportunity to interact and learn from. However, there are some colleagues I would like to mention because they have contributed much to my professional life. They include my University of Idaho colleagues Donn Thill, Charlotte Eberlein, and the late Gary Lee. They also include individuals such as Arnold Appleby, Larry Burrill, Bart Brinkman, Gil Cook, Dave Cudney, Alan Dexter, Steve Dewey, Jack Evans, Pete Fay, Gus Foster, Rod Lym, Steve Miller, Alex Ogg, Paul Ogg, John Orr, Bob Parker, Phil Stahlman, Chuck Stanger, Jeff Tichota, and Tom Whitson.

OPPORTUNITY AS PRESIDENT

Having the opportunity to serve as president of the Western Society of Weed Science has been an opportunity that's been educational and a very rewarding experience. I wish to express my gratitude to the WSWS members and past and present Board members for all of their help and guidance during my tenure as President-elect and President.

Bob Parker, our President-elect, and his Program Committee members, Richard Zollinger and Phil Stahlman, have done an excellent job of putting this meeting together. Richard and Phil are also Education and Regulatory Section and Research Section Chairs, respectively.

Other WSWS officers are Mark Ferrell (secretary), Bob Stougaard (member-at-large), Steve Miller (WSSA representative), Rod Lym (CAST representative), and Wanda Graves (business manager). I cannot thank Wanda enough for all the help and guidance she has given me throughout my involvement with the WSWS, but especially the past two years. She is indeed a true treasure to this Society.

Although the annual meeting is the major activity of our Society, many other activities are dealt with by the Society. For example, Phil Stahlman represented the WSWS at a USDA-ARS workshop in Washington, DC last summer in my place to provide input on research priorities of the ARS programs. Donn Thill, past WSSA representative, attended the summer meeting of the WSSA last summer in Greensboro, NC. Like other WSSA representatives from the WSWS, this requires a big commitment to serve in this capacity. I'm sure Steve Miller will serve our Society very well in that capacity.

IMPORTANT WEED ISSUES

There are many important issues facing those of us in Weed Science. Below, are just a few of those issues.

Invasive plant species. The Harmful Nonnative Weed Control Act of 2000 [S.198] introduced by Senators Larry Craig of Idaho and Tom Daschle of South Dakota offer some excellent opportunities for the prevention and management of invasive weed species. Idaho is currently working to add Eurasian water millfoil to its noxious weed list and Oregon just recently added English ivy to its noxious weed list because of the invasive nature of this species in urban areas of Oregon.

Biotechnology. Herbicide tolerant crops represent just one group of examples of genetically modified or enhanced organisms that have been developed. Currently, herbicide tolerant potatoes and sugar beets are ready for commercial use, but have not been accepted by the public. This is an interesting situation and various groups and individuals have taken opportunities to either promote or condemn this technology.

Chemical company mergers/buyouts. Depending on your perspective, the mergers and buyouts provide opportunities of different sorts. For some, it's an opportunity to expand their market portfolio and for others it's an opportunity to seek gainful employment elsewhere. Hopefully, the agrichemical industry will be around for years to come. Herbicides have played and continue to play an important role in weed management. However, when you look at the chemical company genealogy that Arnold Appleby has tracked for us it is eerily looking more and more like the NCAA basketball championship tournament pairings bracket.

Pesticide safety issues (FQPA). This continues to provide opportunities for many involved with pesticide development, registration, re-registration, and regulation.

Public awareness and education. I think some great accomplishments have been made when you consider the interest in noxious weeds by our political leaders. Of course, we still have many more accomplishments that need to be made in educating the public too.

Funding of weed science research and outreach. This is an issue where we as weed scientists need to be more vocal. We need to inform the decision-makers that more research and outreach funds need to be made available for the Weed Science discipline.

Weed management in our current agricultural economy. This final issue is of extreme importance to those of us who work in agricultural weed management. As growers look for more economical means of managing weeds, we must take to opportunity to provide the best information to them. At the same time, we must be cognizant of the long-term effects of reduced input weed management.

STATE OF OUR WEED SCIENCE SOCIETY

I will finish by giving you, our members, an update on the state of our Society. At our general business meeting next Thursday morning, you'll hear some of this information presented by various committee chairs, but I'd like to present this to you anyway.

Financially, our organization is very healthy. This can be attributed to several things. Some of the most important reasons include Wanda Graves' astute and careful management of our Society, sound investments initiated by Pete Fay and more recently guided by Nelroy Jackson and the Finance Committee, and the very generous support of our organization by the Chemical industry.

Another contributor to the financial health of our Society is our book, Weeds of the West. This book was first published in 1991 and has seen many miles of use. I'm happy to announce that the Millennium edition of the Weeds of the West has just been published and is now available.

Lastly, our 2000 membership was officially recorded at 476. Attendance at this year's meeting is over 400. Our membership is represented from 32 states, 3 provinces, and 1 foreign country (England). Our membership also is represented by several entities that include universities, agrichemical industry, federal agencies, private consultants, state agencies, and counties. We are the only regional weed science society that has increased in membership since 1990. The Aquatic Plant Management Society is the only other weed science society that has increased in membership during this same time period. However, we should not let ourselves become complacent with our membership numbers. I believe there is an opportunity for the WSWS to continue to grow as more and more individuals become involved in invasive weed management. And I believe that the Knapweed Symposium that will dovetail our meeting provides a natural opportunity to recruit new members.

In closing, I just want to reiterate my thanks to all of you for giving me the opportunity to serve as president of this organization. Please take advantage of the opportunity to not only learn from our weed science colleagues, but also network with them throughout the meeting. [Paper Number 50]

WASHINGTON LIAISON REPORT—ACTIVITIES IN THE YEAR PAS AND AHEAD. Robert Hedberg, Director of Science Policy, Washington D.C.

[Paper number 51 not submitted for publication]

MOUNT ST. HELENS REVISITED. Robert Stevens, Washington State University, Prosser, WA

[Paper number 52 not submitted for publication]

THRESHOLDS FOR WEED MANAGEMENT: RECONCILING THE ECOLOGICAL IMPLICATIONS.
Robert F. Norris, Weed Science Program, Department of Vegetable Crops, University of California, Davis, CA 95616

The use of economic thresholds is widely promoted as a means to make more rational decisions concerning management of pests. The weed science literature is replete with examples of research demonstrating relationships between weeds and crop yield loss. These data have been used to develop economic thresholds based on weed density, using the definition described by Auld et al. (1987), Cousens (1987), and others, which states that the economic threshold is the weed density at which losses are equal to the costs of control.

Most research evaluating impacts of weed competition on crop yields does not, however, include any data on weed growth, and even fewer papers include reliable predictions of seed production by the weeds. In the absence of weed fecundity data there is a tendency to ignore the long-term implications of utilizing economic thresholds for weed management decision making. Several weed scientists who have evaluated weed seed production in relation to crop yield loss data have concluded that economic thresholds are not justified for weed management, as noted in my earlier review (Norris 1999). We have recently published a similar conclusion for barnyardgrass in processing tomatoes (Norris et al. 2001a; Norris et al. 2001b). I also note that several papers in the last few years have made statements to the effect that seed production by weeds at or below the economic threshold would be capable of maintaining the weed seedbank. The use of economic thresholds is thus being questioned whenever data on weed seed production and population dynamics are coupled with such economic thresholds.

In the 'My View' article in Weed Science (Norris 2000) I noted that there is a problem with the way in which weed science has adopted the entomological concept of economic thresholds. Agricultural entomologists defined the economic injury level, or EIL, as that pest population density at which economic damage starts to occur. The economic threshold (ET) is then defined as the pest population at which control action should be initiated in order to prevent the pest population from increasing to or exceeding the EIL. Control action must, therefor, be started before the EIL is attained. Weed scientists have adopted a definition of economic threshold that is the same as the entomological EIL. This means that treatment action is only taken once the EIL has been achieved. By using the ET as equivalent to the EIL weed science therefor locks in the maintenance of the seedbank, based on the seed rain from the at or below threshold density of weeds. If weed science adopted the ET and EIL concept it would mean that the long-term nature of weed population dynamics would automatically be considered. The proposed adoption of the concept of economic optimum threshold (EOT) (Cousens 1987) would then be redundant.

Limited knowledge of the true nature of weed fecundity is a serious problem in relation to development of any form of thresholds. Most general reference works cite seed production numbers that are unrealistically low. Recent evidence suggests that seed production by many of the annual weeds in summer cropping systems are in fact anywhere from one to two orders of magnitude higher than published in many of our general reference texts (see Norris 1996 for more details on this aspect of weed biology). When the high fecundity of many of the common weeds in arable systems is recognized the use of economic thresholds must again be questioned.

The longevity of weed seedbanks also influences the decision regarding use of economic thresholds for weed management. Evidence is beginning to accumulate that seedbanks of many common weeds in annual cropping systems are actually shorter that are commonly presented in weed science textbooks. Shorter duration of seedbanks means that modification of seedbank dynamics is probably more feasible than is often recognized.

Adoption of the economic threshold, as implemented for insect management, does not make ecological sense for weed management. The reasons include factors such as the trophic position in the two pest types in the food web, presence of the seedbank for weeds, lack of population 'crashes' for weeds, and differing rates of population decline, fecundity per individual and rate of population increases per generation. More detailed analyses of these differences are presented elsewhere (Norris 1999). An additional point not included in the earlier discussion is that many insect pests have effective biological control agents that help limit population growth at sub-threshold densities; most weeds in arable crops do not have effective biological control agents and thus population growth is not so constrained.

An inherent assumption in the development of economic thresholds is that there is a direct correlation between pest density and the amount of damage that will occur. For example, the amount of food (crop plant) that will be eaten by a second instar larva of a moth is always more or less the same. With this knowledge the damage from 100, or a 1000, larvae can be predicted reasonably accurately. This correlation between weed numbers and damage sustained is not very reliable, making use of economic thresholds based on numerical weed density inherently subject to error.

Economic thresholds are not considered universally applicable to all arthropod control situations. If it is not possible to correlate damage to the crop with the pest population it is not feasible to use economic thresholds. Except for a few weed species there is minimal data on the impact of multiple weeds on crop yield that could be used to develop economic thresholds. The feasibility and cost of estimating the pest population can make economic thresholds impractical to implement. When economic thresholds are very low, such as cosmetic standards for fresh produce, the use of economic thresholds is functionally precluded. Economic thresholds cannot be used when there is no prophylactic treatment that can be used to bring the population under control once it is established that the economic threshold is being exceeded. In many weed management situations there are no satisfactory postemergence treatments, which limits the utility of economic thresholds in such situations. Entomologists argue that thresholds cannot be used for a pest where the population is always above the EIL. Most weed populations, if the seedbank is included, are above the economic threshold, suggesting that use of such thresholds is not useful.

Entomologists recognize that economic thresholds do not work well for univoltine arthropod pests. The ET concept seems best suited to multivoltine pests like spider mites, aphids, codling moth, and other insects with multiple generations per year. This limitation to the application of economic thresholds to insect management indicates that such thresholds may not be useful for weed management, as there are no weeds with multiple generations per year.

In my review of the ecological implications of economic thresholds to weed management (Norris 1999) I proposed that weed science adopt the acronym NST, which is short for 'no seed threshold'. I did not do this lightly or without some trepidation. Adopting NST implies that weeds should not be permitted to set seed, and is based on the rationale that the seedrain sustains the seedbank of nearly all our important weed species. Adoption of NST does not imply that the presence of weeds cannot be tolerated. Weeds that do not achieve reproductive status or do not compete with the crop would not need to be controlled using an NST based philosophy.

I am criticized for suggesting that we adopt an NST policy. On many occasions and by numerous reviewers I have been told that it is not feasible. My response to this is that I am getting the 'knee-jerk' reaction from persons with a preconceived mindset. In California we have anecdotal 'living proof' that NST is achievable and is economically sound. The 60,000 ha Boswell Ranch in the San Joaquin valley has operated a policy of not letting weeds set seed for about 50 years. The managers assert that the policy results in lower weed control costs than if they utilized economic thresholds. A vegetable farmer in the Salinas valley likewise operates a policy of not letting weeds set seed. He has been able to virtually eliminated herbicide use from his vegetable production systems, while at the same time reducing his costs of weed control. He also informed me that his insect management problems have not changed since he adopted a policy of not letting weeds produce seeds.

The utilization of economic thresholds for a pest population that does not have any other control of the sub-threshold population has very serious implications for management of resistance. The population that is judged to be below the economic threshold is comprised of those individuals that can tolerate the control tactics being used. Repeated use of the same control tactic will eventually select for a population that can tolerate the tactic. Use of an NST philosophy results in no gene flow, and thus no development of resistance in the pest population.

Another reaction that I get to implementation of an NST management philosophy is that it will result in increased use of herbicides and will actually make herbicide resistant weed problems worse. If an NST philosophy were implemented based solely on the increased use of herbicides to weed control I would agree. The NST management approach is almost certainly not achievable by simply increasing the use of herbicides. The NST philosophy will only be achieved with integration of weed management technologies, and will require the use of hand labor for controlling low weed populations that have not succumbed to other management tools. I argue that adoption of NST should lead to reduction in herbicide use and reduction in development of resistant weeds. I am often told that hand labor for weeding is not available. My response to that statement is that the situation reflects the level of wages, not the availability of labor. It is indeed possible that an NST philosophy cannot be applied to low value crops due to the costs involved with using hand labor, but this needs testing.

When it comes to spread of an exotic weed species into a previously non-infested area the use of economic thresholds is disastrous. Dewey et al. (1995) recommended adoption of a wildfire management paradigm against exotic species. This implies that adoption of thresholds in not the correct management strategy. Unconscious adoption of economic thresholds, as defined by weed science, would appear to be the policy that most land managers adopt in relation to an invading species. No action is taken until the population of the invading species has reached the EIL. This means that a seedbank is already established before control action is initiated. The wildfire is out of control!

I believe that the goal of every land manager should be to try and end a cropping season, or other management cycle, with a less severe weed problem than when the cycle started. Anything else is essentially saying that you have given up against weeds. By adopting the ET concept for weed management I argue that weed science is acknowledging defeat, and is saying that weed seedbanks cannot be manipulated? I am not willing to accept that. The no seed threshold concept should be the philosophy of any land manager who is looking at weed management from a long-term perspective.

I argue that weed science, in adopting economic thresholds for weed management, is being politically correct. We should challenge those who feel that weed science should adopt economic thresholds as a part of weed management because it does not make long-term economic or ecological sense. A sound ecological and economic basis for weed management best serves our clientele; ignoring science serves our clientele poorly at best, and at worst we are misleading their efforts. Adoption of economic thresholds for weed management will lock arable farming systems into high use of herbicides, as there is currently no feasible alternative to keep the competition from the inevitable weed populations from causing crop loss. As society demands a reduction in herbicide use we must adopt a weed management philosophy that recognizes and addresses the ecological consequences of the weed seedbank utilizing the IPM philosophy to the best of our ability. [Paper number 53]

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WEEDS OF HORTICULTURAL CROPS

ALTERNATIVES FOR METHYL BROMIDE IN FIELD-GROWN FLOWERS IN CALIFORNIA. Clyde L. Elmore*, John Roncoroni and Steve A. Tjosvold. Weed Science Program, Davis and Santa Cruz County, University of California.

Abstract. Microplot field sites were selected with soil types from sandy loam to clay loam to test alternative fumigants to methyl bromide. The fumigant iodomethane at 150 and 235 lb/a , propargyl bromide from 25 to 150 lb/A and metam sodium at 325 lb/A were compared to the standard methyl bromide/chloropicrin. Control of field bindweed was greatest(45%) with propargyl bromide in a sandy loam soil but was only 30 % better than an untreated area. In a clay loam soil the best control was only 29% with iodomethane at 235 lb/A. Annual bluegrass and purslane was controlled with propargyl bromide at 75 lb/A or higher or iodomethane at both rates. Control was higher when seeds were buried at 5 cm than at 15 or 30 cm depth. Calla lily tubers were controlled with propargyl bromide at 50 lb/A or higher and with iodomethane. These control evaluations were comparible to methyl bromide and chloropicrin. In field experiments using brocolli residues at 25 to 50 T/A of wet biomass incorporated to 2 inches or 5 inches into soil, control of common purslane, rough pigweed was not good with broccoli without a polyethylene cover. Weed control was greater than 95% when a tarp was applied at Davis. The broccoli gave an increase in filaree and burclover over solarization alone. When annual ornamentals snapdragon and Godetia, were transplanted into treatments two weeks after removal of the tarp, injury occurred where broccoli and tarps were used. If products can be registered, there will be alternatives to many methyl bromide uses, but this may come at an increased cost and the products may not be available in time to meet the 2005 phaseout deadline. [Paper Number 54]

EVALUATION OF NEW HERBICIDES FOR USE IN STRAWBERRIES. Diane Kaufman*, Joe DeFrancesco, Gina Koskela, Ed Peachey, North Willamette Research and Extension Center, (NWREC), Aurora, OR 97002.

EVALUATION OF NEW HERBICIDES FOR USE IN STRAWBERRIES. Diane Kaufman[1], Joe DeFrancesco[2], Gina Koskela[1], Ed Peachey[3], District Extension Agent, Senior Research Assistant, Research Assistant, Research Associate, [1]North Willamette Research and Extension Center (NWREC), Aurora, OR 97002, [2]Department of Entomology, Oregon State University, Corvallis, OR, 97331, [3]Department of Horticulture, Oregon State University, Corvallis, OR, 97331. Two field trials were established in 1999 at the North Willamette Research and Extension Center (NWREC) on a Quatama silt loam soil with 4% organic matter. Treatments were applied using a CO_2 backpack sprayer equipped with a 4-nozzle boom (TeeJet 8002, flat fan) at 40 psi, at a rate of 40 gallons of water per acre.

1. Establishment Trial. 'Totem' strawberries were planted into raised beds on May 13, 1999. Plots four rows wide and 30 feet long were arranged in a complete randomized block design with four replications. Soil was lightly raked over the strawberry crowns immediately after planting (to ensure that no green growth was visible) then irrigated. Treatments were applied May 15, 1999 then incorporated with one inch of irrigation. Treatments applied at planting were again applied during winter dormancy (similar to the program developed for the use of oxyfluorfen). Because most herbicides began to lose effectiveness by late summer, all plots received a maintenance application of simazine (1 lb/A) and napropamide (2 lb/A) on September 29, 1999, after being hoed free of weeds. All rates are expressed as lb ai/acre.

Weed control was evaluated approximately every 30 days, beginning one month after applications. Plots were hand-weeded after each evaluation. Phytotoxicity was evaluated two days after application then periodically throughout the season. Plant vigor was evaluated July 14, 1999. Yield data was collected in June 2000.

Table 1. Treatments in Establishment Trial.

Treatments	Rate at planting lb/A	Winter Rate lb/A
Azafenidin	0.2	0.3
Dimethenamid	1	1.25
Fluamide	0.25	Fluamide (0.25) + Sulfentrazone (0.125)
Oxyfluorfen	0.25	0.5
Rimsulfuron	0.0117	0.0187
Sulfentrazone	0.0625	0.25
Thiazopyr	0.5	0.25
Hand-weeded control [a]	- - - -	- - - -
Weedy control [a]	- - - -	- - - -

[a] Included in trial to provide a basis for comparison when evaluating plant vigor and yield.

Table 2. Dominant weeds present during growing season, 1999.

Date	Primary Weeds	Other Weeds
June 28	Nightshade	Shepherd's purse, henbit, pineappleweed, chickweed, pigweed, annual bluegrass, barnyard grass.
July 21	Pigweed Crabgrass	Shepherd's purse, sowthistle, pineappleweed, chickweed, nightshade, annual bluegrass, barnyard grass.
August 18	Pigweed	Shepherd's purse, pineappleweed, sowthistle, groundsel, annual bluegrass, crabgrass, barnyard grass. (Heavy grass pressure)
September 20	Annual bluegrass	Shepherd's purse, pineappleweed, sowthistle, groundsel.

Azafenidin provided the longest lasting control of all weeds (Table 3). Thiazopyr provided excellent control of grasses through September and excellent control of broadleaves through August; by September, broadleaf control in the thiazopyr plots had become marginal, with pressure from pineappleweed and groundsel. Sulfentrazone provided good control of broadleaves through August and virtually no control of grasses. Oxyfluorfen, the chemical standard provided excellent control of broadleaves and grasses through August. Dimethenamid provided excellent control of broadleaves through July and excellent control of grasses through August. Fluamide provided excellent control of grasses all season and virtually no control of broadleaves. Rimsulfuron provided only fair-good control of broadleaves through July and little control of grasses.

Table 3. Weed control in establishment trial (express as percent control compared to the weedy check plots) on four dates.

Treatment	Broadleaf Weed Control 6/28	7/21	8/18	9/20	Grass Weed Control 6/28	7/21	8/18	9/20
	%				%			
Azafenidin	99.7	96.5	97.0	96.2	97.2	96.2	92.5	97.5
Dimethenamid	97.0	93.7	71.8	60.6	100.0	98.3	93.8	75.0
Fluamide	66.5	62.0	54.5	56.9	100.0	100.0	97.0	100.0
Oxyfluorfen	93.7	95.0	85.5	66.9	96.0	91.4	93.3	80.0
Rimsulfuron	74.0	86.2	51.0	61.9	56.2	64.2	41.8	62.5
Sulfentrazone	90.8	90.2	89.5	70.0	29.2	50.0	57.9	50.0
Thiazopyr	99.3	98.9	92.2	75.0	100.0	100.0	100.0	97.5
Significance	*	***	***	**	**	***	***	***
LSD (≤ 0.05)	19.7	9.4	14.6	14.3	29.5	15.0	15.3	18.0

*, **, *** = Significance at P ≤ 0.05, 0.01, 0.001, respectively

There were no statistically significant differences among treatments in number of leaves, number of runners, or plant size (Table 4). However, there was a trend for more runners in the azafenidin, dimethenamid, fluamide, and hand weeded plots when compared to the weedy check plots or other treated plots.

Table 4. Strawberry plant vigor evaluated 7/14/99 (plants established 5/13/99, treatments applied 5/15/99).

Treatment	# Leaves per plant	# Runners per plant	Plant Size (cm^2)
Azafenidin	7.95	1.85	498.5
Dimethenamid	7.05	1.85	517.6
Fluamide	7.45	1.85	613.6
Oxyfluorfen	6.75	1.30	483.1
Rimsulfuron	6.10	1.20	423.8
Sulfentrazone	7.05	1.55	534.8
Thiazopyr	6.70	1.00	464.4
Hand-weeded control	6.55	1.95	541.6
Weedy control	5.95	1.05	507.7
Significance ($P \leq 0.05$)	ns	ns	ns

ns=not significant.

Most of the treatments did not cause significant phytotoxicity. The oxyfluorfen-treated plants exhibited many red spots on the first flush of leaves after application and well into early June. By late June, plants treated with oxyfluorfen showed no signs of phytotoxicity. Azafenidin-treated plants had a few red spots on newly emerged leaves. Rimsulfuron-treated plants had some yellowish coloration in the newly emerged leaves and the plants remained a greenish-yellow color throughout the growing season.

Herbicides were applied at the winter rates listed in Table 1 on January 29, 2000. At that time, the fluamide treatment was changed to fluamide (0.25) + sulfentrazone (0.125) to broaden the spectrum of control. There was little weed pressure in all plots during winter and spring so only one weed evaluation was conducted prior to harvest.

Table 5. Weed control in establishment trial, winter application (expressed as percent control compared to weedy check plots) on May 17, 2000.

Treatment	% Weed Control [a]
Azafenidin	100
Dimethenamid	81.25
Fluamide + Sulfentrazone	79.25
Oxyfluorfen	86
Rimsulfuron	82.5
Sulfentrazone	99
Thiazopyr	97.25
Significance	**
LSD	5.88

** = Significance at $P \leq 0.01$.

[a] Weeds present: Pineappleweed, groundsel, shepherds purse, chickweed, annual bluegrass.

Azafenidin, thiazopyr, and sulfentrazone applied at the 0.25 lb rate provided the best weed control. Dimethenamid and rimsulfuron tended to give better control of grass than broadleaf weeds, while oxyfluorfen provided better broadleaf than grass weed control. The mixture of fluamide + sulfentrazone provided excellent annual bluegrass control, however, sulfentrazone used at the 0.125lb rate, performed poorly against broadleaf weeds.

Fruit was harvested four times between June 5 and June 19, 2000.

Table 6. Yield, percent rot, and adjusted berry size in 1999 establishment/winter application trial.

Treatment	Yield (lbs/5 ft. row)	% Rot	Adj. Berry Size (g)
Azafenidin	7.63	6.22	14.68
Dimethenamid	7.97	5.79	14.22
Fluamide + Sulfentrazone	8.15	3.68	14.65
Oxyfluorfen	7.03	7.25	14.41
Rimsulfuron	8.09	7.98	14.89
Sulfentrazone	7.13	10.10	14.57
Thiazopyr	8.64	4.25	14.20
Hand-weeded control	7.97	8.46	15.58
Weedy control	7.53	5.12	14.43
Significance	ns	ns	ns

There were no differences among treatments in yield, percent rot or adjusted berry size. Two weeks following harvest the planting was renovated (e.g. mowed, cultivated, fertilized). Treatments were applied on July 7, 2000. Evaluations of weed control from fall 2000 to summer 2001 will be made on a regular basis and yield data collected in June 2001.

2. Fall Timing Trial. This planting was established on raised beds at NWREC on May 13, 1999. It was used to evaluate herbicide treatments made in the fall to strawberries planted in May. Plots four rows wide and 30 feet long were arranged in a complete randomized block design with four replications. To achieve weed control throughout the summer, napropamide, at 4 lb ai/A, was applied after planting and incorporated with one inch of irrigation. Treatment applications were made on September 29, 1999 and immediately irrigated. As of early November, weed control was good and there were no signs of phytotoxicity in any of the plots.

Table 7. Treatments in fall timing trial.

Treatment	Rate
	lb/A
Azafenidin	0.2
Dimethenamid	1.25
Fluamide + Isoxaben	0.25 + 0.75
Fluamide + Sulfentrazone	0.25 + 0.125
Isoxaben	0.75
Sulfentrazone	0.125
Thiazopyr	1
Simazine + Propionamide	1 + 2
Hand-weeded control	- - - -
Weedy control	- - - -

Weed pressure was moderate in early March. Weed evaluations were conducted on March 15 (168 DAT) and May 18, 2000 (232 DAT). There were differences in control of certain broadleaf weeds among treatments.

Table 8. Broadleaf weed control in fall trial (expressed as percent control compared to weedy check plots) on March 15, 2000.

Treatment	Groundsel	Little bittercress	Chickweed	Speedwell
Azafenidin	100	100	97.50	98.75
Dimethenamid	83.75	88.75	93.75	96.25
Fluamide + Isoxaben	98.75	100	98.75	100
Fluamide + Sulfentrazone	93.75	96.25	55	96.25
Isoxaben	100	100	100	100
Simazine	95	97.5	90	56.25
Sulfentrazone	100	73.75	20	100
Thiazopyr	100	100	100	100
Significance	***	**	***	*
LSD (≤ 0.05)	3.26	6.91	5.84	11.45

*, **, *** = Significance at $P \leq 0.05$, 0.01, 0.001, respectively

Although sulfentrazone gave excellent control of groundsel, speedwell, shepherds purse, and pineappleweed (shepherds purse and pineappleweed data not shown), it provided only marginal control of little bittercress and no control of common chickweed. Simazine performed well against all broadleaf weeds except speedwell.

Table 8. Weed control in fall trial (expressed as percent control compared to the weedy check) on two dates.

Treatment	Broadleaf 3/15	Broadleaf 5/15	Annual Blue 3/15	Annual Blue 5/15	Overall 3/15	Overall 5/15
Azafenidin	98.96	96.87	98.25	96.25	97.75	97
Dimethenamid	90.83	67.5	96.25	92.50	90.75	75
Fluamide + Isoxaben	98.96	86.25	88.75	65	94.5	82.5
Fluamide + Sulfentrazone	88.75	86.25	96.25	90	86.25	83.75
Isoxaben	100	72.5	40	35	77.5	78.75
Simazine	88.67	76.25	77.5	60	81.25	81.25
Sulfentrazone	80.62	83.12	68.75	37.5	70	77.5
Thiazopyr	98.75	80.5	100	100	96.5	88.75
Significance	***	ns	***	***	***	***
LSD (≤ 0.05)	2.35		6.82	12.43	4.75	3.79

***, ns = Significance at $P \leq 0.001$, not significant, respectively.

Azafenidin provided the best control of both broadleaf and grass weeds from March to May. Although thiazopyr provided excellent weed control in March, broadleaf weed control (particularly pineappleweed) had declined to a point that overall weed control was reduced by May. Broadleaf weed control by May was also a concern in dimethenamid-treated plots. Poor annual bluegrass control in isoxaben, simazine, and sulfentrazone-treated plots reduced overall effectiveness, suggesting that these herbicides would be best applied in the fall in combination with a grass herbicide.

Fruit was harvested four times between June 5 and June 19, 2000.

Table 9. Yield, Percent Rot, and Adjusted Berry Size in 1999 planted Fall Timing Trial.

Treatment	Yield (lb/5 ft row)	%Rot	Adj. Berry Size (g)
Azafenidin	7.7	1.97	13.47
Dimethenamid	7.97	4.57	14.39
Fluamide + Isoxaben	6.87	3.29	15.19
Fluamide + Sulfentrazone	7.51	4.37	14.63
Isoxaben	8.68	2.22	13.7
Simazine	6.97	4.93	13.55
Sulfentrazone	6.85	3.10	14.72
Thiazopyr	7.27	2.55	14.85
Hand-weeded control	7.22	2.47	14.44
Weedy control	7.18	3.3	14.46
Significance	ns	ns	ns

ns=not significant.

There were no differences among treatments in yield, percent rot, or adjusted berry size. Two weeks following harvest the planting was renovated. Treatments were applied October 4, 2000. Evaluations of weed control from fall 2000 through summer 2001 will be made on a regular basis. Yield data will be collected June 2001. [Paper Number 55]

OPTIMUM TIME OF GLYPHOSATE APPLICATION IN GLYPHOSATE-TOLERANT LETTUCE.

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Abstract. Studies were conducted in Arizona and California to determine the optimum time to apply glyphosate to glyphosate-tolerant lettuce. The first study was conducted in the Salinas Valley of California during the spring of 2000 and the second study was conducted near Yuma, Arizona in the fall of 2000. In both studies, single applications of glyphosate at 1.0 lb/A were made to iceberg lettuce at the 2-, 4-, 6- and 8-leaf stages. In the Salinas study only, sequential applications of glyphosate at 1.0 lb/A were made to lettuce at the 2-leaf stage followed by a second application 14 days later, or to lettuce at the 4-leaf stage followed by a second application 14 days later. Bensulide and pronamide were applied preemergence as commercial standards. Both studies also included hand weeded and untreated controls. None of the glyphosate treatments resulted in lettuce injury. In the Salinas study, the 4-leaf stage was the optimum lettuce growth stage to apply a single application of glyphosate for the control of hairy nightshade, little mallow and redroot pigweed. At Yuma, a single application made to lettuce at the 2- or 4-leaf stages was optimal for the near-complete control of common purslane, nettleleaf goosefoot, little mallow, and sprangletop. In both studies, applications at the 6- or 8-leaf stages of lettuce allowed weeds, to compete with the lettuce. Both sequential application timings tested at Salinas provided excellent weed control. Treatments that resulted in the lowest lettuce thinning and hand weeding times, at Salinas, were a single glyphosate application made at the 4-leaf stage or either of the sequential applications. At Yuma glyphosate applied to lettuce at the 2- or 4-leaf stages required the least amount of time to hand weed. Lettuce quality was greatest when glyphosate was applied at the 4-leaf stage. Lettuce yield at Salinas was highest when a sequential application of glyphosate was made at the 2-leaf stage followed by a second application 14 days later. [Paper Number 56]

COMPARISON OF SULFENTRAZONE, FLUMIOXAZIN, AND METRIBUZIN FOR WEED CONTROL IN POTATOES. Dodi E. Kazarian, Scott J. Nissen*, and Asunta L. Thompson, Graduate Student, Associate Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO, 80523, and Assistant Professor, Department of Horticulture, Colorado State University, San Luis Valley Research Center, Center, CO, 81125.

Abstract. In Colorado, sulfentrazone has been evaluated for pre-emergent weed control in potatoes since 1996. Flumioxazin was added to field trials in 1999. When evaluated under furrow irrigation with Norkotah potatoes, sulfentrazone and flumixoazin provided excellent broadleaf weed control with minimal crop response. Flumioxazin and sulfentrazone combinations with s-metolachlor provided weed control equal to or better than rimsulfuron plus s-metolachlor and metribuzin plus s-metolachlor. Russet Norkotah, Russet Nugget, Chipeta, and Sangre were used to evaluate variety response to sulfentrazone and flumioxazin. All varieties tested were tolerant to flumioxazin, while Sangre showed significant crop response with sulfentrazone applications of 140 g/ha. Greenhouse studies were conducted to evaluate the response of eight weedy species to sulfentrazone, flumioxazin, and metribuzin. Hairy nightshade, black nightshade, redroot pigweed, redstem filaree, common lambsquarters, kochia, barnyardgrass, and wild proso millet were selected as common weeds in Colorado potato fields. Sulfentrazone and flumioxazin I_{50} values for hairy nightshade, redroot pigweed, redstem filaree, and barnyardgrass were significantly lower compared to metribuzin I_{50} values. Flumioxazin I_{50} values for redstem filaree and barnyardgrass were lower than sulfentrazone I_{50} values, while all three herbicides were equally effective in controlling common lambsquarters. Sorption studies were conducted with sulfentrazone, flumioxazin, and metribuzin to better understand the influence of pH, organic matter and clay content on herbicide adsorption. Soils selected for these studies ranged from 1.1 to 4.4% organic matter, 5.1 to 7.8 pH, and 5 to 29% clay content. Sulfentrazone appeared to have greater sorption than metribuzin, especially for soils with a pH around sulfentrazone's pKa of 6.56 or less. Flumioxazin sorption appeared to be 100% on soils with organic matter contents ranging from 1.1 to 4.4%. Organic matter, pH and CEC were regressed against Kf values. These three parameters explained 92% of the variation in sulfentrazone and metribuzin Kf values. [Paper Number 57]

DIMETHENAMID-P: WEED CONTROL AND POTATO CROP TOLERANCE IN THE PACIFIC NORTHWEST. Pamela J. S. Hutchinson*, Dennis J. Tonks, Corey V. Ransom, Charlotte V. Eberlein, Rick A. Boydston, and Bart A. Brinkman, Assistant Professor, Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210; Dryland Cropping Systems Specialist, Washington State University, Davenport, WA 99122; Assistant Professor, Malheur Experiment Station, Oregon State University, Ontario, OR 97914; District III Cooperative Extension, University of Idaho, Twin Falls, ID 83303; Plant Physiologist, USDA-ARS, Irrigated Agriculture Research and Extension Center, Prosser, WA 99350; Senior Technical Services Representative, BASF Corp., Salem, Or 97306.

Abstract Dimethenamid-p efficacy and potato tolerance field trials were conducted in Idaho and Oregon in 1998, 1999, and 2000. The Oregon trials were conducted on a Oyhee silt-loam with pH 8.0 and 1.1% organic matter, and the Idaho trials were conducted on a Declo loam with pH 7.9 and 1.2% organic matter. In all trials, herbicides were applied after hilling, prior to potato and weed emergence, and sprinkler incorporated immediately after application. 'Russet Burbank' variety was planted in all trials with the exception of the 1998 Oregon trials planted with Shepody. In efficacy trials, 0.64 lb/A dimethenamid-p in combination with metribuzin (0.5 lb/A) or rimsulfuron (0.016, or 0.023 lb /A), provided greater than 95% redroot pigweed control at all locations, all years. The dimethenamid-p alone treatment was only included in 1998 and 2000 Idaho trials, and resulted in 98% redroot pigweed, and 90% hairy nightshade control. Dimethenamid-p tank mixtures with metribuzin or rimsulfuron resulted in improved common lambsquarters, hairy nightshade, kochia, and volunteer oat control compared to dimethenamid-p applied alone. Control of all weeds present by dimethenamid-p tank mixtures was comparable to rimsulfuron + metribuzin (0.023 or 0.016 + 0.5 lb /A), or dimethenamid + metribuzin (1.17 + 0.5 lb/A) control in Idaho and Oregon trials. Dimethenamid-p + rimsulfuron (0.64 + 0.023 lb/A), or rimsulfuron + metribuzin (0.023 + 0.25 lb/A) provided 93-100% common lambsquarters and hairy nightshade control at Prosser, WA in 2000. Tolerance trials were kept weed-free during the season. The 1X rate of dimethenamid-p at 0.64 lb/a was compared to 2X and 4X rates of dimethenamid-p (1.28 and 2.56 lb/A), 2X and 4X rates of s-metolachlor (2.6 and 5.2 lb/A), the 2X rate of dimethenamid (2.34 lb/A), and either the 1.5X (Idaho) or 3X rate (Oregon) of pendimethalin. Early leaf injury

consisting of stunting, and leaf crinkling and malformation, was observed until approximately 3 to 4 weeks after emergence. Visual symptoms were not evident after row-closure except in Idaho 1998 in dimethenamid-p 4X rate treated plots. Because of year by location by treatment interaction, initial injury data were not combined. In general, the dimethenamind-p 1X rate resulted in injury levels similar to pendimethalin. The dimethenamid-p 2X rate usually resulted in greater injury than injury from the 1X rate, and in similar injury from the 2X rate of dimethenamid or s-metolachlor. In Oregon, the dimethenamid-p or s-metolachlor 4X rate resulted in greater injury than the 2X rates of either herbicide. U.S. No. 1 or total tuber yields were not significantly different among treatments including a weed-free check. [Paper Number 58]

PACIFIC NORTHWEST POTATO TOLERANCE AND VARIETAL RESPONSE TO SULFENTRAZONE. Dennis J. Tonks*, Pamela J. S. Hutchinson, Corey V. Ransom, Rick A. Boydston, and Claude G. Ross, Dryland Cropping Systems Specialist, Washington State University, Davenport, WA 99122; Assistant Professor, Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210; Assistant Professor, Malheur Experiment Station, Oregon State University, Ontario, OR 97914; Plant Physiologist, USDA-ARS, Irrigated Agriculture Research and Extension Center, Prosser, WA 99350; and Senior Research Biologist, FMC Corp., Loveland, CO 80537.

Field studies were conducted in Idaho, Oregon, and Washington in 2000 to evaluate potato tolerance to sulfentrazone applied PRE to potatoes. Oregon trials were conducted on a silt-loam soil with pH 8.0 and 1.1% organic matter and Idaho trials were conducted on a loam soil with pH 7.9 and 1.2% organic matter. The Washington trial was conducted on a sandy soil with pH 7.0 and 0.5% organic matter. In all trials, herbicides were applied after hilling and prior to potato emergence. Sulfentrazone was applied alone at rates ranging from 0.7 to 0.42 kg/ha, and at 0.11 or 0.21 kg/ha in mixtures with 0.56 or 0.26 kg/ha metribuzin, 3.4 kg/ha EPTC, 1.1 kg/ha s-metolachor, 0.72 kg/ha BAS 656 07H, or 1.1 kg/ha pendimethalin, depending on location. Previous work in Idaho showed that sulfentrazone rates above 0.21 kg/ha caused unacceptable crop injury, therefore, sulfentrazone trial rates in Idaho were lower than in Oregon. Injury from sulfentrazone applied alone ranged from 15 to 34% in Oregon, from 10 to 34% in Idaho, and from 2 to 22% in Washington, depending on rate. Injury for mixtures ranged from 15 to 21%, 10 to 15%, and 15 to 21% in Oregon, Idaho and Washington, respectively. Tuber yield was not affected by sulfentrazone treatments in Idaho or Oregon regardless of rate or mixture. Sulfentrazone tank-mixed with metribuzin or pendimethalin in Washington trials resulted in early visual potato injury, but this injury was transient. In a separate 2000 Idaho trial, potato cultivar tolerance was evaluated in weed-free plots. Sulfentrazone was applied PRE at 0, 0.11, and 0.21 kg/ha to 'Russet Burbank', 'Ranger Russet', 'Russet Norkotah', and 'Shepody' potatoes. Initial injury ranged from 5 to 25% depending on sulfentrazone rate. 'Russet Burbank' exhibited greatest visual injury during the season, regardless of rate, compared to the other cultivars. U.S. No. 1 yield was reduced in sulfentrazone-treated 'Russet Burbanks' relative to the untreated "Russet Burbank' control. Tuber yield was not affected in the other potato cultivars. [Paper Number 59]

EFFECT OF TILLAGE ROTATIONS ON WEED POPULATIONS IN IRRIGATED ROW CROPS. R. Edward Peachey*, Ray D. William, and Carol Mallory-Smith, Senior Research Assistant, Professor, and Associate Professor, Departments of Horticulture and Crop Science, Oregon State University, Corvallis OR 97331

Abstract. Field experiments were conducted on a silty-clay loam soil in Corvallis, OR from 1997 through 2000 to study the effects of tillage rotational strategies on summer annual weeds in row crops. Four tillage rotation treatments were imposed on a cropping rotation of snap beans, followed by fall tillage and cover crop planting, sweet corn, fall tillage and winter wheat, and then snap beans. In the spring preceding snap beans and sweet corn planting, plots were either disked and tilled (conventionally tilled: CT) or left untilled (direct-seeded: DS), depending on the tillage rotation treatment. Subplots within each tillage rotation included three levels of weed management intensity imposed by herbicide rate. Snap beans and sweet corn were planted with a cross-slot notill planter into CT and DS seedbeds. The entire rotation was replicated twice with the crop rotation of the second replication out of phase by one year. Soil samples (10 cm in dia by 3.8 cm in depth) were taken from each plot before and after tillage in the spring and weed seeds extracted from the soil. Weed emergence four weeks after

planting in the fourth year of the rotation averaged 90 % less in rotations that included DS in one or more years compared to CT plots. Weed drymatter followed a similar trend for nightshade but not pigweed. Pigweed drymatter at harvest only averaged 10 percent less in plots with DS in one year, compared to CT. Seed bank analysis indicated that weed emergence in DS systems was not determined by seed redistribution during tillage. [Paper Number 60]

ROTATIONAL CROP RESPONSE TO SEVERAL HERBICIDES USED IN GREEN PEA. Timothy W. Miller* and Carl R. Libbey, Extension Weed Scientist and Agricultural Technologist, Washington State University Mount Vernon Research and Extension Unit, Mount Vernon WA 98273.

Abstract. Several herbicides with current or potential registrations in green pea have relatively long soil residuals. Since peas are an integral component of most crop rotations in Washington state, the impact of these herbicides on rotationally grown crops is of interest to regional growers. Trifluralin, imazamox, pendimethalin, clomazone, and sulfentrazone were evaluated for efficacy and crop safety in green pea, and their effect on certain rotational crops grown in northwestern Washington was measured. Two-year weed control was 99 and 94% from clomazone and imazamox + pendimethalin (PRE), respectively. Pea injury from imazamox + 32-0-0 + nonionic surfactant (POST) ranged from 21 to 28%, while injury from imazamox + pendimethalin (PRE) and pendimethalin alone was 13 and 6%, respectively. Pea population was not significantly altered by herbicides, but peas treated with imazamox (POST) produced fewer than 4 pods/plant and yielded the same as nontreated, weedy peas (< 2 tons/a). Fall-planted rotational crops were winter wheat, cabbage seed, and tulip, while spring-planted crops were potato, cucumber, spinach seed, sweet corn, and strawberry. Growth parameters for most crops were significantly different in 1998-99 and 1999-2000. In 1998-99, sweet corn biomass was 40% lower in sulfentrazone-treated soil and strawberry leaf area was 23% lower in plots treated with imazamox at 0.04 lb/a. Neither of these trends was evident from the 1999-2000 data, however, when no herbicide affected rotational crop growth parameters. [Paper Number 61]

DURATION OF WEED-FREE MANAGEMENT IN CITRUS PREDICTS SEED BANK CONTRIBUTION TO WEED DENSITY. Tim Prather[1]*, Fuhan Liu[2], Neil O'Connell[3], Kurt Hembree[4]. [1]University of Idaho, Moscow ID, [2]University of California, Parlier CA, [3]University of California, Visalia CA, [4]University of California, Fresno CA.

Abstract. Citrus historically has been managed to remove all vegetation from the orchard floor. Preemergent herbicide application for season long control followed by postemergent herbicide application should have a negative effect on seed banks. This management system has made it difficult for farmers to determine whether a weed seed reserve remains. Herbicide use records should be a predictor of the remaining seeds in the seed bank. These use records would then serve as input into a decision table to determine the risk to the farmer to changes in orchard floor management. Core samples were taken for weed seed analysis from orchards varying in age from 2 years to 60 years. Seeds were counted after separation using elutriation and sieving. Tarps were placed in orchards to prevent herbicide application to determine weed emergence. Results indicated that tree rows had higher weed densities for young orchards with tree middles maintaining higher seed densities. Weed seed numbers were reduced in orchards over 12 years of age. Orchards over 20 years of age had few seeds detected in soil from either the tree row or the tree middle. Weeds that emerged from tarped areas consisted of species with wind-borne seed and likely maintained populations through continual reinvasion. These results indicate changes in management are possible as the orchard ages, allowing the farmer to benefit financially from earlier weed-free orchard floor maintenance. Preemergent herbicide use in citrus has been implicated in contamination of surface and groundwater. Reducing preemergent herbicide use in citrus also would have a positive effect on surface and groundwater quality. [Paper Number 62]

AGRONOMIC SECTION (Continued on Page 60)

VENICE MALLOW *(HIBISCUS TRIONUM L.)* CONTROL IN SUGARBEETS. Abdel O. Mesbah* and Stephen D. Miller, Research Scientist and Professor, Powell Research and Extension Center, 747 Road 9, Powell, WY 82435, and Department of Plant Sciences, P.O. Box 3354, University of Wyoming, Laramie, WY 82071.

Abstract. Field studies were conducted in 1999 and 2000 at the Big Horn County, WY to evaluate the effect of postemergence treatments with or without layby treatments on venice mallow control in sugarbeet. Postemergence treatments consisted of the combination desmedipham-phenmedipham or desmedipham-phenmedipham-ethofumesate plus triflusulfuorn plus clopyralid using micro-rate and full rate systems. Methylated seed oil at 1.5% v/v. was added to the micro-rate system. Each treatments consisted of three applications, seven days apart, starting at cotyledon or two leaf-venice mallow stage. Layby treatments consisted of ethofumesate and dimethenamid applied few hours before the second irrigation. Venice mallow control was moderate with both systems, micro rate and full rate, when applied at cotyledon-stage and good to excellent when applied at two leaf-stage. Sugarbeet injuries were slightly higher with full rate than with micro-rate system. Layby treatments appears to increase venice mallow control by at least 5%. Sugarbeet injuries with dimethenamid were slightly higher than with ethofumesate. Sugarbeet root yields were higher in herbicide treated compared to the check and yield increases were closely related to venice mallow control. Sugar contents among all treatments including the check were similar. [Paper Number 63]

EFFECT OF GLUFOSINATE APPLICATION RATE, METHOD, AND SPRAY VOLUME ON WEED CONTROL IN GLUFOSINATE-RESISTANT SUGAR BEET. Michael J. Wille* and Don W. Morishita, Research Support Scientist and Professor; Twin Falls Research and Extension Center; University of Idaho, Twin Falls, ID 83301.

Abstract. Because glufosinate does not readily translocate in plants, spray coverage may be an important factor contributing to its efficacy. Studies were initiated in 1998 and 1999 to evaluate glufosinate application rate, timing, application method, and spray volume for weed control in glufosinate-resistant sugar beet. The experiment was located at the University of Idaho Research and Extension Center near Kimberly, Idaho. The experimental design was a randomized complete block with four replications. Individual plots were 4-rows by 30-feet. Sugar beet ('8455 LL' in 1999' and '8757 LL' in 1998) was planted 0.75 inch deep, at a rate of 47,520 seed/A on 22-inch row spacing on April 22, 1998, and April 15, 1999. The soil was a Portneuf silt loam with 1.45% organic matter, 8.3 pH, and CEC of 17.5 meq/100 g soil. The major weeds present were kochia, common lambsquarters, redroot pigweed, hairy nightshade, and annual sowthistle in 1998, and kochia, common lambsquarters, and volunteer wheat in 1999. Glufosinate was applied at either 0.268 or 0.357 lb ai/A when weeds were I-inch tall. Application methods compared were broadcast at 10 or 20 gpa, or band-applied at 20 gpa with even fan or twinjet nozzles (1998) or air induction (AI) nozzles (1999) All band applications were 10-inches wide. Three applications of ethofumesate & desmedipham & phenmedipham (Efs&Dmp&Pmp) at 0.33 lb/A at 7 d intervals beginning at sugar was included as a standard herbicide treatment. Herbicides were applied with a CO2-pressurized bicycle-wheel sprayer. Crop injury and weed control evaluations were taken 7 and 28 days after the last treatment was applied (DALT). The two center rows of each plot were harvested with a mechanical harvester October 8, 1998, and September 22, 1999. In 1998, all broadcast applications controlled the weeds 94 to 100% 7 DAT. At 28 DAT, broadcast applications controlled all weeds 91 to 100% with the exception of glufosinate applied at 20 gpa and 0.268 lb/A which controlled common lambsquarters and kochia 80 and 77%, respectively. With the even band nozzles all weeds except common mallow were controlled 96 to 100% 7 DAT and 92 to 100% 28 DAT. Common mallow control with the even band nozzles averaged 90 to 92% at 0.268 lb/A. Overall, weed control with the twinjet nozzles was lowest. Weed control ranged from 87 to 100% 7 DAT, and decreased to as low as 74% control of common lambsquarters 28 DAT. Weed control with Efs&Dmp&Pmp + triflusulfuron applied three times ranged from 90 to 100% for all weeds at both evaluation dates. In 1999, kochia control with all glufosinate treatments ranged from 86 to 100% 7 and 28 DAT. Common lambsquarters control ranged from 88 to 100% for all herbicide treatments 7 and 28 DAT. Volunteer wheat control with glufosinate was similar to that observed for kochia. Glufosinate at 0.268 lb/A applied with AI band nozzles controlled volunteer wheat 73% 28 DAT, however there was no statistical difference among any of the treatments.

The herbicide treatments consisting of ethofumesate & desmedipham & phenmedipham + triflusulfuron applied in a band or broadcast did not satisfactorily control kochia. All of the herbicide treatments had higher sugar beet root yields and more extractable sugar than the check. Sugar beet yields ranged from 31 to 37 ton/A in 1998 and 16 to 24 ton/A in 1999. The untreated checks in those years yielded 13 and 0.8 ton/A, respectively. In 1999, glufosinate applied broadcast or with even fan band nozzles had yields ranging from 16 to 24 tons/A. Both glufosinate rates applied with AI nozzles had root yields equal to the ethofumesate & desmedipham & phenmedipham + triflusulfuron treatments. Weed control, root yield, and extractable sugar yield does not appear to be affected by application volume or broadcast versus even fan band application methods. Root and extractable sugar yield appear to be reduced with AI band nozzles. [Paper Number 64]

CROP TOLERANCE OF DRY EDIBLE BEANS TO COMBINATIONS OF FLUMETSULAM AND ETHAFLURALIN IN NORTH DAKOTA. Todd C. Geselius*, Dow AgroSciences, Fargo, ND.

Abstract. Crop tolerance of dry edible beans to combinations of flumetsulam and ethafluralin was investigated in North Dakota to determine if acceptable tolerance existed for its use in this crop. Previous research had indicated that different types of dry edible beans reacted similarly to flumetsulam but that crop tolerance was variable between locations. In order to determine which environmental and edaphic factors influenced dry edible bean tolerance a study consisting of 14 separate sites was established. Each site consisted of treatments including flumetsulam at 70 g/ha + ethafluralin at 1050 g/ha (considered 1X rate), flumetsulam at 140 g/ha + ethafluralin at 2100 g/ha (considered 2X rate) and an untreated check. Results indicated that a combination of fine soil texture and significant amounts of rainfall over a short period of time combined to cause unacceptable (10% or greater) injury at the 1X rate 36% of the time and 50% of the time at the 2X rate. Due to this high occurrence of unacceptable injury further development of this concept has been halted. [Paper Number 65]

WEED CONTROL IN DRY BEAN WITH SULFENTRAZONE, FLUMIOXAZIN, AND IMAZAMOX.
Brian M. Jenks*, Kent R. McKay, Denise M. Markle, and Gary P. Willoughby, North Dakota State University, North Central Research Extension Center, Minot, ND 58701.

Abstract. Studies were conducted in 1999 (Washburn, ND) and 2000 (Minot and Underwood, ND) to evaluate herbicide efficacy and dry bean tolerance to sulfentrazone, flumioxazin, and imazamox. At Washburn, imazamox at 0.023 or 0.031 lb/A in combination with bentazon, NIS, COC, or Quad 7 provided excellent control of foxtail and redroot pigweed, but did not control wild buckwheat. Sulfentrazone at 0.125 or 0.25 lb/A and flumioxazin at 1.25 or 2 oz did not control foxtail or wild buckwheat. Flumioxazin provided excellent control of redroot pigweed while sulfentrazone provided only fair redroot pigweed control. Imazamox plus Quad 7 caused some initial leaf discoloration, but the crop quickly recovered. Dry bean stands were reduced approximately 25% with flumioxazin. No visible crop injury or stand reduction was observed with sulfentrazone. The soil pH and organic matter content at the Washburn site is 7.5 and 3.0%, respectively. At Underwood, imazamox at 0.031 lb/A in combination with bentazon, fomesafen, NIS, or Quad 7 provided good to excellent control of wild mustard and foxtail. Flumioxazin at 1.25 oz and sulfentrazone at 0.25 lb (each followed by sethoxydim) provided fair to good control of wild mustard and excellent foxtail control. Flumioxazin and sulfentrazone reduced the crop stand approximately 20%. There was no visible injury with imazamox. The soil pH and organic matter content at Underwood is 7.5 and 3.5%, respectively. At Minot, imazamox combined with fomesafen or bentazon generally provided poor control of biennial wormwood and kochia. Flumioxazin at 1.5 oz and sulfentrazone at 0.125, 0.25, or 0.5 lb/A provided good to excellent control of biennial wormwood and kochia. Flumioxazin caused severe crop injury that resulted in a 44% yield reduction. There was little to no injury with sulfentrazone. The soil pH and organic matter content at the Minot site is 5.5 and 4.3%, respectively. [Paper Number 66]

MANAGEMENT OF BIENNIAL WORMWOOD IN SOYBEAN AND DRY BEANS George O. Kegode* and Brian Jenks, Assistant Professor Department of Plant Sciences, North Dakota State University, Fargo, ND 58105; and Weed Scientist, North Central Research Extension Center, Minot, ND 58701.

Abstract. Biennial wormwood (*Artemisia biennis*) is an important weed in the northern Great Plains and primarily is economically important in soybean and dry beans. Increasing soybean and dry bean acreage, above average precipitation from 1993 to present, and tolerance of biennial wormwood to several herbicides that are routinely used for broadleaf weed control in soybean and dry beans all have contributed to the observed increased incidence of biennial wormwood. Studies were conducted to evaluate several herbicides for biennial wormwood control in soybean at Fargo, ND, and pinto bean at Minot, ND, in 2000. Two sites were used at each location and all had acceptable biennial wormwood populations. In pinto bean, preemergence-applied sulfentrazone at 2 to 8 oz/A, metribuzin at 4 oz/A, and flumioxazin at 1.5 oz/A all provided greater than 90% control of biennial wormwood at the final evaluation date. Flumioxazin, however, caused significant injury to pinto bean which resulted in a yield reduction of 44%. In soybean, preplant incorporated flumetsulam & metolachlor at 0.8 plus 29.9 oz/A, flumetsulam at 0.8 oz/A, and metribuzin at 4 oz/A generally gave better than 90% control of biennial wormwood at the final evaluation date. Poor control of biennial wormwood with sulfentrazone at 4 oz/A at Fargo was probably due to the dry period immediately following application. Flumetsulam effectively controlled biennial wormwood at Fargo but not at Minot. The soil pH was 7.5 at Fargo and 5.5 at Minot, and flumetsulam is recommended for use in soils with pH ranging from 5.9 to 7.8. Flumetsulam has greater activity as soil pH increases so the lack of control by flumetsulam at Minot may have been due to low soil pH. Bentazon split-applied at 8 plus 8 oz/A gave greater than 90% control at both locations, whereas a single application at 16 oz/A gave 56 to 90% control of biennial wormwood. Biennial wormwood emergence tends to be erratic, so many weed sizes can be present. The best control was achieved when seedlings were treated before they were taller than 3 inches. [Paper Number 67]

TOLERANCE OF ROUNDUP READY COTTON TO TOPICAL AND POST-DIRECTED GLYPHOSATE APPLICATIONS. William B. McCloskey* and Hal S. Moser, Associate Specialist and Assistant Research Scientist, Department of Plant Sciences, University of Arizona, Tucson, AZ 85721-0036.

Abstract. The tolerance of Roundup Ready cotton to topical and post-directed applications of glyphosate was evaluated in a series of experiments conducted in 1996 to 2000 at three University of Arizona Experiment Stations; the Maricopa Agricultural Center (MAC) at an elevation of 1,000 ft, the Marana Agricultural Center (MAR) at an elevation of 1,800 ft, and the Safford Agricultural Center (SAC) at an elevation of 3,000 ft. The experimental plots were typically 4 rows wide by 40 ft in length arranged in a randomized complete block design with six to eight replications depending on location. Glyphosate was applied topically at 0.75, 1.125 and 1.5 lb ae/A at the 2 to 4 leaf growth stage and at various times after the 4 leaf growth stage. Post-directed applications of glyphosate at 0.75, 1.125 and 1.5 lb ae/A were also made following topical glyphosate applications in some treatments. The post-directed applications were made at various growth stages between six leaf and 18 in tall cotton. In addition, the post-directed applications were either directed at the base of the cotton with the spray patterns of nozzles on either side of the seed line intersecting at the cotyledonary node (minimal contact of foliage with glyphosate) or the spray patterns intersected about 6 in above the bed top (i.e., sloppy post-direct) leading to substantial glyphosate contact with cotton foliage. The experiments were plant mapped and machine harvested using a spindle picker modified for harvesting plots. The data were analyzed using SAS. Topical applications of glyphosate at 0.75, 1.12, and 1.5 lb/A made before the fifth true leaf growth stage had no effect on cotton yield as compared to plants that were not treated with glyphosate in all experiments. Topical applications made after the fifth true leaf growth stage (equivalent to five node growth stage) had variable effects on cotton yield depending on year and location. At MAR in 1999, 0.75 lb/A topical glyphosate applications at the 7, 11, and 12 node growth stage did not significantly reduce yield. In contrast, at MAC in 1997, 0.75 lb/A topical glyphosate applications made at the 6, 11, and 14 node growth stages reduced yield 5.9 (not statistically significant), 60, and 20.6%, respectively. Plant mapping in both locations showed a change in boll distribution with topical applications made after the five node growth stage causing boll distribution to shift up the plant (i.e., bolls occurred on fruiting branches higher in the plant) and at fruiting positions further out on individual fruiting branches. The difference in yield results between the two locations was due to the hotter weather at MAC in 1997 that resulting in a lack of boll retention above about node 16 combined with early termination and harvest that year at MAC. In contrast, at MAR in 1999, late season boll retention was good so that

late season lint production compensated for bolls aborted earlier in the season by topical glyphosate applications. At all locations and in all years where the treatments were included in the experiments, a single topical 0.75 lb/A glyphosate application followed by two or three 0.75 lb/A post-directed glyphosate applications did not affect yield. Glyphosate post-directed at rates of 1.12 and 1.5 lb/A multiple times and especially, sloppy post-directed applications of glyphosate at the higher rates caused significant yield reductions. Plant mapping data indicated a shift in boll distribution similar to that observed in the treatments receiving post-six node topical glyphosate applications. The data indicate that off-label glyphosate applications change the distribution of bolls on cotton plants and have the potential to reduce yield depending on late-season environmental conditions and insect pressures that affect compensatory, late-season boll production and retention. [Paper Number 68]

SPURRED ANODA COMPETITION IN WIDE ROW AND ULTRA NARROW ROW COTTON. William T. Molin[1], H. Harish Ratnayaka[2], Tracy M. Sterling[2], Plant Physiologist, Postdoctoral Fellow and Associate Professor, [1]Southern Weed Science Research Unit, USDA-ARS, Stoneville, MS 38776 and [2]Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces, NM 88003

Abstract. Spurred anoda [*Anoda cristata* (L.) Schlecht.] competition was investigated in two cotton species, Delta Pine 5415 (*Gossypium hirsutum* L.) and Pima S-7 (*G. barbadense* L.), under wide (1 m) and ultra narrow (0.25 m) row spacings. These species were selected because they have different growth patterns and yield potentials. A split plot randomized complete block design was used with row spacing and cotton species as the main factors and spurred anoda densities as the subplots. The weed densities were 0, 6, 12, 24, 48 and 96 spurred anoda per 12 m^2. Seed cotton, plant biomass distribution and plant mapping were determined after defoliation to assess the effects of competition on vegetative growth and yield. Seed cotton yields and boll number decreased exponentially as the spurred anoda density increased for both species and row spacings. The overall decrease in seed cotton yield was from 401 to 167 gm and boll number from 151 to 84. Fruiting patterns were not affected by spurred anoda density. Branch biomass decreased as spurred anoda density increased for both species under wide row spacing but not under ultra narrow row spacing. Thus, the decrease in yield resulting from competition from spurred anoda under wide row spacing was perhaps due to a reduction in fruiting sites. Contrarily, plant mortality increased as spurred anoda density decreased for both species under ultra narrow row spacing but not under wide row spacing. Thus, the yield decrease under ultra narrow row spacing was probably due a reduction in plant number. The reduction in yield in response to competition from spurred anoda resulted from different mechanisms for the different row spacings. In summary, row spacing influenced the mechanism of yield reduction resulting from spurred anoda competition in cotton. Thus, the role of row spacing and tolerance to stress from competition is investigated. [Paper Number 69]

BASIC SCIENCES

DIURON-RESISTANT ANNUAL BLUEGRASS IS RESISTANT TO NORFLURAZON. Bradley D. Hanson* and Carol Mallory-Smith, Graduate Research Assistant, Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339; and Associate Professor, Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002.

Abstract. Repeated use of diuron in perennial grass seed crops in western Oregon has resulted in several populations of annual bluegrass with resistance to diuron. Field experiments are underway to identify herbicide alternatives to diuron. Annual bluegrass control with norflurazon was different between two field trials in 1999. At the field site with a diuron-resistant biotype of annual bluegrass (R/S = 3.18) control was less than at a site with a known diuron-susceptible biotype. Diuron-resistant and –susceptible biotypes of annual bluegrass were subjected to a range of norflurazon doses in the greenhouse. Plant biomass 14 DAP was used to calculate GR50 values for each biotype. The R/S ratio for norflurazon in these experiments was 4.8; thus, confirming that diuron-resistant annual bluegrass is resistant to norflurazon. [Paper Number 70]

INDIRECT EFFECTS OF HERBICIDES ON AVIAN FOOD RESOURCES AND BENEFICIAL ARTHROPODS. Rebecca L. Taylor*, Bruce D. Maxwell, Graduate Student and Associate Professor, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717.

Abstract. Heavy herbicide use has been implicated in the decline of British game-bird populations. Multiple studies support the hypothesis that herbicide use and the concomitant reduction in weeds cause a reduction in arthropods, even in the absence of insecticides. Arthropod reduction, in turn, causes game-bird chicks to starve and their populations to decline. Furthermore, predatory arthropods have been shown to display a similar, negative association with sprayed, relatively monocultural areas. Effects of herbicides on arthropods consumed by game-bird chicks have not been researched in North America. We conducted a randomized complete block experiment, comparing plant and insect populations in herbicide sprayed and unsprayed plots that simulate wheat fields and adjacent idle areas. We tested the following hypotheses. Herbicide treated farm fields contain lower weed volume and plant diversity than unsprayed fields, as well as lower abundance, biomass and diversity of arthropods. Arthropod abundance, biomass and diversity decline with increasing distance from an uncultivated, relatively high plant diversity field edge. Uncultivated, relatively high plant diversity areas contain higher arthropod abundance, biomass and diversity than nearby crop monocultures. To test these hypotheses, we sampled plants in quadrats, and collected insects by pitfall trapping and sweep netting. Unsprayed plots had a significantly greater volume of weeds than sprayed plots, and supported a significantly greater biomass of vegetation-dwelling chick-food arthropods and a significantly higher number of ground-dwelling beneficial arthropods. Furthermore, numbers of beneficial arthropods decreased significantly with increasing distance from an idle, fencerow area. Thus birds may suffer negative impacts from conventional herbicide weed management. [Paper Number 71]

INTERFERENCE BETWEEN YELLOW MUSTARD OR CANOLA WITH WILD OAT IN THE FIELD. Oleg Daugovish* and Donald C. Thill, Graduate Student and Professor, Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339.

Abstract. Use of alternative crops is an important tool in non-chemical suppression of wild oat in cereal grain production. An experiment was conducted near Genesee, Idaho in 1999 and repeated in 2000 to compare interference between 'Sunrise' canola and wild oat with 'Idagold' yellow mustard and wild oat. The study was an addition series design with all possible weed-crop combinations of five densities (0, 75, 150, 225 and 300 plants/m^2). Plant above-ground biomass, crop seed yield and wild oat seed production were determined. The data were used to develop and compare models that quantify intra- and interspecific interference for both crops. In monocultures yellow mustard yielded 30% more than canola and seed yield of both crops was independent of crop

density. Wild oat had no effect on yellow mustard yield at any density, while canola yield was reduced, on average, by 40% for all wild oat/canola proportions. Wild oat seed production was reduced 64% by canola and 90% by yellow mustard on average compared to wild oat in monoculture. Wild oat seed production tended to increase with increasing wild oat density in wild oat/canola proportions. Yellow mustard decreased wild oat seed production independently of wild oat density. Greater competitive ability of yellow mustard with wild oat compared to canola also was observed previously in interference experiments in greenhouse. [Paper Number 72]

MODELLING WILD OAT - WHEAT STEM SAWFLY - SPRING WHEAT INTERACTIONS WITH SPATIALLY-REGISTERED DATA. Sharlene Sing[1]*, Bruce Maxwell[1], and Greg Johnson[2], Graduate Student, Associate Professor, Department Head, [1]Department of Land Resources and Environmental Sciences, [2]Department of Entomology, Montana State University, Bozeman, MT 59717

Abstract. Crop fields seldom present a homogeneous host matrix for seasonal herbivore colonization. Intra- and inter- specific competition result in a variable crop density and patchily-distributed weeds. Herbivore invasion gradients are thought to influence the relative vulnerability of both individual crop plants and confer variable risk of infestation to specific regions of the crop field. Crop, weed and herbivore density and location were reported in spatially-registered data collected from ten hectare study plots situated within crop fields. The methodology utilized to quantify and characterize crop-weed-herbivore interactions from this field data will be discussed. Results from this analysis are used to model wheat stem sawfly and wild oat impacts on spring wheat yield. [Paper Number 73]

SIMULATION OF ECONOMIC OPTIMIZATION OF SITE-SPECIFIC MANAGEMENT IN WILD-OAT INFESTED FIELDS. Nicole Wagner*, Bruce Maxwell, Alvin J. Bussan, Edward Luschei, Lee van Wychen. Graduate Student, Associate Professor, Assistant Professor, Graduate Student, Graduate Student, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717.

Abstract. Simulation experiments and analysis have repeatedly demonstrated the relative value of site-specific over conventional management. Measured wild oat distributions in Montana wheat and barley fields have verified the value of precision wild oat management. Our research specifically demonstrates the economic advantages (or disadvantages) in site-specific application of wild oat herbicides, coupled with variable nitrogen application and seeding rates. In order to determine the economic optimization of agricultural resources, we have designed an input management decision aid that considers the spatially specific interaction of spring grain seeding rate, nitrogen application rate, and herbicide application rate in wild oat infested fields over a 3-year period. Our simulation model outputs the best management strategy for the field and compares it against a high input and low input approach to management. Monte Carlo simulation was used to determine the probability of obtaining the mean net return with the best management practice recommended. We have found that the economic advantages of site specific management increase with the availability of natural resources, such that natural resource quantity is the dominant factor in the viability of site specific management. [Paper Number 74]

THE RELATIVE ADVANTAGE OF BARNYARDGRASS CONTROL IN LIGHT OF IMPERFECT INFORMATION. Edward Luschei*, Lee Van Wychen, Bruce Maxwell, Alvin Bussan, Graduate Student, Graduate Student, Associate Professor, Assistant Professor, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717.

Abstract. The economic threshold concept has been used as a management guideline to indicate when weed control is warranted. The models and the inference procedures used to establish the threshold level for a given weed management scenario contain many assumptions. Ambiguity of model structure and parameters creates threshold distributions rather than point estimates. Weed density estimates contain further uncertainty because they are generally calculated from population subsamples. The effects of model and data uncertainty are explored for published data on Barnyardgrass control. In general, uncertainty due to density estimation is capable of reducing the effective threshold to zero, depending on the risk preferences of the decision-maker. Stochastic stage-structured models of the Barnyardgrass life cycle indicate that even the economic optimum threshold is greater than zero for reasonable levels of risk aversion and weed density uncertainty. [Paper Number 75]

EFFECT OF SPRING WHEAT SEEDING RATE ON WILD OAT COMPETITION: GROWTH ANALYSIS. Q. Xue* and R. N. Stougaard, Postdoctoral Research Scientist and Associate Professor, Montana State University, Northwestern Agricultural Research Center, Kalispell, MT 59901.

Abstract. Wild oat management is based mainly on herbicide technologies. However, economic considerations, environmental concerns, and the increased occurrence of herbicide resistance biotypes have made the adoption of competitive cropping systems increasingly important. Increasing crop seeding rates has been found to be an effective way to suppress wild oat in spring barley and wheat. However, the mechanistic processes involved with this response are poorly understood. The objective of this study was to quantify differences in wild oat growth and development as a function of spring wheat density. A field trial was conducted in Kalispell, MT during 2000. The treatment design was a four by two factorial and consisted of four wild oat densities (0, low, moderate, and high), and two spring wheat seeding rates (175 and 280 plants m-2). The experimental design was a split plot where wild oat densities represent the whole plot factor and spring wheat seeding rate represent the subplot effect. Treatments were replicated four times. Starting four weeks after sowing, both species were sampled on a bi-weekly basis from randomly placed 0.14 m2 quadrates. Each species was separated into leaves, stems and spikes, and the biomass of each individual component was determined. Green leaf area (LAI) was determined for each species with a leaf area meter. Crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR), specific leaf area (SLA), leaf area ratio (LAR), and leaf weight ratio (LWR) were determined for each species based on the biomass and leaf area data. There were significant differences in growth parameters between spring wheat and wild oat plants. Spring wheat plants had greater CGR and NAR than wild oat plants, particularly during the early developmental stages. However, wild oat plants had greater SLA, LAR, and LWR resulting in greater LAI values relative to spring wheat. As wild oat density increased, spring wheat LAI, biomass, CGR, RGR, and NAR were reduced. Increased spring wheat seeding rate significantly decreased wild oat LAI, biomass and CGR. Wild oat density and spring wheat seeding rate had little effect on SLA, LAR, and LWR in either species. [Paper Number 76]

SIMULATING SPATIAL AND TEMPORAL DYNAMIC INTERACTIONS AMONG SPRING WHEAT, WILD OAT AND WHEAT STEM SAWFLY. Bruce Maxwell*, Sharlene Sing, Greg Johnson, Associate Professor, Graduate Student, Department of Land Resources and Environmental Science, Professor, Department of Entomology Montana State University, Bozeman, MT 59717

Abstract. The interaction of spring wheat, wild oats and wheat stem sawfly was studied with a simulation model that would allow comparison of a range of spatial distribution conditions of wild oat and sawfly and the subsequent simultaneous impact of these pests on the spring wheat yield. The interaction among the weed and insect pest is particularly interesting because wheat stem sawfly eggs that are laid in the stems of wild oat become larvae but they do not survive to the adult stage like they do in spring wheat. Thus, the wild oat is an ecological sink for the insect pest creating a situation where optimum management, when both pests are present, may include significantly raising the wild oat density threshold. Simulations indicate that increasing wild oat densities along edges of the field adjacent to wheat stem sawfly source populations decreases the total impact on yield and may represent an optimum management approach when both pests are present. [Paper Number 77]

ASSESSMENT OF SOIL SAMPLING METHODS TO ESTIMATE WEED SEEDBANK POPULATIONS.
James A. Mickelson, Robert N. Stougaard, Alvin J. Bussan, Michael G. Particka, Scott Halley, and Susan Kelly, Assistant Professor, Associate Professor, Assistant Professor, and Research Associates, Montana State University, Southern Agricultural Research Center, Huntley, MT 59037, Montana State University, Northwestern Agricultural Research Center, Kalispell, MT 59901, and Montana State University, Bozeman, MT 59717

Abstract. Accurate estimation of weed seedbank populations is necessary for conducting weed demographic research. The objectives of this research were to examine the effects of sample size, soil corer size, and seedbank density on estimation of means and variances of wild oat seedbank populations. Wild oat seedbanks were sampled near Kalispell, MT in 1999 and near Kalispell and Bozeman, MT in 2000. At each site, 2.9% of a 1 m^2 quadrat was sampled to a 15 cm depth using two sizes of soil corers. Soil was sampled from each quadrat by collecting three cores using a 9.9 cm by 9.9 cm square soil corer and collecting either 19 cores from a 4.4 cm diameter circular corer (Kalispell sites) or 26 cores from a 3.8 cm diameter circular corer (Bozeman site). Six seedbanks (quadrats) with a range of densities were sampled at each site. At Kalispell in 1999, magnitude of the means varied between the two soil corer sizes. However, significant difference between mean densities estimated by the two soil corers was detected in only one of six seedbanks (the lowest density seedbank). Sampling variances of the mean and standard errors of the mean for the large corer were greater than or equal to those of the small corer in four of six seedbanks. However, coefficients of variation for the large corer were less than those of the small corer for all six seedbanks. [Paper Number 78]

INTERACTION BETWEEN COMPETITION AND OXIDATIVE STRESS TOLERANCE IN COTTON AND SPURRED ANODA. H. Harish Ratnayaka[1], William T. Molin[2], Tracy M. Sterling[1], Postdoctoral Fellow, Plant Physiologist, and Associate Professor, [1]Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces, NM 88003 and [2]Southern Weed Science Research Unit, USDA-ARS, Stoneville, MS 38776.

Abstract. The effect of intraspecific and interspecific competition on the oxidative stress tolerance of two cotton cultivars, Delta Pine 5415 (*Gossypium hirsutum* L.) and Pima S-7 (*Gossypium barbadense* L.), was investigated under greenhouse conditions. Delta Pine or Pima was grown one or three plants per pot for intraspecific competition studies while two plants of spurred anoda [*Anoda cristata* (L.) Schlecht.], an important weed in cotton, were grown with a single plant of either Delta Pine or Pima for interspecific competition. A single plant of spurred anoda was maintained per each replication, as well. Biomass was reduced 60% in Delta Pine and 48% in Pima due to interspecific competition, a greater reduction compared to intraspecific competition, at 11 weeks after planting (WAP). At three WAP (pre-canopy closure), net photosynthesis and photochemical quantum yield [$(F_{ms}-F_s)/F_{ms}$] were not different among treatments. Delta Pine and spurred anoda had greater chlorophyll a+b content than Pima while carotenoid content was highest in spurred anoda. The two cotton cultivars had constitutively greater catalase and ascorbate peroxidase (APX) activity than spurred anoda, at pre-canopy closure with similar lipid peroxidation levels in all species. A six-day drought at 8 WAP decreased relative water content (RWC) 12% in Delta Pine, and 11% in Pima with intraspecific competition, and RWC was decreased 23% and 15%, respectively, with interspecific competition. Drought reduced net photosynthesis by 33% and 67% in Delta Pine, and 53% and 51% in Pima with intraspecific and interspecific competition, respectively. Competition at 8 WAP did not influence activities of catalase, glutathione reductase (GR) or APX in any species, except for the reduction in catalase and GR activities in Delta Pine with interspecific competition. APX activity increased 62% in Delta Pine and 66% in Pima due to drought with catalase and GR activities unaffected. Competition or drought did not influence lipid peroxidation in any of the species. [Paper Number 79]

PHYSIOLOGICAL CHARACTERIZATION OF DICAMBA RESISTANCE IN KOCHIA. William E. Dyer*, Harwood J. Cranston, and Anthony J. Kern, Professor and Graduate Research Assistants, Department of Plant Sciences and Plant Pathology, Montana State University, Bozeman, MT 59717-0312.

Abstract. Extensive use of the auxinic herbicide dicamba has selected for resistant (R) kochia populations in several areas of the United States. Dose response studies show that an inbred R line derived from plants collected near Fort Benton, MT is 4- to 5-fold more tolerant to dicamba than susceptible (S) plants. This line is also resistant to the related auxinic herbicides MCPA, 2,4-DB, and picloram as well as to unrelated sulfonylurea and imidazolinone herbicides. Other populations with resistance to fluroxypyr have been verified. Resistance to dicamba cannot be attributed to altered rates of herbicide uptake, translocation or metabolism. We are currently investigating the hypothesis that resistance is conferred by reduced herbicide binding to the auxin receptor protein (a.k.a. auxin binding protein, ABP) on the cell surface. We speculate that such a mutation in ABP may also affect endogenous auxin binding and thus alter auxin-mediated responses such as gravitropism and root growth inhibition. The gravitropic responses of 6-cm tall R and S kochia seedlings were compared by determining rates of stem vertical reorientation after the plants were shifted to a horizontal position. The rate of stem bending in two S accessions was 3.9° per 10 min, while the rate of the dicamba-resistant inbred line was only 1.2° per 10 min. Interestingly, the rate of an accession with resistance to both dicamba and fluroxypyr was intermediate at 2.4° per 10 min. These results show that the gravitropic response in R kochia is impaired, and suggest that a perturbation of auxin perception or signal transduction could be responsible for this phenotype. Further studies examining the effects of exogenous indoleacetic acid (IAA) and synthetic auxins on root growth inhibition showed that R plants were less sensitive than S plants. To compare rates of auxin-inducible gene expression in R and S kochia, suspension cell cultures will be treated with IAA and mRNA levels of ACC synthase, a gene known to be rapidly induced by auxin, will be determined. We are currently attempting to clone the kochia ABP using a combination of PCR and library screening with heterologous probes. Our eventual goal is to obtain and compare the DNA sequences of ABP from R and S kochia. The evolution of weed populations like these with resistance to several unrelated herbicides is particularly troubling, and underscores the need to implement effective herbicide resistance management strategies. [Paper Number 80]

RESPONSE OF THE XERIC TALLGRASS PRAIRIE TO PICLORAM HERBICIDE APPLICATIONS FOR DIFFUSE KNAPWEED CONTROL AT THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, COLORADO. Jody K. Nelson*, Botanist/Plant Ecologist, Exponent, Boulder, CO 80301.

Abstract. Diffuse knapweed has become a serious threat to the native grasslands at the Rocky Flats Environmental Technology Site (Site), a former nuclear weapons component facility owned by the U.S. Department of Energy. Because the xeric tallgrass prairie at the Site is an imperiled, relict plant community, a study was begun in 1997 to evaluate the effect of picloram applications (0.25 lb ae/A), used for diffuse knapweed control, on the native prairie species. Annual monitoring of control and treatment plots from 1997 to 2000, measured species richness, cover, and frequency, as well as cactus and diffuse knapweed density. Results have shown overall species richness and overall foliar cover has not been substantially effected by the herbicide applications. Species diversity declined significantly from 0.83 to 0.56 and forb cover decreased significantly by 69% after the herbicide application. However, two years after the treatment, species diversity and forb cover were no longer statistically different from the control plot. In 2000, native cover equaled that of the control plot, while non-native cover continued to be depressed. Graminoid cover increased after the herbicide application in response to lowered forb competition. In the treatment plot, prickly pear cactus density decreased by over 90% and diffuse knapweed densities were reduced significantly and remain depressed. The forb species most affected by the herbicide included those in the Asteraceae, Fabaceae, and Brassicaceae, although not all species in these families were equally affected. Results suggest that prudent use of picloram does not have a deleterious effect on a native prairie. [Paper Number 81]

THE COMBINED EFFECT OF HERBICIDES AND *SPHENOPTERA JUGOSLAVICA* ON DIFFUSE KNAPWEED POPULATION DYNAMICS AND *S. JUGOSLAVICA* REPRODUCTION SUCCESS. Robert Wilson*, K. George Beck, and Philip Westra, Graduate Student and Professors, Department of Bio-agricultural Science and Pest Management, Colorado State University, Fort Collins, CO 80523.

Abstract. Sphenoptera jugoslavica negatively influences diffuse knapweed populations, but inconsistently in space and time. In the spring of 1998, a three-year field experiment was established to determine if low rates of picloram or clopyralid in combination with *S. jugoslavica* could enhance *S. jugoslavica* control of diffuse knapweed. The experiment was located at three sites in Colorado where *S. jugoslavica* was previously released in 1993. Picloram and clopyralid were applied separately to plots at 0, 0.5, 1, and 2 oz/A during June or September (12 treatments) in a randomized complete block design with four blocks. Density and cover measurements were collected three times during the growing season in permanent quadrats to determine herbicide effects on the growth of diffuse knapweed. Diffuse knapweed plants were harvested outside the permanent quadrats to determine seed production and the percentage of plants bearing *S. jugoslavica* larvae. The spring following herbicide application, all picloram rates applied in June and the 0.5 oz/A rate of clopyralid applied in June increased the percentage of plants infested by *S. jugoslavica* compared to the control (untreated plots). None of the herbicide treatments increased the percentage of plants infested by *S. jugoslavica* compared to the control two years following herbicide application, suggesting the herbicides' positive effects on *S. jugoslavica* the year of herbicide application did not last into the next year. Two years following herbicide application, the June applied 2 oz/A rate of both herbicides decreased diffuse knapweed bolted plant density by more than 70% compared to the control. Results show that combining low rates of picloram or clopyralid applied in June with *S. jugoslavica* improves control of diffuse knapweed without harming *S. jugoslavica* population density. [Paper Number 82]

RUSSIAN KNAPWEED, *ACROPTILON REPENS*, DOMINANCE AS RELATED TO SOIL CLAY CONTENT. Harold D. Fraleigh[1]*, K. George Beck[2], and Debra P. Peters[3], Graduate Research Assistant, Professor, and Research Scientist, [1]Natural Resources Ecology Laboratory, [2]Department of Bioagricultural Sceinces and Pest Management, Colorado State University, Fort Collins, CO 80523, and [3]USDA-ARS, Jornada Experimental Range, Box 30003, MSC 3JER, NMSU, Las Cruces, NM 88003

Abstract. The historical literature on Russian knapweed, *Acroptilon repens*, states that the plant grows well regardless of soil texture , although no data is presented in support. Our observations in Colorado suggested that there may be a correlation between soil texture and the dominance in Russian knapweed stands. We hypothesized that there is a positive relationship between soil clay content and Russian knapweed dominance of the vegetative community. We surveyed the vegetation at randomly selected Russian knapweed infestations throughout the state of Colorado. Regression of Russian knapweed density, Russian knapweed cover, total grass cover, and litter cover against soil clay content each indicated no correlation. However, all four of the field vegetation measurements were more variable at sites with lower soil clay content compared to sites with higher soil clay content. [Paper Number 83]

INFLUENCE OF HERBICIDES, MOWING, AND INSECTS ON THE SEASONAL CHANGES IN CARBOHYDRATES IN THE ROOTS OF CANADA THISTLE. Robert G. Wilson, Professor, University of Nebraska, Scottsbluff, NE 69361

Abstract. Field experiments were conducted near Scottsbluff, NE to assess the seasonal changes in total sugars, glucose, fructose, sucrose, and fructans in the roots of Canada thistle. Plant roots were exhumed from the soil monthly for a 2 yr period and analyzed with high-performance anion exchange chromatography. In addition, the herbicides 2,4-D and dicamba and mowing were applied to selected plants in the fall at various time periods before and after freezing temperatures. Canada thistle plants infested and not infested with *Ceutorhynchus litura* were also monitored during the summer to examine the influence of insect feeding on root carbohydrates. The initiation of Canada thistle growth in May was accompanied by an increase in sucrose and fructose. During flowering in June, glucose and fructose concentrations increased. From June to October, there was an increase in mid- to high-degree of polymerization fructans. Freezing soil temperatures in November caused an increase in sucrose and decline in high-degree of polymerization fructans. When soil froze in December sucrose and low-degree of polymerization fructans increased and mid- to high-degree of polymerization fructans decreased. Application of dicamba 9 d after the first frost caused an increase in sucrose and depolymerization of fructans. Mowing 9 d after the first frost caused a decrease in sucrose and depolymerization of fructans. *Ceutorhynchus litura* feeding initially caused a decrease in root carbohydrates but by the end of the summer insect damaged plants had recovered and root carbohydrates were similar between damaged and not damaged plants. [Paper Number 84]

USE OF IMAZAPIC FOR CONTROL AND RESTORATION OF *BROMUS* INFESTED AREAS. Jennifer L. Vollmer* and Joseph G. Vollmer, Market Development Specialist/Invasive Species and Market Development Specialist/Industrial Vegetation Product Group, BASF Corporation, 26 Davis Drive, RTP, NC 27709.

Abstract. Imazapic is a new tool for the release of desired species from cheatgrass and downy brome, and for restoration of burned areas predominately made up of *Bromus spp.* Imazapic is a reliable tool for control of these grasses and allows for immediate reestablishment of desired vegetation. Cheatgrass and downy brome are best controlled with a preemergence application of imazapic and may give two years of control. This requires a fall application for control of these winter annuals. When brome species exceed the 4 leaf stage, control with imazapic is difficult and a high rate of 0.125 to 0.15 lbs. ae/A is needed for acceptable control. The greater the amount of residue, the higher the rate of imazapic is needed in order to get sufficient herbicide to the soil to control emerging brome seedlings. Fall 1999 applications of imazapic at 0.032 lbs. ae/A to an area burned during the summer of 1999, gave 100% control the following March. By November of 2000, after cheatgrass had begun germination, 0.063 of

imazapic still achieved excellent control of 90%. The area had been seeded the fall of 1999 to Vavilov Siberian wheat and Bozoiski Russian wildrye with no decrease in population up to the 0.125 lbs. ae/A imazapic rate. Treatments were also applied in the fall of 1999 to a cheatgrass invaded area previously planted in 1997. Due to the light duff layer, 15% to 30% trash, 0.094 lbs. ae/A was needed for greater than 90% control the first year; however, 0.032 gave 90% control the following November. Sandbergs bluegrass, bottlebrush squirreltail and green rabbit brush were released. [Paper Number 85]

INVASIVE WEED MANAGEMENT AND RANGELAND IMPROVEMENT WITH IMAZAPIC. Daniel D. Beran*, Joseph G. Vollmer, and Jennifer Vollmer, Rangeland Consultant, Senior Technical Specialist, and Senior Market Development Specialist, BASF Corporation, Research Triangle Park, NC 27709.

Abstract. Invasive weeds threaten the productivity, diversity, and wildlife habitat of western rangeland. Imazapic has the potential to control many invasive weeds and be a component of rangeland improvement practices. Experiments were initiated in spring and fall 1999 to evaluate the efficacy of imazapic applied alone or in combination of growth regulator herbicides on several invasive weeds. Results from experiments in Montana and Utah indicated that Russian knapweed control with fall-applied imazapic was greatest (87-95%) when treated at 0.188 lb ai/A. Similarly, fall-applied imazapic at 0.188 lb/A provided 83-96% control of Dalmatian toadflax in experiments conducted in Montana, Wyoming, and Colorado. In these experiments, the addition of 2,4-D ester or amine at rates up to 1 lb/A to imazapic treatments did not improve control. Diffuse knapweed and broom snakeweed were not effectively controlled with imazapic. Diffuse knapweed control required the addition of 2,4-D ester or picloram at 0.25 lb/A, and broom snakeweed control required the addition of picloram at 0.25 lb/A. Downy bromegrass was a common species in most experiments and imazapic provided consistent control when applied at 0.125 lb/A. The additional benefit of downy bromegrass control makes imazapic a valuable tool in invasive weed management when used as the primary herbicide or in a tank mixture with common growth regulator herbicides. [Paper Number 86]

DIFLUFENZOPYR IN COMBINATIONS WITH DICAMBA FOR WEED CONTROL IN PASTURES.
M.C. Boyles*, BASF Corp. Ripley, Okla., and K.L.Smith, University of Arkansas, Monticello.

Abstract. Studies were conducted in Texas and Oklahoma in 1997, 1998, 1999, and 2000 to evaluate diflufenzopyr applied alone (0.01, 0.05, 0.075, 0.1 lbs ai) alone or in combination with dicamba for the control of key difficult to control weed species in pasture. No pasture injury was noted from any rate of diflufenzopyr applied alone or in combination with 0.125 and 0.25 lbs ai of dicamba on bermudagrass, little and big bluestem, and bahiagrass. Study results showed that diflufenzopyr applied alone did not provide acceptable efficacy on any weed species tested. Dicamba applied alone at 0.125 lbs ai also did not provide acceptable efficacy on any weed species. Dicamba applied alone at 0.25 lbs ai provided acceptable (>80%) control of only spotted beebalm and camphorweed. Studies have also shown that diflufenzopyr applied at 0.05 and 0.075 lbs ai in combination with dicamba (0.125, 0.25 lbs ai) provided increased control on all species tested compared to equal rates of dicamba applied alone (the improved efficacy with the tankmix was a synergistic response as defined by Colby's formula). Data supports the use of diflufenzopyr in combination with dicamba in improved control of yellow thistle, spotted beebalm, bullnettle, camphorweed, groundcherry, woolly croton, dogfennel, and sericea lespedeza. Research studies showed that the most efficacious and synergistic rate of diflufenzopyr in combination with dicamba was 0.05 to 0.075 lbs ai. Combinations of diflufenzopyr plus dicamba also provided commercial control of annual broomweed, western ragweed and sericea lespedeza. Diflufenzopyr plus dicamba (0.013 + .03 lb ai) provided equal or better efficacy on annual broomweed and western ragweed than Weedmaster((0.5 lbs ai), Rave((0.16 lbs ai), Clarity(plus Ally((0.125 + 0.0075 lbs ai), or Ally((0.0075 lbs ai). Results also showed that diflufenzopyr plus dicamba (0.013 + 0.03 lbs ai) applied alone provided equal or better efficacy on sericea lespedeza than Weedmaster((0.5 lbs ai) or Rave((0.16 lbs ai). Treatments of diflufenzopyr plus dicamba plus Ally((0.013 + 0.03 + 0.0075 lbs ai) provided equal or better control on sericea lespedeza than that provided by Rave (0.16 lbs ai), Weedmaster((0.5 lbs ai), Ally((0.0075 lbs ai) or Clarity(plus Ally((0.125 + 0.0075 lbs ai). Diflufenzopyr plus dicamba (0.05 + 0.125 lbs ai) provided excellent (>90%) efficacy on sericea lespedeza. Weedmaster(, Ally(, and Rave(did provide acceptable efficacy on annual

broomweed and western ragweed, but these treatments did not control sericea lespedeza. Study results 12 months after treatment showed that diflufenzopyr plus dicamba plus Ally((0.013 + 0.03 + 0.0075 lbs ai) provided significantly better control (>90%) of sericea lespedeza than provided by Ally((0.0075 lbs ai), Clarity(plus Ally((0.125 + 0.0075 lbs ai), Weedmaster((0.5 lbs ai), Rave((0.16 lbs ai), Weedmaster(plus Ally((0.5 + 0.0075 lbs ai) or 2,4-D amine (1.0 lbs ai). [Paper Number 87]

TEACHING AND TECHNOLOGY

PREDICTING SUSCEPTIBILITY OF INVASIVE SPECIES USING GIS. John H. Gillham[1]*, Ann L. Hild[2], and Tom D. Whitson[3], Graduate Student, Assistant Professor, and Professor, [1&2]Department of Renewable Resources, [3]Department of Plant Sciences, University of Wyoming, Laramie, WY, 82071.

Abstract. Managing weed invasions has been a problem since the beginning of rangeland management. One of the biggest problems facing resource managers has been simply keeping track of where weed problems exist. Effectively focusing on the most vital areas can allow managers better control of weed infestations. Geographic Information Systems (GIS) can offer a credible solution to this problem. This project was initially performed in the Jack Morrow Hills Wilderness study area near Rock Springs, Wyoming. The project has developed a GIS based model to predict occurrence of five weed species within semiarid rangelands. The five species included in this ArcView extension were black henbane, hoary cress, leafy spurge, perennial pepperweed, and spotted knapweed. The predictive model associates risk of invasion by an individual weed species to its relative geographical location on the ground. These risks are based upon rankings of invasion susceptibility factors for each weed species. A database of these rankings was created in order to allow for easy expansion of additional species in the future. A "spread of known invasions" tool, also included in the model, uses already mapped invasions to predict spread throughout the future based on environmental and biological factors. As well, a report generator option is included within the extension to allow users to quickly develop statistical and control option reports for their invasions. This predictive model allows land managers to more easily and accurately predict invasions and to remotely assess resources of concern in order to better fight the war against noxious weeds. [Paper Number 88]

COOPERATIVE EXTENSION COUNTY OFFICES AND INVASIVE PLANTS: IS THERE A ROLE? Carl E. Bell, Regional Advisor-Invasive Plants, Cooperative Extension, University of California, San Diego, CA 92123

Abstract. Invasive alien plants are impacting rangeland, forests, and natural landscapes in every county in every state in the western US. Are Cooperative Extension (CE) offices providing a response to this issue? A site visit and informal survey of 15 counties in coastal and southern California was conducted to assess the scope of the invasive weed problem in each county. An effort was made to determine the level of awareness of this problem by CE staff and to see what types of resources were being devoted to invasive plants. Invasive plants are present in all counties, but the species and type of habitat impacted varies considerably. In general, CE academics in the area of this study were aware of this problem, but with two exceptions, did not have any type of organized educational or research program for invasive plants. Resources focused on invasive alien plants from outside of CE are much greater throughout this part of California. Groups involved in this issue are a combination of government agencies with land management responsibilities, such as for park, open space, flood control, and wildlife reserves. Non-governmental organizations (NGO's) are also actively involved, either as land owners, such as the Nature Conservancy, or as environmental activists, such as the California Native Plant Society. An educational brochure was produced and distributed to CE academics in this region to provide a basic introduction to the topic and to direct them to other educational resources such as internet websites and reference materials. [Paper Number 89]

CREATING AN INTEGRATED WEED MANAGEMENT PLAN. Alan T. Carpenter*, Thomas A. Murray, and Karin Decker, President, Associate and Resource Planner, Land Stewardship Consulting, Inc., 2941-20th Street, Boulder, CO 80304 and Colorado Natural Areas Program, 1313 Sherman Street, Room 618, Denver, CO 80203.

Abstract. We developed a planning process that landowners and land managers can use to create integrated weed management plans for wild lands. There are seven steps in the process. 1) Describe the property or management area. This is often but not always obvious. 2) Inventory the property or management area for weeds. Focus on areas most likely to harbor the worst weeds. 3) Develop land management goals and weed management objectives. Be mindful of the adage that if you don't know where you are going, any road will get you there. 4) Set priorities for

weed management. These will be based on the weed species present and the locations and sizes of infestations. 5) Select weed management actions. Most weed management focuses on this step and ignores the other steps. 6) Develop an integrated weed management plan. 7) Develop a monitoring plan. Feedback from monitoring will permit learning and adaptive management. This plan plus a wealth of supplementary material is contained in Creating an Integrated Weed Management Plan: A Handbook for Owners and Managers of Natural Lands which is published by the Colorado Natural Areas Program in Denver, CO. [Paper Number 90]

A CENTER FOR FACILITATING THE REGISTRATION OF PEST MANAGEMENT SUBSTANCES FOR MINOR CROP GROWERS IN OREGON. Robert B. McReynolds*, Joe DeFrancesco, Diane Kaufman, Chris Cornwell, Gina Koskella and Karen Cornwell, Area Extension Agent, Research Associate, Area Extension Agent, Research Assistant, Research Assistant, and Bio-Science Technician, North Willamette Research and Extension Center, Oregon State University, Aurora, OR 97002.

Abstract. Oregon produces over 50 minor horticultural food crops with a value to the state economy of over $500 million. The loss of critical pest management substances because of the implementation of the FQPA and the slow pace of new registrations has been a major concern to growers. In Oregon, as in many other states, grower groups, commodity commissions or their representatives have worked independently with manufacturers, state agencies, IR-4 and the EPA in efforts to maintain existing registrations or obtain new ones. Some groups have been successful, but most have found it to be a frustrating experience as they try to navigate among the various agencies, provide them with the information they require and monitor the registration progress of products. In 1995, the principle investigators initiated a new program designed to assist growers in obtaining registrations. A center was established at the North Willamette Research and Extension Center in western Oregon to facilitate the registration of minor crop pest management substances. The Center faculty assists the growers by developing performance data to support requests to the IR-4 Project and then monitors the progress of the products requested. They conduct residue field studies to support petition requests to the EPA for many of the requested products. Once residue analyses data are available they use the information to prepare Section 18 and Special Local Need Requests for submission to the Oregon Department of Agriculture. Since its establishment, the Center has assisted in obtaining more than 25 pesticide registrations for the producers of vegetable, small fruit, tree fruit and nut crops. Funding for the Center relies upon a partnership that recognizes there are many beneficiaries of the program who have vested interests in its success. They are the registrants, the growers, the Oregon Department of Agriculture and the USDA. The majority of the funding, 47% to 55%, is provided by the IR-4 Project to support magnitude of residue field studies. The Oregon Department of Agriculture provides an additional 30% to 35% based upon the recommendation of a Minor Crops Advisory Committee it maintains. Commodity groups and registrants provide the balance of the operating funds. The contribution of Oregon State University is "in kind", through the salaries of the two extension agents who participate in the program and in the use of the NWREC facilities. The Center works directly with some commodity groups and collaborates with extension personnel who have pest management program responsibilities for other groups. None are obligated to use the Center to pursue registrations. The process followed to "facilitate minor use registrations" is defined by the series of steps that follow. The process used to "Facilitate Minor Use Registrations" with Oregon commodity groups. 1. Educate the groups regarding what is required to register products and the responsibilities of each organization. 2. Identify essential pesticides currently registered and potential replacement products. 3. Assess the information available for desired products to determine if it is adequate to support requests to IR-4. 4. Generate the data package, if information is not available from other sources. 5. Submit requests to IR-4 and support priorities. 6. Monitor and report to commodity groups on the progress of projects. 7. Use residue data for state registration requests when appropriate (Section 18 and 24c SLN). The program has documented an economic benefit to Oregon minor crop growers of over $22 million from Section 18 and SLN 24c registrations alone. The economic impact from Section 3 registrations would likely increase that amount significantly. There have also been environmental benefits. Many of the new insecticides registered are target specific and nontoxic to beneficial insects. Other products registered have reduced the use of organosphophates and carbamates, a goal of the EPA. The Center has played a vital role in obtaining minor use pesticide registrations. The success of the program can be credited to the collaborative effort of the USDA/IR-4 Project, the Oregon Department of Agriculture, the manufacturers, the producers and the Center who together are achieving the goal of providing minor use

registrations. The Center "team" and other cooperating extension personnel can be complemented for a successful program that has produced tangible benefits to the growers as well as to the funding organizations. [Paper Number 91]

AGRONOMIC SECTION (Continued from Page 48)

SPRING BARLEY TOLERANCE TO FENOXAPROP AS INFLUENCED BY VARIETY, TIME OF HERBICIDE APPLICATION, AND TANK MIXTURE. Lori J. Crumley* and Donald C. Thill. Graduate Research Assistant and Professor, Plant Science Division, University of Idaho, Moscow, ID 83844-2339.

Abstract. Fenoxaprop/safener (fenchlorazole) is registered for control of wild oat in wheat and barley. However, fenoxaprop alone and in combination with broadleaf herbicides may injure spring barley. Four studies were established to determine the effects of fenoxaprop on growth and yield of spring barley. The effect of two rates of fenoxaprop (0.083 and 0.166 lb/A) on visual injury and grain yield of 20 spring barley varieties was determined near Moscow and Winchester, ID. Klages and Galena, the two most sensitive varieties at both locations, were visibly injured 16%. Grain yield of all barley varieties (no herbicide by variety interaction) was reduced about 10% when treated with fenoxaprop. The response of four spring barley varieties to fenoxaprop in combination with bromoxynil and MCPA was examined near Moscow, ID. Visible injury was slight and grain yield did not differ among treatments, including the untreated control. The effect of two fenoxaprop rates (0.083 and 0.166 lb/A) and six application times on spring barley injury was determined near Moscow, ID. Fenoxaprop applied at 0.166 lb/A to 1 to 2, 3 to 4, 4 to 5, and 6 tiller barley reduced crop height 17 to 36%. In addition, fenoxaprop at 0.083 lb/A reduced crop height 14 and 19% when applied at the 1 to 2 and 4 to 5 tiller stages, respectively. Grain yield in herbicide treated plots tended to be less than control plots, but differences were not significant. [Paper Number 92]

WEED POPULATION DYNAMICS IN GLYPHOSATE RESISTANT CROPS. Sandra M. Frost* and Stephen D. Miller, Masters Candidate and Professor, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071.

Abstract. This 3-year weed shift study maximizes tillage, crop rotation and herbicide selection pressures on weeds in glyphosate resistant corn and sugarbeets. Research was conducted at the Research and Extension Center in Torrington, Wyoming. The study was a two factorial set in a split plot in space. Factors were rotation (continuous corn or corn/sugarbeets) and herbicide (0.84 kg ae/ha glyphosate, 0.42 kg ae/ha glyphosate, rotating glyphosate and no-glyphosate). No change in weed biomass occurred. Number of weeds increased significantly in the no-glyphosate treatment compared to the high or rotating glyphosate treatments from 1998 to 2000. Corn yield was reduced in the corn/sugarbeet rotation. Sugarbeet yield in the low glyphosate treatment was lower than in all other treatments. Volunteer corn and common lambsquarters weed counts increased during the study. Volunteer corn in the continuous corn rotation increased more than volunteer corn in the corn/sugarbeet rotation. Common lambsquarter and hairy nightshade populations increased in the corn/sugarbeet rotation compared to the continuous corn rotation. The low glyphosate treatment gave the least effective common lambsquarter control, the no-glyphosate treatment gave the most effective control, while rotating and high glyphosate gave intermediate control. The seed bank populations responded similarly across all herbicide treatments. A cropping sequence of corn-corn-sugarbeets may provide the best control of common lambsquarters and volunteer corn. [Paper Number 93]

THE EFFECT OF SOIL MOISTURE AND TEMPERATURE ON TOLERANCE OF SPRING WHEAT AND BARLEY AND CONTROL OF WILD OAT WITH TRALKOXYDIM. Branden L. Schiess and Donald C. Thill, Graduate Research Associate and Professor, Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID 83843-2339.

Abstract. In many cereal producing areas, herbicides are applied when weather conditions are less than optimal. Cold, wet conditions can slow metabolic processes in plants, including herbicide metabolism. The integrated effects of three soil moisture levels and four air temperature regimes on tolerance of wild oat, spring barley, and spring wheat to different rates of tralkoxydim were determined in growth chamber and greenhouse experiments. Experiments were completely randomized split, split plot designs. Wheat, barley, and wild oat were grown in the greenhouse until they reached the three leaf stage and were transferred to a growth chamber set to a specific temperature regime. Soil moisture conditions were established at this time. After 96 hr, plants were sprayed with tralkoxydim and returned to the growth chamber for 10 days, after which they were transferred to a greenhouse for 14 days. At 10 and 24 days after treatment (DAT) leaf and tiller number, and biomass were determined. At 10 DAT, barley biomass was reduced up to 31% with increasing tralkoxydim rate at -1.1 to 4.5 C. Wheat and barley biomass was not adversly affected by tralkoxydim at any other soil moisture/temperature treatment 10 or 24 DAT. Wild oat biomass was not affected by tralkoxydim at any moisture and temperature combination 10 DAT. Wild oat biomass was inversly related to tralkoxydim rate 24 DAT regardless of soil moisture or temperature. [Paper Number 94]

AVENA FATUA **RESPONSE TO PLANT AVAILABLE WATER.** L. R. Van Wychen*, A. Bussan, B. Maxwell, and E. Luschei. Montana State University, Bozeman, MT 59717.

Abstract. Wild oat (*Avena fatua L.*) is a major grass weed problem in dryland spring grain cropping systems. Our overall research objective is to predict the spatial distribution of wild oat in response to crop competition and sub-field scale soil plant available water heterogeneity. This study will be used to parameterize a plant water balance routine for INTERCOM, an ecophysiological simulation model of crop/weed competition. A greenhouse study was conducted at the Plant Growth Center at Montana State University. Three soil plant available water (PAW) treatments were established, based on lab analysis of soil matric potential (psi = 1, 10, and 15 bars). Temperature varied according to growth stage to simulate average Montana growing conditions, while all other environmental variables remained constant, including soil type. The study had six replications, with six pots for each sequential destructive harvest from the three-leaf stage until maturity. Growth variables for both species were total above ground biomass (TBIO), leaf area index (LAI) and seed head yield. The PAW treatment at 1 bar had three and 10 times more TBIO at maturity than the PAW at 10 and 15 bars, respectively. Further analysis will identify the critical PAW content at which potential wild oat carbon assimilation is reduced due to a decreased transpiration rate. [Paper Number 95]

EVALUATION OF IMAZAMOX AND CLEARFIELD™ WINTER WHEAT FOR JOINTED GOATGRASS *(AEGILOPS CYLINDRICA)* MANAGEMENT. Brent R. Beutler* and John O. Evans, Graduate Research Assistant and Professor, Department of Plants, Soils, and Biometeorology, Utah State University, Logan, UT 84322-4820.

Abstract. Jointed goatgrass is a serious weed problem for many wheat producers throughout the western United States and infestations are growing rapidly. The Clearfield™ winter wheat system is being developed to control a wide range of weeds, including winter annual grasses in winter wheat. This system uses winter wheat that has been selected to be resistant to the imidazolinone herbicides. In the fall of 1999, three identical trials were established to evaluate imazamox and imazamox combinations for jointed goatgrass control, as well as winter wheat injury. Two trials were established in the presence of natural infestations of jointed goatgrass and one trial was established in a field with little to no weed pressure. Treatments consisted of imazamox alone, imazamox with 2,4-D combinations, and imazamox with a variety of adjuvants. Visual evaluations for wheat injury and jointed goatgrass injury were

performed 3 and 9 weeks after treatment and reproductive jointed goatgrass tillers were counted 12 weeks after treatment. None of the treatments appeared to have any negative effect on winter wheat. All treatments that included imazamox severely reduced the jointed goatgrass population. The split application of imazamox and imazamox+methylated seed oil treatments resulted in jointed goatgrass injury ratings above nine, on a 0-10 scale, and reduced jointed goatgrass stands from over 500 plants per square meter to approximately one plant per square meter. [Paper Number 96]

FITTING CLEARFIELD WHEAT TECHNOLOGY INTO CENTRAL GREAT PLAINS CROPPING SYSTEMS. Reginald D. Sterling*, Todd Pester, Scott Haley, Scott J. Nissen, and Philip Westra. Department of Bioagricultural Sciences and Pest Management, Colorado State University, Ft. Collins, CO.

Abstract. The winter annual grass complex of bromes, jointed goatgrass, and feral rye currently represent the single greatest threat to sustainable winter wheat production on millions of acres best suited for wheat production because of erratic rainfall amounts and patterns in the Central Great Plains region. These weeds have spread uncontrolled because historically there have been no selective herbicides for their control in winter wheat. Clearfield spring and winter wheat offer producers new value-added technology for the management of these weeds. Research at Colorado State University will address key issues pertaining to Clearfield wheat technology, including relative wheat tolerance to imazamox, efficacy on key grassy weeds, herbicide performance with potential tank-mix partners and additives, emergency follow-crop options, imazamox efficacy on feral rye treated at various growth stages, and education on stewardship for this technology through the use of large scale research demonstration plots. Currently there are Central Great Plains adapted winter wheat lines in large-scale seed increase for sale to farmers in 2002. Future winter wheat varieties are currently in the screening stage and should be released in 2003 and beyond. With more than three years of research experience with Clearfield winter wheat, the Colorado State University program is well poised to continue important research on new topics as they arise. [Paper Number 97]

FLUMIOXAZIN AS A POTENTIAL BROADLEAF HERBICIDE IN DRY BEANS. Dana F. Coggon* Scott J. Nissen, Stephen D. Miller, and Robert G. Wilson, Graduate Student, Associate Professor Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523, Professor University of Wyoming Plant Sciences, Laramie, WY 82071, and Professor, University of Nebraska, Panhandle Research Station, Scottsbluff, NE 69361.

Abstract. Flumioxazin is a pre-emergence N-phenylphthalimide herbicide that is being developed for broadleaf weed control in soybeans and peanuts. Field research was conducted during the 2000-growing season at three locations to evaluate the potential use of flumioxazin in dry beans. Three market classes were evaluated: pinto (Bill Z), black (Shiny Crow) and great northern (Marque). Percent weed control, crop response, and yield were evaluated at all three locations. Plots were treated with flumioxazin rates from 0.016 lb ai to 0.125 lb ai. The Colorado and Wyoming sites were sprinkler irrigated, while the Nebraska sight was furrow irrigated. Results from all three sites showed that at 0.016 lb ai per acre broadleaf weed control ranged from 85-98%. Crop response varied between the market classes at the three sites. The black bean variety was the most sensitivity at the Nebraska site with visible injury of 22% at 0.063 lb ai per acre. In Colorado and Wyoming the pinto bean variety was the most sensitive, with visible injury of 7% at 0.125 lb ai per acre. At the Colorado and Wyoming sites no significant yield losses occurred; however, at the Nebraska site significant yield losses occurred at the 0.125 lb ai per acre rate. It should be noted that 0.125 lb ai per acre would be equivalent to a 3x application rate on most soil types. Information derived from this experiment will help determine a suitable flumioxazin application rate while taking into account dry bean market classes and environmental variation. [Paper Number 98]

EFFICACY OF WEED MANAGEMENT SYSTEMS IN SUGARBEETS. Charles A. Rice*, Stephen D. Miller. University of Wyoming, Laramie, WY.

Abstract. Effective season long weed control in sugarbeet production is imperative as sugarbeets compete poorly with weeds. The development of herbicide tolerant sugarbeets by means of genetic engineering may provide additional herbicide options for effective weed control. Irrigated field studies were conducted at the Research and Extension Center, Torrington, WY in 1999 and 2000, and at the Research and Extension Center, Powell, WY in 2000 to evaluate weed control in glufosinate tolerant, glyphosate tolerant, and conventional sugarbeets. Each sugarbeet variety received three different herbicide treatments, plus a hand weeded treatment, and an untreated check. The effect of either 0, 1, or 2 cultivation operations on weed control was also evaluated within each system. Weed control at Torrington in 1999 was excellent with all glyphosate and conventional herbicide treatments, whether applied as a standard or micro-rate program. Weed control with glufosinate was fair to poor depending upon herbicide application timing and the number of applications. Weed control at Torrington and Powell in 2000 was excellent with all glyphosate treatments and glufosinate applied as three separate applications. Conventional herbicide treatments provided only fair weed control at both Torrington and Powell in 2000. Sugarbeet yields were different among treatments and were generally related to weed control. [Paper Number 99]

WEED POPULATION DYNAMICS IN DIVERSIFIED CROPPING SYSTEMS OF THE NORTHERN PLAINS. Andrew G. Hulting*, Alvin J. Bussan, Bruce D. Maxwell, and Perry R. Miller, Graduate Research Associate, Assistant Professor, Associate Professor, and Assistant Professor, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717.

Abstract. Little information exists about how implementing diversified cropping systems can beneficially impact dynamics of weed populations and reduce the need for costly off-farm inputs. This research focuses on spatial and temporal population dynamics of redroot pigweed, common lambsquarters, Persian darnel, and wild oat as influenced by cropping system, herbicide inputs, and cultural management techniques. The research is being conducted through a long-term cropping systems study that was established near Moore, MT, in 1999. At this site, four unique crop rotations were implemented in the spring of 1999. The rotations are four-year rotations, but differ in attributes such as crop type, herbicide use programs, and tillage regimes. Each rotation is managed in both a conventional, high input manner as well as in a reduced input (reduced herbicide applications and rates) manner. Metapopulations of the above four weed species were established in individual 0.9 m by 0.9 m plots in the fall of 1999. Each species was established in treated and untreated areas of each phase of each rotation. Initial analysis of weed density data indicates that P. darnel established at greater densities than did wild oat. Lower densities of wild oat and P. darnel in spring wheat and barley phases of rotations were also quantified under the reduced input management system compared to the conventional, high input system. Analysis of spatial data indicates movement of weed seedlings out of establishment zones within one growing season. Short term results of this study provide insight into temporal and spatial aspects of weed population dynamics during the transitional phase from conventional, tilled, small grain-fallow systems to no-till, diversified systems. In the long term, this research has the potential to broaden our understanding of system effects on weed population dynamics if changes in agricultural cropping practices are adopted at the landscape level. [Paper Number 100]

PERSIAN DARNEL INTERFERENCE IN SPRING WHEAT, CANOLA, SUNFLOWER, AND FALLOW. Johnathon D. Holman* and Alvin J. Bussan, Graduate Research Assistant and Assistant Professor, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717-3120.

Abstract. Persian darnel, *Lolium persicum*, significantly decreases spring wheat yield and contaminates harvested grain. Crop rotation is seen as a management tool for Persian darnel. The focus of this research is to quantify the impact of different crops on Persian darnel seedling establishment and fecundity. An experiment was established on spring wheat stubble in the spring of 2000 at Bozeman, MT. Persian darnel was established at different densities.

Spring wheat, canola, and sunflower were established at 1, 1.5, and 2x their local seeding rates. Fertilizer was applied according to results from the MSU Soil Analytical Lab, and based on individual crop nutrient requirements and targeted yields. Spring wheat and canola were seeded the 8th of April. Sunflower was seeded the 16th of May, preceded by an application of glyphosate and ammonium sulfate at 0.42 kg ae ha^{-1} and 1.9 kg ha^{-1}, respectively. Persian darnel seedling density, reproductive tiller density, seed production, and crop seedling densities were measured. Persian darnel seedling establishment was the lowest in sunflower and canola. Spring wheat reduced Persian darnel seedling establishment by 75% relative to the crop free area. Different crops reduced Persian darnel seedling establishment through depletion of resources and agronomic production practices. Seed production was related to crop and weed seedling densities, using a single and combined modified hyperbolic function. Persian darnel fecundity was highest in monoculture, and was dramatically reduced by crop competition. Sunflower had the greatest impact on Persian darnel fecundity, followed by canola then spring wheat. The delayed seeding and preplant weed management in sunflower reduced Persian darnel stand density 98%, leading to a dramatic decrease in fecundity. Cultural management practices greatly reduce Persian darnel fecundity independent of herbicides. Combining cultural management with herbicides will enhance and sustain management of Persian darnel. [Paper Number 101]

USING PRECISION AGRICULTURE TECHNOLOGY TO EVALUATE FACTORS, INCLUDING WEEDS, THAT INFLUENCE IRRIGATED CORN YIELDS. Philip Westra*1, Lori Wiles2, and Dawn Wyse-Pester1, Colorado State University, Ft. Collins, CO1 and USDA/ARS, Ft. Collins, CO2

Abstract. In interdiciplinary team of 15 scientists from Colorado State University and the USDA/ARS working with 6 graduate students, 3 extension agents, and 2 corn producers has produced multiple data layers relating to irrigated corn yields. The corn fields were managed in a normal manner by the corn farmers. Research from 1997 through the 2000 growing season focused on fertility, water, and pest impacts on final corn yield. Variability in water application, ammonium, organic matter, phosphorus and soil electrical conductivity were factors that were significant in explaining the yield variability. The growers exhibited low tolerance for weeds and used sufficient herbicides to minimize weed pressure. Spatial dependence for weed populations varied by weed species, but was generally low due to the low number of weeds detected. Preliminary data analysis suggest that triazine resistant pigweed was correlated with soil type, suggesting that triazine binding or leaching could impact the development of resistance in certain weed species. IFAS funding will support additional research on this integrated project for three additional years. [Paper Number 102]

MON 37500 SOIL RESIDUES AFFECT SUBSEQUENT CROPS IN THE CENTRAL GREAT PLAINS.
Drew J. Lyon*, Stephen D. Miller, and Phillip W. Stahlman, Associate Professor, Panhandle Research and Extension Center, Scottsbluff, NE 69361; Professor, Department of Plant Sciences, University of Wyoming, Laramie, WY 82071; and Professor, Kansas State University, Agricultural Research Center - Hays, Hays, KS 67601.

Abstract. MON 37500 is a newly registered herbicide for use in winter wheat. It is capable of providing selective control of downy brome in winter wheat; however, little information is available on the potential for this herbicide to carryover and injure rotational crops. Field studies were initiated in 1997 at Hays, KS; Sidney, NE; and Archer, WY to investigate the potential of MON 37500 herbicide, applied in winter wheat for downy brome control, to carryover and affect subsequent summer crops. The soils were silt loams, except for Archer, where the soil was a sandy loam. Organic matter contents ranged from 1.3% at Archer to 3.2% at Hays, and soil pH ranged from 6.6 at Sidney to 7.8 at Hays. MON 37500 herbicide was applied at four rates (0, 0.031, 0.062, and 0.124 lb ai/acre) to winter wheat in the fall of 1997. Wheat was harvested in the summer of 1998 and summer crops were planted in 1999 and 2000. Corn, grain sorghum, and sunflower were grown at all locations. Additionally, soybean was grown at Hays, KS; proso millet at Sidney, NE; and foxtail millet at Archer, WY. At Hays, grain sorghum was the only crop visually injured in 1999. Grain sorghum in plots treated with MON 37500 at the rate of 0.124 lb/acre exhibited minor, early-season stunting; however, no treatment affected grain sorghum stand density or grain yield. Due to the lack of crop injury observed at Hays in 1999, grain sorghum was the only crop grown in 2000, and it was not affected by MON 37500 carryover. Crop response at Sidney and Archer was similar. Neither proso millet at Sidney, nor foxtail millet

at Archer, exhibited injury symptoms in 1999 or 2000 from MON 37500 treatments applied in the fall of 1997. Visual corn injury in June of 1999 consisted of stunting and chlorosis that increased in severity with increasing herbicide rate. However, by the end of July plants had recovered from the earlier injury and no treatment affected corn stand density or grain yield. No corn injury was observed in 2000. Crop injury was most evident in grain sorghum and sunflower at both locations in 1999. Sunflower yields in 1999 were reduced by more than 75% in plots treated with MON 37500 at 0.062 or 0.124 lb/acre compared to the zero rate. Grain sorghum yields were reduced by more than 85% at Archer in plots treated with MON 37500 at any rate, while at Sidney grain yield reduction ranged from 27% at the 0.031 lb/acre rate to 91% at the 0.124 lb/acre rate compared to the zero rate. No sunflower data were collected at Sidney in 2000 due to poor plant emergence. Grain sorghum yields at Sidney in 2000 were reduced more than 70% in plots treated with 0.124 lb/acre of MON 37500, but yields were not reduced significantly by the two lower rates. Grain yields were not obtained at Archer in 2000 due to drought, but visual injury ratings and crop biomass measurements indicated grain sorghum and sunflower were still negatively affected by MON 37500 soil residues. Of the crops tested, grain sorghum and sunflower were the most susceptible to soil residues of MON 37500 herbicide. Proso millet, foxtail millet, and soybean appeared to be the least susceptible. Corn exhibited a moderate level of susceptibility. Soil factors and climate appeared to influence the carryover potential of MON 37500, with the greater soil organic matter content, greater precipitation level, and longer season of Hays, KS resulting in less crop injury than at Sidney, NE or Archer, WY, despite the fact that the soil pH at Hays was significantly higher than at either Sidney or Archer. [Paper Number 103]

WEED CONTROL IN GLYPHOSATE RESISTANT SPRING WHEAT. Kirk A. Howatt* and Stephen A. Valenti, Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105 and Agronomic Research Manager, Monsanto Company, St. Louis, MO 63167.

Abstract. Canada thistle is an increasing problem in North Dakota. Wild oat and wild mustard are persistent, troublesome weeds in North Dakota small grain fields. While conventional tank-mix applications offer broad spectrum weed control, the grass component has potential to cause crop injury and Canada thistle may escape treatment. Applying glyphosate in glyphosate resistant spring wheat may provide weed control options that minimize crop injury risk while providing broad spectrum weed control. A field experiment was established in Fargo, ND, to examine weed control and crop response to glyphosate applications in glyphosate resistant wheat. Glyphosate, glyphosate tank-mixes, and split treatments of glyphosate were compared to a conventional treatment of 120 g ai/ha fenoxaprop plus 280 g ai/ha bromoxynil and 280 g ai/ha MCPA at early and late post-emergence application timings. No treatment elicited wheat response. Glyphosate and glyphosate tank-mixes generally provided equal performance within application timing. Two applications of glyphosate at 420 or 840 g ae/ha provided the most effective control of early and late season wild oat, wild mustard, and Canada thistle, which resulted in a yield increase of 41% compared to the conventional treatment. Early applied treatments did not provide full season Canada thistle control while late treatments did not remove early season weed competition. Early applied glyphosate treatments produced higher yield than late applied treatments but lower yield than split treatments. Isopropylamine and trimethylsulfonium glyphosate formulations provided equal performance. [Paper Number 104]

MULTIPLE HERBICIDE RESISTANT WEEDS IN AUSTRALIAN CROPPING SYSTEMS ARE DRIVING INNOVATION. James M. Krall, Michael J. Walsh, and Stephen B. Powles, Professor, Department of Plant Sciences, University of Wyoming, Torrington, WY 82240; and Research Fellow and Professor, WAHRI, University of Western Australia, Nedlands, WA 6907.

Abstract. Multiple herbicide resistance in the annual grass weed *Lolium rigidum* has changed weed control emphasis in Australia from solely decreasing weed competition to include decreasing weed seed production. Practices that are specifically targeted at reducing weed seed reserves are a uniquely Australian component of a Integrated Weed Management Program. The aim is not only to minimize survival of weeds, but to minimize or prevent production of viable seed by established plants, and undertake practices that greatly reduce the weed seedbank. As in the United States traditional practices including crop rotation, cultivation, and herbicide diversity are important components of the program. The objective is to discuss other practices not commonly considered in

the United States. These practices include delayed sowing, physical removal of weed seeds with chaff carts at harvest, 'spray-topping' using paraquat or glyphosate post-anthesis to specifically kill developing weed seeds either in the pasture the year before cropping or in–crop. These practices have been shown to be effective. For example, a delay in crop sowing of 21 days has been shown to reduce subsequent *L. rigidum* seed bank reserves by 50 to 80%. Seed capture methods at harvest can reduce *L. rigidum* seed bank reserves by 40 to 65%, while crop-topping has been documented to reduce seed reserves by 75 to 85%. The current level of acceptance by broad acre Western Australia farmers, reporting moderate to high levels of herbicide resistance, is estimated to range from 14% using collection of weed seeds at harvest to 92% using chemical pasture topping. [Paper Number 105]

MODELLING HERBICIDE RESISTANCE DEVELOPMENT IN JOINTED GOATGRASS (AEGILOPS CYLINDRICA). D. ERIC HANSON*, DANIEL A. BALL, AND CAROL A. MALLORY-SMITH; Faculty Research Assistant, Department of Forest Science, Oregon State University, Corvallis, OR 97333; Associate Professor, Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, OR 97801; Associate Professor, Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97333.

Abstract. We constructed a population model to simulate the development of herbicide resistance in jointed goatgrass (JGG) caused by imazamox use in imazamox-resistant (Clearfield™) wheat. The model computed changes in the surface and the buried JGG seed bank for both resistant and susceptible biotypes. Simulations started with an initial density of 1000 susceptible and no resistant seeds/m2 in each seed bank. Simulation of continuous, no-till, Clearfield™ wheat cultivation resulted in rapid development of resistant goatgrass without potential hybridization with wheat and extremely rapid resistance development with hybridization. In less than 10 yr, the resistant population was growing exponentially in both simulations. Adding a fallow year with tillage into the simulated rotation did not slow the development of resistance substantially but did reduce the rate of resistant population increase by several orders of magnitude over 10 years. Alternating Clearfield™ and non-resistant wheat varieties in combination with fallowing prevented establishment of a resistant goatgrass population and caused the susceptible seed population to decline. These projections suggest imazamox-resistant wheat can be a tool for reducing jointed goatgrass populations when included in a rotation of crops and varieties. [Paper Number 106]

JOINTED GOATGRASS SEED PRODUCTION IN SPRING WHEAT. Darrin L. Walenta*, Joseph P. Yenish, Frank L. Young, and Eric Gallandt, Washington State University, Pullman, WA; Daniel A. Ball, Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, OR.

Abstract. Jointed goatgrass is a persistent winter annual grass weed that infests winter wheat in the Pacific Northwest. Rotating to a spring crop for three or more consecutive years is a recommendation for the management of jointed goatgrass infestations. Studies were established during the spring of 1998 and 1999 near Lind, WA, Pendleton, OR, and Pullman, WA to evaluate spring establishment and reproduction by jointed goatgrass grown in pure stands and in competition with spring wheat. Two studies at each location investigated jointed goatgrass infestations that 1) were seeded by broadcasting 161 spiklets/m^2 on the soil surface of a jointed goatgrass free-site, and 2) emerged from an established soil seed bank. Average annual precipitation for each of the study locations were 235, 420, and 560 mm/year, respectively. The experimental design was a randomized complete block factorial arrangement with four replications. Main factors were seeding date and pure or mixed stands of jointed goatgrass and spring wheat. At each location, spring wheat and jointed goatgrass was seeded on four different dates at approximately two week intervals. At all sites with planted infestations, jointed goatgrass plants established at all seeding dates. Jointed goatgrass populations at Lind, the driest location, were less than populations at Pendleton and Pullman. In both years, spikelet production was greater at Lind than other locations. In 1998, spikelets were produced in the two earliest seeding dates and, in 1999, the three earliest seeding dates at all locations. Jointed goatgrass plants established (1 plant/meter^2) from the soil seed bank at all spring wheat seeding dates and were less than in planted infestations. Jointed goatgrass plants that emerged from established soil seed banks produced spikes at all spring wheat seeding dates but was dependent upon location. In both studies at each location, spring wheat grain yield was influenced by seeding date and competition with jointed goatgrass. Grain yield was significantly reduced after the second seeding date in both years and most locations. A vernalization study was conducted with

spikelets collected from spring- and fall-emergent jointed goatgrass plants. Results from this study indicate that there are no differences in vernalization requirement for either jointed goatgrass cohorts. [Paper Number 107]

THE EFFECT OF BAY MKH 6561 ON JOINTED GOATGRASS Hans J. Santel*, James E. Anderson, Ron G. Brenchley, John E. Cagle and Alan C. Scoggan, Bayer Corp., Kansas City, MO 64120

Abstract. Propoxycarbazone-sodium is a new sulfonyl-amino-carbonyl-triazolinone herbicide being developed by Bayer. The product acts as an inhibitor of the enzyme acetolactate synthase (ALS). It provides excellent activity against grass weeds and several important broadleaf weeds when applied postemergence to wheat. The product has demonstrated strong and consistent activity against important grass weeds like Bromus species, wild oat, canarygrass, blackgrass, wind grass and the perennial grass quackgrass. At the suggested use rates of 45 - 60 g ai/ha weeds were selectively controlled in wheat. Propoxycarbazone-sodium is also active against jointed goatgrass. However, efficacy on jointed goatgrass is less consistent than on other annual grass weeds. In field experiments conducted between 1994 and 2000 in winter wheat the U.S. single applications of 30 - 90 g ai/ha resulted in suppression of the weed. Fall applications (mean values of effect over rate range: 30 - 39% control) were less effective than spring applications (mean values of effect over rate range: 34 - 52% control). Best control was provided by sequential applications consisting of a fall treatment followed of 30 g ai/ha by a spring treatment with the same rate. In 10 observations 64 % control of jointed goatgrass, with individual ratings ranging from 40 to 94 % control, was observed. Yield response to propoxycarbazone-sodium applications varied depending on timing of herbicide applications, density of weed infestations and the level of jointed goatgrass control achieved. Yield increases ranged from 5 to 71%. [Paper Number 108]

PROGRESS REPORT ON CONTROLLING JOINTED GOATGRASS IN WINTER WHEAT IN NEBRASKA WITH ROTATIONS, TILLAGE, AND CULTIVARS, 1997-2000. Gail A. Wicks, Gordon E. Hanson, Gary W. Mahnken, and Steven D. Miller, University of Nebraska, 461 West University Drive, North Platte, NE 69101 and University of Wyoming, Laramie, WY 82071

Abstract. After one cycle of the four-year rotation, crop rotations, winter wheat cultivars, and time of initial tillage are affecting jointed goatgrass (JGG) densities. Beginning tillage for fallow in the spring and preparing a seedbed for grain sorghum and corn production in April provided conditions suitable for more than a three-fold decrease in jointed goatgrass seeds to germinate before wheat planting than delaying tillage until July during the pre-wheat fallow period in wheat, grain sorghum, or corn stubble. This trend as been consistent across four years. Jointed goatgrass plant density in the winter wheat at harvest was 10 to 14 times greater in the winter wheat-fallow (W-F) than in the winter wheat-ecofallow corn-grain sorghum-fallow (W-C-S-F) or winter wheat-ecofallow-corn-fallow (W-C-F) rotations in 2000. The low density of jointed goatgrass apparently did not interfere with winter wheat grain yield because drought prevented maximum growth of late emerging seedlings. The corn planted in the wheat stubble in the W-C-F rotation had 55% more jointed goatgrass seedlings than grain sorghum planted into the wheat stubble in 1997 after corn and sorghum grain harvest.

INTRODUCTION

Rotations have long been prescribed as a method to control different species of weeds, especially weeds with different life cycles than the crop. Traditionally the land infested with jointed goatgrass in the central Great Plains has been in a winter wheat-fallow rotation for decades. This has changed the weed spectrum to one that favors winter annual weeds. Initially, jointed goatgrass was introduced in Nebraska by contaminated winter wheat seed. However, it was spread more rapidly by combines harvesting winter wheat as they moved from Texas, Oklahoma, and Kansas into Nebraska.

Gates (1941) wrote that jointed goatgrass is very difficult to control in winter wheat grown continuously. At that time in western Kansas ordinary fallow methods controlled jointed goatgrass in the winter wheat-fallow rotation. This most likely involved the moldboard plow. At that time commercial harvest of wheat with combines was nonexistent. As farmers changed from moldboard plowing to stubble mulching in order to reduce erosion, winter annual weeds flourished. Cheat and downy brome were the first winter annual grasses to become major problems in the wheat-fallow rotations. Jointed goatgrass was rarely found in Nebraska in the 1960s. Once commercial harvest became the norm, combines started moving north from Texas and Oklahoma, quickly spreading jointed goatgrass across a wide geographic area. Gradually, jointed goatgrass spread from field to field by combines and trucks, etc in Colorado, Kansas, and Nebraska.

Control of winter annual bromes in stubble mulching was best served by eliminating seed production during the prewheat-fallow period (Wicks, 1984). This was done by timely tillage in the 1960s and with tillage and/or herbicides in the 1980s and 1990s. Many growers in the 1970s in west-central Nebraska planted grain sorghum, corn, sunflower, or spring small grain following winter wheat to aid in controlling downy brome. As for jointed goatgrass, growers found that summer crops were more effective than the early spring planted crops because some jointed goatgrass emerged with the spring grain crops and produced seeds.

Farmers in central Nebraska began to change from the W-F rotation to longer rotations in the 1950s with the introduction of hybrid grain sorghum (Ramig and Smika 1964). At this time dryland corn was considered unprofitable because of low yields caused by insufficient soil water available to withstand drought stress during late summer. Grain sorghum was the favorite row crop until the 1980s because of its drought tolerance.

Ecofallow was introduced in 1972 as a University of Nebraska extension program after nine years of research with a winter wheat-grain sorghum-fallow rotation. With the additional 2 inches of stored soil water grain sorghum yields were increased 23 bu/A over the conventional planted grain sorghum (Wicks et al. 1989). With the additional stored soil water corn became a viable crop when using ecofallow practices in much of the semiarid areas of the central Great Plains (Wicks et al. 1995).

Seed burial studies in Kansas, Nebraska, and Colorado showed that jointed goatgrass survival decreased rapidly over a three-year period after burial (Donald and Zimdahl 1987). They suggested that three years of fallow should reduce or eradicate the jointed goatgrass if new seeds are not introduced. Fallowing for three years is not practical. A better solution is to plant a summer crop the year following winter wheat. Lyon and Baltensperger (1995) reported that jointed goatgrass density was reduced more when winter wheat followed rotational crops. They compared densities in a winter wheat-sunflower-fallow or a winter wheat-proso millet-fallow rotation with a winter wheat-fallow rotation. They also found that tillage immediately after winter wheat harvest in a winter wheat-fallow rotation reduced jointed goatgrass density in the following wheat crop more than delaying tillage until the next spring.

Presently, we do not know how long jointed goatgrass seeds survive on the soil surface. Time of seed rain was important in survival of downy brome (Wicks 1997). Seeds germinated more rapidly when placed on the soil surface in August rather than September, October, or November because seeds had longer exposure to rainfall events and natural decomposition.

We do know that, if one wants to store water in the soil, reduce evaporation, and erosion, one does not want to till after wheat harvest in many areas of the central Great Plains. It is important that stubble remains weed-free and undisturbed over winter to trap snow and reduce evaporation. Since many farmers are using ecofallow in areas infested with jointed goatgrass it is important to know if jointed goatgrass could be controlled in this soil and water conservation program without excess tillage.

Ogg Jr. (1991) listed the introduction of semidwarf winter wheat may have aided the increase in jointed goatgrass infestations. Tall winter wheat cultivars are more competitive than shorter cultivars with downy brome (Challaiah et al. 1986). The same is true with summer annual weeds (Wicks et al. 1986).

The objective for this experiment was to determine the influence of best integrated-weed management practices for controlling jointed goatgrass in winter wheat rotations. We are attempting to follow similar practices used by farmers using ecofallow.

MATERIALS AND METHODS

An experiment involving winter wheat-fallow (W-F), winter wheat-ecofallow corn-fallow (W-C-F), and winter wheat-ecofallow corn-grain sorghum-fallow (W-C-S-F) rotations were initiated in 1996 with the seeding of 200 joints/m2 across the four replications. Each phase of the rotations is present every year. This allowed the comparison of W-C-F and W-S-F in the same year (1997). Both corn and grain sorghum were planted into wheat stubble treated with glyphosate plus atrazine after wheat harvest.

'Pronghorn', 'Alliance', and 'Vista' which represent a medium-tall, medium, and short winter wheat cultivars adapted to western Nebraska were planted each year in the fallow plots. Individual plot size was 15 by 60 ft. Two tillage treatments were imposed on each wheat cultivar plot imposed the spring following wheat harvest. One to plant the jointed goatgrass in the spring and the second in mid-summer during the prewheat-fallow period. Preemergence herbicides were applied after corn or grain sorghum planting. Half of the plots were tilled in April before planting and cultivated in June. The other half of the corn or grain sorghum plots was no-till. Herbicides were used to control weeds as needed during the fallow period to insure that excess tillage was not used that would promote erosion.

Jointed goatgrass plant counts were taken from five permanently marked 1-m^2 areas in every plot before they were tilled or sprayed with a herbicide. In addition, jointed goatgrass tiller counts were taken in the winter wheat before harvest and seedlings were counted following corn and grain sorghum harvest.

RESULTS AND CONCLUSION

The three rotations, winter wheat-fallow, winter wheat-ecofallow corn-fallow, winter wheat-ecofallow grain sorghum or corn-fallow, and winter wheat-ecofallow corn-grain sorghum-fallow have been in place four years. This is the first year that data collection has been obtained for the complete cycle for all rotations.

Effect of Rotations on Jointed Goatgrass. The jointed goatgrass tiller densities were greatest in the W-F rotation than the W-C-F or W-C-S-F rotation (Table 1). Winter wheat planted after grain sorghum had 40% more jointed goatgrass tillers ($p = 0.11$) and 30% more seed rain than when planted after corn. However, dockage and seed rain was greater in the grain sorghum rotation than in the corn rotation (Table 2). Corn was more effective than grain sorghum in depleting the soil seedbank of jointed goatgrass. This supports Anderson and Nielsen (1996) research. They suggested that because grain sorghum roots are more concentrated near the soil surface than corn, the soil dries out sooner and reduces volunteer wheat emergence. They suggest that producers could use corn in the rotation to simulate emergence of winter annual grasses. This would hasten depletion of soil seedbank quicker than with using grain sorghum. Also this is what some farmers have reported in Nebraska that the rotation of winter wheat-ecofallow grain sorghum-fallow reduces jointed goatgrass in the winter wheat but does not eliminate the weed (personnel communication from farmers). Thus it appears that it would be wise to follow the first crop of grain sorghum with another summer crop to control jointed goatgrass. This would assure that sufficient time has been allowed to reduce viable jointed goatgrass seed density to an amount that would not affect winter wheat yield or dockage in a dry year or an area that has less rainfall than North Platte.

In 1999, corn was substituted for the grain sorghum portion of the rotation of the four-year rotation because grain sorghum does not die until frost and therefore uses valuable soil water that could be used by the next crop following the fallow period. It is speculated that grain sorghum in 1998 used more soil water than corn and winter wheat.in 1999 and corn yield in 2000 were reduced. Another problem with the grain sorghum is that it kept growing in 1998 until frost and suppressed germination of the jointed goatgrass in the fall of 1998. This hinders loss of jointed goatgrass seeds in the soil seed bank. In addition, corn is more adapted to the areas of western Nebraska, eastern Colorado, and northwestern Kansas infested with jointed goatgrass because of higher elevation and cool temperatures in August delays maturity of the grain sorghum.

To date jointed goatgrass has not greatly reduced grain yields in any of the rotations. This is probably due to timely rainfall in spring or fall to germinate the seeds so a crop of seedlings could be destroyed before planting winter wheat.

Tillage did not reduce corn yields following the ecofallow period in 1998 and 1999 because of timely rainfall, but yields were less than no-till in 1997 and 2000. In 2000, corn suffered from drought as this was the second driest year since 1907. This reduced corn yields below 35 bu/A and wheat yields were less than 25 bu/A. Corn was 5 inches taller when planted into Pronghorn winter wheat stubble, a medium-tall cultivar, than into Vista stubble, a short wheat.

Effect of Tillage on Jointed Goatgrass and Crop Yields. Beginning tillage in early spring provided conditions suitable for more jointed goatgrass seeds to germinate before wheat planting (Table 3). Tillage did not affect winter wheat or corn yields following the ecofallow period when rainfall was timely. Corn yields were reduced 7 bu/A in 1997 when tillage was done before planting corn compared with no-till. In the drought year of 2000, there was potential for greater yield losses with early tillage vs. no-till. This reduced corn yields below 35 bu/A and wheat yields were less than 25 bu/A. Corn was 5 inches taller when planted into >Pronghorn= winter wheat, a medium-tall cultivar, stubble than >Vista= a short wheat. It took 10 to 14 days longer for the no-till corn to develop stress than corn that was cultivated. A rain during this time would have greatly benefited the no-till corn. Corn yields were reduced to zero in the continuous corn plots that were tilled because the corn had used up all the stored water before kernels were filled.

Effect of Winter Wheat Cultivars on Jointed Goatgrass. Pronghorn winter wheat reduced jointed goatgrass tiller numbers 57 and 59% compared to Alliance and Vista in 1999, respectively (Table 4). Reduction in seed rain was similar. No difference occurred in 2000 among cultivars, probably because of drought. Differences among winter wheat cultivars were not significant in 2000. However, it still would be wise to plant taller cultivars in fields that are infested with jointed goatgrass. Seefeldt et al. (1996) found that wheat height was important in reducing jointed goatgrass competitiveness. In the fall, jointed goatgrass densities were less in the corn that was planted into

Pronghorn wheat stubble vs. Alliance and Vista stubble. In addition, corn yield was greater with corn planted into Pronghorn stubble than Vista wheat stubble.

Integrated Weed Management Suggestions. Growers with jointed goatgrass infestations in a winter wheat-fallow rotation should consider switching to a three-year rotation. By planting a summer crop the year following winter wheat harvest would reduce the jointed goatgrass soil seedbank so less jointed goatgrass would be present in the following winter wheat crop. Thus, allowing for more time for jointed goatgrass emergence and be killed with herbicides or cultivation. Corn, grain sorghum, proso millet, soybean, and sunflower are commonly grown in the semiarid areas of the central Great Plains. Corn is a better crop to follow winter wheat than grain sorghum or proso millet. Soybean is not a good choice because there is insufficient precipitation during pod-filling time.

Applying herbicides after winter wheat harvest not only controls weeds present, but preserves more soil moisture near the soil surface which should hasten jointed goatgrass germination in the fall. Although early spring tillage to start the fallow period of to prepare a seedbed for corn is beneficial in reducing the number of jointed goatgrass seedlings in winter wheat, it may not be necessary in a winter wheat-corn-fallow rotation.

We are beginning to see patterns of other weed species becoming less important and some becoming adapted to the various treatments imposed in the rotations and crops grown. Weeds that appear to be affected are volunteer wheat, wild buckwheat, kochia, field pennycress, and downy brome.

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Table 1. Effect of rotation on jointed goatgrass in winter wheat at North Platte, NE.

Rotation	JGG tillers 1999	JGG tillers 2000	JGG seed rain 1999	JGG seed rain 2000
	----------------	no./m²	----------------	
W-F	271	195	2210	1520
W-C-F	103	3	790	17
W-S-F	171	--	1160	--
W-C-S-F	--	1	--	3
LSD ($\alpha = 0.05$)	83	63	610	500

Table 2. Effect of rotation on jointed goatgrass in winter wheat at North Platte, NE, 1999.

Rotation	JGG dockage Tillage	JGG dockage No-till	JGG seed rain Tillage	JGG seed rain No-till
	----------------	no./m²	----------------	
W-F	2.0	2.4	1630	2790*
W-C-F	0.4	0.9*	120	1460*
W-S-F	1.7	3.2	310	2020*
LSD ($\alpha = 0.05$)	1.2		128	

* Significant difference within row.

Table 3. Effect of early tillage on jointed goatgrass in winter wheat at North Platte, NE.[a]

Tillage	JGG tillers 1999	JGG tillers 2000	JGG seed rain 1999	JGG seed rain 2000
	----------------	no./m²	----------------	
Tillage	90	15	690	110
No-till	273	118	2090	920
LSD ($\alpha = 0.05$)	75	73	580	580

[a]Tillage in early spring vs. no-till until mid-summer during fallow period.

Table 4. Effect of winter wheat cultivar on jointed goatgrass in winter wheat at North Platte, NE.

Wheat cultivar	JGG tillers 1999	JGG tillers 2000	JGG seed rain 1999	JGG seed rain 2000
	----------------	no./m²	----------------	
Alliance	220	80	1700	610
Pronghorn	95	50	690	400
Vista	230	69	1780	530
LSD ($\alpha = 0.05$)	92	ns	720	ns

CONTROL OF OVER-WINTERED WHEAT IN FALLOW SITUATIONS. Robert N. Klein*, Jeffrey A. Golus, and Jeffrey M. Tichota, Professor and Extension Research Technologist, University of Nebraska, North Platte, NE 69101, and Monsanto Agronomic Research Manager, Littleton, CO 80122.

Abstract. A study was conducted to evaluate selected herbicides for control of volunteer winter wheat. Plots were laid out in a randomized complete block design and applied with a ten foot boom (six 11002XR nozzles on 20 inch

spacing) at 22 psi and 13.5 gpa. The trial was in winter wheat seeded September 14, 1999. Early treatments were applied on March 22, 2000, with the wheat six inches tall, while late treatments were applied on April 6, with the wheat 10 inches tall. Percent control was rated visually on April 6, May 11 and June 21 for wheat, and on June 21 for downy brome. [Paper Number 110]

Table. Control of volunteer wheat.

			Percent Control			
			Wheat			Downy Brome
Treatment	Rate (Lb ai/a)	Timing	4-6	5-11	6-21	6-21
1. Glyphosate	0.75	Early	45	98	99	95
2. Quizalofop + MSO	0.046 + 1%	Early	16	91	100	75
3. Quizalofop + MSO	0.061 + 1%	Early	22	94	100	81
4. Quizalofop + MSO	0.076 + 1%	Early	27	97	98	89
5. Glyphosate + quizalofop + MSO	0.75 + 0.046 + 1%	Early	54	100	100	87
6. Glyphosate + quizalofop + MSO	0.75 + 0.061 + 1%	Early	59	100	100	91
7. Glyphosate + quizalofop + MSO	0.75 + 0.076 + 1%	Early	64	100	100	94
8. Clethodim + MSO	0.109 + 1%	Early	23	91	98	91
9. Sethoxydim + MSO	0.375 + 1%	Early	18	75	69	0
10. Glyphosate	0.75	Late		99	100	96
11. Quizalofop + MSO	0.046 + 1%	Late		68	97	76
12. Quizalofop + MSO	0.061 + 1%	Late		73	99	88
13. Quizalofop + MSO	0.076 + 1%	Late		76	99	94
14. Glyphosate + quizalofop + MSO	0.75 + 0.046 + 1%	Late		100	100	98
15. Glyphosate + quizalofop + MSO	0.75 + 0.061 + 1%	Late		100	100	98
16. Glyphosate + quizalofop + MSO	0.75 + 0.076 + 1%	Late		100	100	99
17. Clethodim + MSO	0.109 + 1%	Late		74	94	81
18. Sethoxydim + MSO	0.375 + 1%	Late		71	81	0
19. Untreated Check			0	0	0	0
AMS applied at 17 lbs/ 100 gal to all treatments		LSD (0.05)	5.0	2.8	2.1	4.6

IMAZAMOX EFFICACY ON DIFFERENT GRASS SPECIES IN CLEARFIELD WINTER WHEAT IN THE CENTRAL GREAT PLAINS. . Paul J. Ogg, J. Gus Foster, Drew J. Lyon, Stephen D. Miller, Philip Westra, Field Biologist, BASF Corporation, Longmont, CO 80503; Technical Service Representative, BASF Corporation, Fort Collins, CO 80523; Associate Professor, Panhandle Research and Extension Center, University of Nebraska, Scottsbluff, NE 69361; Professor, Department of Plant Science, University of Wyoming, Laramie, WY 82071; and Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523.

Abstract. Field research was conducted in the Central Great Plains from 1996 to 2000 to evaluate imazamox in Clearfield winter wheat for annual grass control. Imazamox registration is pending at the EPA for application to Clearfield wheat. Imazamox was applied postemergence at 0.032, 0.04, and 0.048 lb ai/A at different weed stages. Applications were targeted to select the growth stage of the grasses and not Clearfield winter wheat. Research results indicate Imazamox at 0.032, 0.04, and 0.048 lb/A applied at the 1 to 5 leaf stage of feral rye provides 91, 92 and 95 % control, respectively. When application timing was at 1 to 5 tiller or fully tillered growth stage, feral rye control was from 50 to 64 %. Imazamox at 0.032, 0.04, and 0.048 lb/A applied at the 1 to 5 leaf stage of jointed goatgrass growth provided from 90 to 94 % control. Applications made at 1 to 5 tiller growth stage of jointed goatgrass gave 90 to 94 % control. Imazamox provided 82 to 87 % efficacy when applied to fully tillered jointed goatgrass. Imazamox at 0.032, 0.04, and 0.048 lb/A applied at the 1 to 5 leaf stage of downy brome provided from 86 to 99 % control. Imazamox provided 89 to 94 % control of downy brome when applied at the 1 to 5 tiller growth stage. Imazamox provided from 80 to 91 % control of downy brome when applied to fully tillered plants. Research shows that Imazamox efficacy on the above three grass species is dependent on the stage of growth of the particular grass at application. Imazamox provided the best efficacy of feral rye at the 1 to 5 leaf stage of growth. Later applications were not effective on feral rye. [Paper Number 111]

WEED CONTROL AND ROTATIONAL RESPONSE TO IMAZAMOX APPLICATIONS IN WINTER WHEAT. Stephen D. Miller, Craig M. Alford, Department of Plant Sciences, University of Wyoming, Laramie, Wyoming.

Abstract. Downy brome, jointed goatgrass, and feral rye are winter annual grassy weeds, which are rapidly spreading in the winter wheat areas of the high plains of Colorado, Nebraska, and Wyoming. The spread of these winter annual grasses has been rapid in recent years responding favorably to changes in farming practices (i.e. conservation tillage, fertilizer use and short stature wheat). Field experiments were conducted at two locations in southeastern Wyoming from 1997 to 2000 to evaluate winter annual grass control and rotational crop response to imazamox in imi-tolerant (Clearfield) wheat. Winter annual broadleaf weed control with Imazamox was excellent and was not influenced by rate or application timing. However, winter annual grass control generally increased as rate increased, and was better with fall compared to spring applications. Downy brome and jointed goatgrass were equally susceptible, while feral rye was more tolerant especially of spring applications. Tolerance of "Fidel" winter wheat was marginal and appeared to influence winter-hardiness. At one site, winter wheat stands were excellent in all plots when spring treatments were applied in March. However, when plots were evaluated in May, wheat stands in fall treatments were reduced 7 to 13%. In emergency plant back trials (loss of crop to hail or other factors in the spring) standard corn and sunflower were injured by applications of imazamox made 2 to 6 months earlier in winter wheat. However, when these crops were seeded in a normal rotational cropping sequence 14 to 18 months following application in winter wheat both crops exhibited adequate tolerance. [Paper Number 112]

POSTEMERGENCE WEED CONTROL IN CLEARFIELD™ SPRING WHEAT WITH IMAZAMOX Ted Alby, Gary M. Fellows, and Stephen Lewis, BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709-3528

Abstract. Trials were performed in eight states over seven years to investigate the effectiveness of imazamox used in conjunction with the Clearfield production system for control of problem weeds in spring wheat. Registration for

imazamox is currently pending at the EPA for use in Clearfield wheat. Trial results indicate that at 0.032 lb ai/a, imazamox applications will give good to excellent (>90%) control of several of the most troublesome grassy weeds in spring wheat. Grasses controlled included giant, green, and yellow foxtail, downy brome, barnyardgrass, wild oats, and Italian ryegrass. Control of volunteer wheat, an increasingly important consideration today as greater emphasis is placed on consistency of milling characteristics, was excellent. While the emphasis of this research focused on control of grassy weeds in spring wheat, imazamox also gave good to excellent postemergence control of several key broadleaf weeds. Research has shown that at rates of 0.032 lb/a, broadleaf weeds controlled include cocklebur, henbit, Venice mallow, tumble mustard, wild mustard, hairy nightshade, redroot pigweed, and shepherdspurse. Kochia and Russian thistle were also well controlled by imazamox alone or in tank mix combination with herbicides with alternative modes of action. Tank mixes with several commonly used broadleaf companion herbicides which complimented the weed spectrum of imazamox were tested with no incompatibility or antagonism noted. [Paper Number 113]

POSTEMERGENCE WEED CONTROL WITH IMAZAMOX IN CLEARFIELD ™ WINTER WHEAT IN THE PACIFIC NORTHWEST Steve Van Vleet * and Ted Alby, BASF Corporation, Field Biologist, Potlach, ID 83855, Field Biologist, Vancouver, WA 98683

Abstract. Effective and timely control of grasses and broadleaf weeds is an important consideration in maximizing yield potential of winter wheat. In the Pacific Northwest, studies have shown that postemergence treatments of imazamox in Clearfield winter wheat provide broadspectrum control of economically important annual weeds, including many troublesome grasses. Registration for Imazamox in Clearfield wheat is pending at the EPA. In postemergence studies conducted since the mid 1990's, 0.023 to 0.047 lbai/A of imazamox have effectively controlled downy brome, jointed goatgrass, wild oats, Italian ryegrass, and feral rye in Clearfield winter wheat. Downy brome and emerged Italian ryegrass are best controlled with fall treatments of imazamox; whereas, spring applications have been most effective against jointed goatgrass, wild oats and secondary flushes of Italian ryegrass. Good to excellent control of feral rye was achieved in field studies when imazamox was applied at 0.047 lb/A in Autumn at the 1-3 leaf stage of feral rye, or in the Spring when feral rye was less than 4 tillers in size. Fall followed by spring applications of imazamox at 0.023 fb 0.023 lb/A have also effectively controlled feral rye. In addition to graminicidal activity, trials have shown imazamox to provide broadspectrum postemergence control of key broadleaf weeds. In field trials, 0.032 lb/A of imazamox has effectively controlled an array of taxonomically diverse broadleaf weeds, which infest winter wheat in the Pacific Northwest. Tankmixes with several commonly used broadleaf companion herbicides which complimented the weed spectrum of imazamox were tested with no incompatibility or antagonism noted. [Paper Number 114]

REGISTRATION STATUS OF IMAZAMOX HERBICIDE ON CLEARFIELD* WHEAT. Fred R. Taylor* Project Manager, BASF Corp., 26 Davis Drive, Research Triangle Park, NC 27709.

Abstract. Imazamox is currently registered for weed control on soybeans. Application for registration was submitted to the EPA for use of imazamox on CLEARFIELD Wheat, CLEARFIELD Canola, alfalfa and dry edible legumes. CLEARFIELD crops, including CLEARFIELD Wheat and CLEARFIELD Canola were developed through conventional breeding procedures (not GMO) to tolerate applications of imazamox herbicide. The registration application was submitted to the EPA in December 1999. The application was granted "reduced risk" status in January 2000. A registration package was submitted to the California DPR with a request for concurrent review with the EPA. Registration approval is anticipated for fall 2001 and product launch in 2002. Research data indicates a 30-day grazing restriction. Imazamox will be registered for postemergence applications on spring or winter wheat for control of broadleaf and difficult to control grass weeds. Grasses controlled in field studies include annual brome species (downy brome, cheat, Japanese brome and California brome), jointed goatgrass, wild oats, Italian ryegrass, littleseed canarygrass, Persian darnel and annual foxtail species (giant foxtail, green foxtail, yellow foxtail) and volunteer cereals. Studies also indicate that Imazamox will control many annual broadleaf weeds in wheat, including catchweed bedstraw, common chickweed, kochia (non-ALS resistant), mustard species, field pennycress, pigweed species, wild radish, London rocket, shepherd's-purse, and tansymustard. Testing has shown that imazamox may be

tankmixed with other cereal herbicides for additional broadleaf control. When registered for use, imazamox will be the only herbicide that provides selective control of jointed goatgrass in wheat. [Paper Number 115]

WEED MANAGEMENT STRATEGIES WITH GLYPHOSATE-RESISTANT CANOLA. Gregory J. Endres*, Brian M. Jenks, John R. Lukach, and Matthew E. Pauli, Area Extension Specialist/Cropping Systems, Weed Scientist, Director/Agronomist, and Field Biologist, North Dakota State University Carrington Research Extension Center, Carrington, ND 58421, NDSU North Central Research Extension Center, Minot, ND 58701, NDSU Langdon Research Extension Center, Langdon, ND 58249, and Monsanto, Fargo, ND, 58103.

Abstract. Three trials were conducted in North Dakota to examine glyphosate (Roundup Ultra) rates and application timing for weed management and crop response with glyphosate-resistant canola. At Langdon in 1999, wild oat and annual smartweed control was generally excellent with all glyphosate rates (0.38, 0.56, 0.75, and 1.50 lb ae/A) and application timing (4-, 6-, and 2-/6-leaf stages of canola). Canola initially had slight to severe mottling after glyphosate application with some treatments at ≥ 0.56 lb ae/A. Visual injury was observed with glyphosate at 1.50 lb ae/A when applied at all canola growth stages. Canola physiological maturity was delayed 2 to 5 days with glyphosate at 1.50 lb ae/A applied at the 6-leaf stage compared to other application timings and rates. Canola seed yield was highest with glyphosate applied at the 4- and 2-/6-leaf stages compared to application at the 6-leaf stage. The yield loss associated with the late glyphosate application was due to early-season weed competition. At Minot in 1999, trifluralin or ethalfluralin followed by POST glyphosate provided similar or greater control of common lambsquarters, green and yellow foxtail, kochia, and redroot pigweed compared to trifluralin or ethalfluralin alone. Glyphosate at 0.38 lb ae/A controlled all weeds. Glyphosate applied at 29 days after canola planting (cotyledon- to 2-leaf canola stage) controlled emerged weeds, but missed a new weed flush that emerged soon after application. Sequential applications (29/38 days after planting) of glyphosate at 0.19/0.19 lb ae/A provided 93-100% weed control. At Carrington in 2000, green and yellow foxtail, horseweed, and redroot and prostrate pigweed control was ≥ 90% with glyphosate at 0.38 lb ae/A among application timings (22, 30, and 36 days after canola planting). Common lambsquarters control was highest (96-99%) with glyphosate at 0.38 lb ae/A applied 22 or 30 days after planting compared to the late application. Wild buckwheat control at canola physiological maturity was highest (95-96%) with sequential applications (22/36 days after planting) of glyphosate at 0.56/0.38 lb ae/A. Canola injury was not detected with any glyphosate treatment. [Paper Number 116]

APPLICATION TIMING AND WILD OAT CONTROL IN SPRING WHEAT. C. Alford*, S. D. Miller, and R. Hybner, Dept. Plant Sciences, University of Wyoming, Laramie, Wyoming.

Abstract. Wild oat (AVEFA) is a serious weed problem in barley and wheat production fields in the Northern Great Plains. Timing of herbicide application can have a great effect on AVEFA control and thus wheat and barley yields. A study was conducted at the Research and Extension Center, Sheridan; Wyoming to test the effectiveness of application timing for five herbicide treatments to control wild oat in spring wheat. Plots were established in a RCB design with 3 replicates. Newana wheat was planted on April 8, 2000. Five herbicide treatments were applied at three application timings. Application timings were the 2, 4, and 6 leaf stage of wheat, AVEFA generally had 0.5 to 1 less leaf when applications were made. The herbicides treatments were clodinafop, fenoxaprop, trakloxydim, imazamethabenz, and MKH-6561. Treatments applied at the 2 leaf stage provided 8% higher yields than those applied at the 4 leaf stage, and the 4 leaf treatments yielded 17% higher than the 6 leaf treatments. Clodinafop treatments had the best yields, although they were not significantly different from the other treatments. There were significant differences between treatments and application timing related to AVEFA control. AVEFA control was 95, 83, and 72% for the 2, 4, and 6 leaf timings respectively. AVEFA control ranged from 96% with clodinafop to 76% with imazamethabenz. Clodinafop was the only treatment to provide excellent control at all application timings. There were slight height differences observed between treatments, however only slight injury was observed in the 2 leaf application of clodinafop and the 6 leaf application of MKH-6561. [Paper Number 117]

BARLEY VARIETY, FERTILIZER PLACEMENT, AND TRALKOXYDIM RATE AFFECT WILD CONTROL. Joan Campbell* and Donn Thill, Research and Instructional Associate and Professor, Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow ID 83844-2339.

Abstract. Barley variety and fertilizer placement effects on wild oat control with tralkoxydim were evaluated near Moscow, Idaho in 1999 and 2000. 'Harrington', 'Colter', 'Galena', and 'Nebula' spring barley varieties were seeded and nitrogen fertilizer was broadcast and incorporated or fertilizer was placed in a band with the drill. Tralkoxydim was applied when barley had 3 to 5 leaves and wild oat had 1 to 4 leaves. Tralkoxydim rates were 0, 0.09, and 0.18 lb/A. The experimental design was a split-split-plot with variety as the main plot, fertilizer placement as the subplot, and tralkoxydim rate as the sub-subplot. Wild oat and barley height, tiller number, and biomass were measured after heading. Grain was harvested at maturity. In 1999, barley height averaged over variety was 29 inches when fertilizer was banded compared to 28 inches when fertilizer was broadcast. Fertilizer placement did not affect any other measurement. Grain yield was best with 'Harrington' and least with 'Nebula' when averaged over tralkoxydim rate and fertilizer placement. Grain yield difference in varieties was correlated positively to barley height. When data were averaged over variety and fertilizer placement, the untreated control always had the most wild oat tillers and biomass, and the least barley biomass and grain yield compared to the tralkoxydim treated plots. There were no differences between the two tralkoxydim rates. Only barley tillers were not affected by tralkoxydim application. In 2000, barley was taller, barley biomass and grain yield were higher, wild oat was shorter, and wild oat biomass was lower with banded fertilizer compared to broadcast fertilizer. 'Harrington' was the tallest variety and had higher biomass and grain yield, shorter and fewer wild oat tillers, and lower wild oat biomass than 'Nebula', the shortest variety. Barley yield correlated positively with tralkoxydim rate, while wild oat height, density, and biomass correlated negatively with tralkoxydim rate. [Paper Number 118]

BARLEY SEEDING RATE INFLUENCES MANAGEMENT OF WILD OAT (*AVENA FATUA*) WITH VARIABLE HERBICIDE RATES. J. T. O'Donovan*, K. N. Harker, G. W. Clayton, and R. N. Pocock, Agriculture and Agri-Food Canada, Lacombe-Beaverlodge Research Centre, Alberta; D. Robinson and J. C. Newman, Alberta Research Council, Vegreville; and L. M. Hall, Alberta Agriculture, Food and Rural Development, Edmonton.

Abstract. Field experiments were conducted at Vegreville, Alberta in 1997, 1998 and 1999, and Lacombe, Alberta in 1997 and 1998, to determine if barley row spacing (20 and 30 cm) and seeding rate (75, 125 and 175 kg/ha) influenced the effects of variable tralkoxydim rates on barley seed yield, net economic returns, and wild oat seed production. In most cases barley seed yield was unaffected by row spacing or seeding rate. Where no herbicide was applied, the presence of wild oat reduced barley yield at each location each year. When the herbicide was applied at 50, 75 or 100% of recommended, barley yields were not affected by the presence of wild oat. Results were more variable at 25% of the recommended rate, especially at Lacombe where yield losses occurred each year at this rate. The lowest net economic returns consistently occurred in the absence of herbicide application; but the influence of herbicide rate on net returns varied among years and locations. Net returns were either higher at the lower herbicide rates, or were unaffected by herbicide rate. Both seeding rate and herbicide rate affected wild oat shoot dry wt and seed production at each location each year, while row spacing had no effect. There was also a consistent and highly significant seeding rate by herbicide rate interaction. The effects of tralkoxydim on wild oat, especially at relatively low rates, were generally superior at the higher barley seeding rates. The results suggest that seeding barley at relatively high rates can result in optimum yields, undiminished economic returns, and effective wild oat management when tralkoxydim is used at lower than recommended rates. [Paper Number 119]

EFFICACY OF CLODINAFOP, FENOXAPROP, FLUCARBAZONE-SODIUM, IMAZAMETHABENZ, AND TRALKOXYDIM ACROSS 8 ENVIRONMENTS IN MONTANA. Alvin J. Bussan* and Susan Kelly, Assistant Professor and Research Associate, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, 59717-3120.

Abstract. Wild oat herbicide performance varies dramatically with climatic conditions and conditions of plant growth at time of application. Herbicide failures and lack of control complaints could be minimized if herbicides could be selected to maximize their activity within a given environment. Predicting herbicide performance based on current environmental conditions may be possible through analysis of herbicide rate response. The objectives of this research were to: 1) quantify rate response of wild oat to 5 different herbicides across 8 site-years 2) relate parameters of rate response curves (D, or maximum efficacy; and ED50, herbicide rate of 50% response) to environmental conditions across sites. Experiments were established in 4 producer fields in each of 1999 and 2000. The experimental design was a randomized complete block with a split-plot treatment arrangement and 6 replications. Whole plots were herbicide and sub-plots were herbicide rate. Herbicides evaluated included clodinafop, fenoxaprop, flucarbazone-sodium, imazamethabenz, and tralkoxydim. Herbicide rates were 0, 1/12, 1/6, 1/3, and 1x the minimum label rate. Minimum label rates were 0.056 kg/Ha clodinafop, 0.09 kg/Ha fenoxaprop, 0.030 kg/Ha flucabazone-sodium, 0.067, 0.42 kg/Ha imazamethabenz, and 0.20 kg/Ha tralkoxydim. Flucarbazone-sodium and imazamethabenz were applied when wild oat were in the 1to 2 leaf stage of development, and clodinafop, fenoxaprop, and tralkoxydim were applied when wild oat were in the 3-4 leaf stage of development.Crop response to herbicides was quantified by taking visual injury ratings 1 and 2 wk after treatment. Efficacy of herbicide treatments for wild oat control was visually rated 4 and 8 wk after treatment. In addition, 2 - 0.25 m2 rings were permanently established in each plot. Wheat and wild oat seedling density, reproductive tiller density, and seed yield were counted and measured in each ring. Maximum and minimum air temperatures, daily precipitation amounts, and relative humidity were measured with weather stations located within 2 km of each experimental site.Clodinafop and fenoxaprop were the most consistent herbicide treatments across all site-years as indicated by 90% or greater maximum percent control. Achieve was the most variable in 1999 as indicated by maximum wild oat control that ranged from 78 to 96%. In 2000, imazamethabenz was the most variable as indicated by maximum wild oat control of 54 to 82%. ED50 varied dramatically for all herbicide treatments across locations and should give the best indication of which environments are conducive for each herbicide.This research should allow for better wild oat management recommendations, as it will improve our ability to match herbicides with different environmental conditions. Further research is needed to help interpret the variation around responses, and how to use that variation to improve management recommendations even further. [Paper Number 120]

KOCHIA MANAGEMENT WITH DICAMBA AND FLUROXYPYR ACROSS THE GOLDEN TRIANGLE OF MONTANA. Alvin J. Bussan, Susan Kelly, and John Holman, Assistant Professor, Research Associate, and Graduate Research Assistant, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, 59717-3120.

Abstract. Kochia management has become difficult across the Golden Triangle of Montana due to resistance to ALS inhibiting and growth regulating herbicides. Kochia with resistance to dicamba have been suspected to be cross-resistant to fluroxypyr. The objectives of this research was to 1) quantify susceptibility of kochia to dicamba and fluroxypyr across the Golden Triangle and 2) determine if applications of dicamba or fluroxypyr selected for increased tolerance within kochia. Experiments were established in 6 producer fields (Fort Benton N, Fort Benton W, Floweree, Manchester, Brady, and Priest Butte) in the Golden Triangle Region of Montana. The experimental design was a randomized complete block with 4 replications. Dicamba and Fluroxypyr were applied at 0.07 and 0.14 kg/Ha to kochia 3 cm tall. Kochia control was evaluated 4 and 8 weeks after application. In July, 5 cuttings 5-15 cm in length were collected from 5 surviving kochia plants within each plot at each location (prior to flower). Cuttings were treated with rooting hormone and established in soil in the greenhouse, covered with pollination bags to prevent out-crossing, grown to maturity, and seed harvested. Seedlings from each mother plant were established by planting 20 seed in 16 flats. Dose response was used to quantify the level of tolerance of the seedling from each mother plant to dicamba and fluroxypyr. Field results suggest kochia was resistant to dicamba at Floweree and both Fort Benton locations, but was susceptible at the remaining sites. Kochia at the Floweree and both Fort Benton

locations were not controlled with fluroxypyr either. Results of dose response should determine if kochia from these locations have increased ED50 and developed resistance to fluroxypyr. [Paper Number 121]

KOCHIA CONTROL WITH FOMESAFEN. Richard K. Zollinger* and Scott A. Fitterer. Associate Professor and Research Specialist, North Dakota State University, Fargo, ND 58105

Abstract. Experiments were conducted near Perley, MN to evaluate kochia control from fomosafen at different formulations, spray volumes, application timings, and adjuvants. EPOST treatments were applied June 7, 2000 to unifoliate soybean. Kochia was 1 to 3 inches tall and at population densities from 1 to 5 plants/ft2 to 25 to 40 plants/ft2. POST treatments were applied June 12, 2000 to 1 trifoliate soybean. Kochia was 3 to 5 inches tall and at similar densities listed above. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles or 17 gpa at 40 psi through 8002 flat fan nozzles, using a wind shield. The experiment had a randomized complete block design with three replicates per treatment. Fomesafen at 0.176 lb/A is the label use rate for North Dakota. The fomesafen&adjuvant formulation is registered only on soybean and the fomesafen formulation is registered for use on dry edible beans in North Dakota through Section 18 registration. Injury ranged from 0 to 12% soybean injury. The greatest injury occurred from fomesafen was applied at higher rates, with oil adjuvants and in sequential application timings. Injury was confined to leaf speckling or burning of leaves. Trifolioliate leaves that emerged after application were not affected. Substituting a methylated seed oil adjuvant for a petroleum oil adjuvant generally did not increase soybean leaf phytotoxicity. The fomesafen&adjuvant formulation generally caused more soybean injury than the fomesafen formulation. Spray volume or application timing had little effect on soybean injury. Generally, greater kochia control resulted from use of the fomesafen&adjuvant formulation, especially at low or medium rates, at 17 gpa, with oil adjuvants and at EPOST applications to smaller kochia plants. The 17 gpa water volume was an advantage over 8.5 gpa with EPOST applications of fomesafen&adjuvant. No differences in kochia control were observed between water volumes for POST applications with fomesafen&adjuvant. However, fomesafen gave better kochia control at 17 gpa than 8.5 gpa. Greater kochia control resulted when fomesafen was applied with methylated seed oil rather than petroleum oil or surfactant. Sequential EPOST/POST applications generally provided near complete kochia control by controlling small plants, allowing better spray coverage of large plants and kochia under high populations, and controlling successive flushes that germinate after the first application. At June 16, kochia regrowth was evident in plots with poor to good initial control. No evaluations were taken after June 19 due to a rain event that delivered eight inches of rain and resulting in flooding and standing water for several days. Significant kochia regrowth would have occurred in most plots with less than 80% kochia control, especially in plots sprayed at the later POST timing. This study demonstrates the importance of maximum coverage with high spray volume, treatment of small plants, and use of oil adjuvants with this contact type herbicide. [Paper Number 122]

TRIASULFURON, PROSULFURON, AND TRIASULFURON PLUS DICAMBA FOR KOCHIA CONTROL IN WINTER WHEAT. Robert N. Klein*, Jeffrey A. Golus and Denny Stamm, Professor and Extension Research Technologist, University of Nebraska, North Platte, NE 69101, and Research Specialist, Syngenta, York NE 68467.

Abstract. A study was conducted to evaluate selected herbicides for control of kochia in winter wheat. Plots were laid out in a randomized complete block design and applied with a ten foot boom (six 11002XR nozzles on 20 inch spacing) at 22 psi and 13.5 gpa. The wheat was late seeded following corn. These conditions, along with drought stress, made the wheat less competitive. Early treatments were applied on April 21, with kochia being less than one inch tall and the wheat three to four inches tall. Late treatments were applied on May 16, with kochia being one to four inches tall and the wheat six to eighteen inches tall. The plots were rated visually for kochia percent control on May 15, June 9 and June 16. [Paper Number 123]

Table. Control of kochia in winter wheat.

Treatment	Rate (Lb ai/a)	Timing	Percent Kochia Control May 15	June 9	June 16
1. Untreated Check			0	0	0
2. Triasulfuron & dicamba + fluroxypyr	0.074 + 0.062	E POST	100	98	98
3. Triasulfuron & dicamba + fluroxypyr	0.074 + 0.124	E POST	100	100	100
4. Triasulfuron & dicamba + carfentrazone-ethyl	0.074 + 0.008	E POST	100	93	93
5. Prosulfuron + fluroxypyr	0.009 + 0.062	E POST	100	94	94
6. Prosulfuron + fluroxypyr	0.009 + 0.124	E POST	100	100	100
7. Prosulfuron + carfentrazone-ethyl	0.009 + 0.008	E POST	68	45	41
8. Chlorsulfuron & metsulfuron	0.014	E POST	45	19	21
9. Triasulfuron + fluroxypyr	0.013 + 0.062	L POST		70	69
10. Triasulfuron + fluroxypyr	0.013 + 0.124	L POST		88	80
11. Triasulfuron + carfentrazone-ethyl	0.013 + 0.008	L POST		64	56
12. Prosulfuron + fluroxypyr	0.009 + 0.062	L POST		58	55
13. Prosulfuron + fluroxypyr	0.009 + 0.124	L POST		96	93
14. Prosulfuron + carfentrazone-ethyl	0.009 + 0.008	L POST		35	35
15. Prosulfuron + carfentrazone-ethyl + 2,4-D ester	0.009 + 0.008 + 0.125	L POST		56	58
16. Prosulfuron + 2,4-D ester	0.009 + 0.125	L POST		21	20
17. Chlorsulfuron & metsulfuron + fluroxypyr	0.014 + 0.062	L POST		60	58
18. Chlorsulfuron & metsulfuron + fluroxypyr	0.014 + 0.124	L POST		85	83
NIS at 0.25% v:v included in all treatments	LSD (0.05)		8.6	6.2	8.5

AGRONOMIC BENEFITS AND CONCERNS FOR ROUNDUP-READY® WHEAT. Alex G. Ogg, Jr. and Paul J. Isakson, Weed Scientist, Ten Sleep, WY 82442 and US Wheat Technical Manager, Monsanto, St. Louis, MO 63167.

INTRODUCTION

The purpose of this report is to enumerate and discuss the agronomic benefits and concerns for Roundup-Ready® Wheat. To identify the various agronomic considerations for Roundup-Ready® Wheat, all the weed scientists in the western United States conducting weed management research in wheat were contacted by mail and later by telephone. Before being interviewed by telephone, each researcher received a list of questions upon which the interview was based. During the interview, issues for winter wheat were considered separate from those for spring wheat. Because some of the issues are different, the two wheats will be discussed separately.

In addition to the weed scientists interviewed, several plant breeders were contacted and about 10 wheat producers were also interviewed.

This report will focus on the agronomic benefits/advantages and the agronomic concerns/disadvantages for Roundup-Ready® Wheat. A number of non-agronomic issues were raised in these discussions and they are mentioned as a separate subheading because they can eventually affect wheat production.

WINTER WHEAT

Agronomic Benefits/Advantages for Roundup-Ready® Winter Wheat.

Improved Control of Grassy Weeds. The most frequently mentioned and usually the first mentioned benefit for Roundup-Ready® Wheat (R-R Wheat) was improved control of winter annual grasses such as jointed goatgrass, feral rye, downy brome, cheat and related Bromus species. Control of jointed goatgrass and feral rye was the highest priority, because there are no selective herbicides available to remove these two weeds from the growing crop. However, several individuals commented that the greatest use of R-R Wheat would be areas infested with downy brome and related Bromus species because these weeds infested by far the greatest acreage of wheat lands. In addition to the above-mentioned weeds, several researchers mentioned Persian darnel, quackgrass, herbicide-resistant Italian ryegrass, and perennial weeds in general.

Broadspectrum Weed Control. The second most frequently mentioned benefit for R-R Wheat was broad-spectrum weed control. Roundup® herbicide will control or suppress greatly almost all weeds found in winter wheat fields. For most R-R Wheat fields, the only herbicide necessary will be Roundup. Two weeds mentioned as being most difficult to control with Roundup were prairie cupgrass and plains coreopsis.

Wider Window of Herbicide Application. The third most frequently mentioned benefit of R-R Wheat was the wider window of application timing for Roundup herbicide. Because Roundup will control weeds over a wide range of growth stages, wheat producers will have more time to apply the herbicide. This will be especially beneficial during periods of rain or windy conditions. It will also be beneficial for controlling weeds that emerge in several flushes, that is, for most weeds, growers can wait until all flushes have emerged before applying Roundup. One respondent pointed out that there are two periods when producers have to be concerned about weed control in winter wheat, October-November and late winter-early spring. With currently available herbicides, the window of application for safe and effective weed control is narrow and not all herbicides can be used in both time periods. On the other hand, with R-R Wheat, Roundup could be applied safely and effectively in both periods.

Greater Crop Safety. The fourth most frequently mentioned benefit for R-R Wheat was greater crop safety than most of the currently available herbicides. Many of the currently available herbicides for winter wheat have a narrow window in terms of plant size or weather conditions when they can be applied safely to wheat. With R-R

Wheat, Roundup can be applied at any growth stage and apparently without worrying about subsequent freezing temperatures that might slow herbicide metabolism and injure the wheat. Also, tolerance of R-R Wheat to Roundup is very high, so there is almost no chance of crop injury. This is important because many field sprayers in use today have long booms and in small or irregular-shaped fields, some areas of the field may receive three doses of the herbicide during the application.

No Soil Residual Problems. Another often mentioned benefit for R-R Wheat was no soil residual from Roundup. If the winter wheat freezes-out or dies from other pest problems, there are no rotational crop restrictions.

Simple Weed Management Decisions. Because of the above-mentioned benefits, weed management in wheat will be very simple with R-R Wheat and Roundup herbicide. If a grower sees weeds in his wheat, he simply applies Roundup herbicide, confident that regardless of weed species, weed size, or wheat stage of growth, the weeds will be controlled without injuring the crop.

Control of Perennial Weeds. Control or suppression of perennial weeds with Roundup was another agronomic benefit of R-R Wheat. Control of quackgrass was mentioned several times, as was suppression of field bindweed.

Control of SU-Resistant Weeds. R-R Wheat would provide the technology needed to control sulfonylurea-resistant weeds such as kochia and Russian thistle.

Less Risk of Developing Herbicide-Resistant Weeds. Several respondents thought there would be less risk of developing herbicide resistant weeds with R-R Wheat technology compared to some of the herbicides currently used in wheat.

Decrease the Weed Seed Soil Bank. R-R Wheat technology will control weeds very well and will decrease the weed seed soil bank, thus there will be fewer weeds in subsequent crops.

Improved Management of Herbicide Resistant Wheat. The availability of R-R Wheat will provide a herbicide-resistant wheat with a mode of action different from imidazolinone-resistant wheat and should improve the resistant weed management programs for both herbicide-resistant wheat technologies. The two different technologies should also be useful for the control of volunteers from the different herbicide-resistant wheats.

Make It Easier to Changes Class of Wheat Grown. R-R Wheat will allow growers to changes the classes of wheat they are growing without worrying about volunteers from the previously grown class of wheat.

Less Dockage in Harvested Grain. Another agronomic benefit of R-R Wheat mentioned was cleaner harvested grain, and thus less dockage, less storage problems, and greater net farm income.

Increase Soil Moisture. Using R-R Wheat technology may increase soil moisture because less tillage would be needed to control weeds, and this technology may speed the adoption of direct seeding and other conservation tillage practices.

Reduced Environmental Hazard. Several respondents mentioned less environmental hazard compared to current chemical weed control programs in wheat because Roundup is more environmentally friendly than many of the herbicides that are currently used in wheat.

Reduced Phenoxy Herbicide Damage to Non-target Crops. R-R Wheat may reduce the use of phenoxy herbicides and thus reduce injury symptoms on grapes and other non-target crops that are especially sensitive to phenoxy herbicides.

Rapid Adoption of R-R Wheat Technology. There could be rapid adoption of R-R Wheat technology because wheat producers are already familiar with Roundup herbicide and how to use it properly compared to introducing new chemistry. Also, growers could use existing machinery and the same cultural practices.

Roundup More Compatible with Closed-Injector Systems. One respondent mentioned that because Roundup(is a liquid formulation, it works better with closed-injector systems that many of the commercial applicators are using and this would be a benefit of R-R Wheat.

Better Able to Return CRP Lands to Wheat Production. One grower mentioned that with R-R Wheat, it would be easier to return CRP (Conservation Reserve Program) lands to wheat production. He has observed that CRP lands have lots of cheatgrass, jointed goatgrass and perennials and he is concerned about controlling these weeds in winter wheat planted when CRP is over. He feels that being able to use Roundup in winter wheat would be a big benefit for the first couple of years after CRP.

Reduced Incidence of Other Pests. Finally, using R-R Wheat technology may reduce the incidence of other pests in wheat by eliminating weeds and volunteer crops that serve as hosts for these pests.

Agronomic Concerns/Disadvantages of Roundup-Ready(Winter Wheat.

Control of Volunteers. By far the greatest concern of R-R Wheat was how to control the volunteers from these plants. For many years now, Roundup(herbicide has been the product of choice for controlling volunteer wheat and weeds between crops in winter wheat cropping systems. Current conservation tillage systems including direct drilling were not really feasible until Roundup(was labeled for this use in the late 1970s. It is the backbone of no-till farming systems. With this in mind, it is easy to see why this was the dominate concern among all growers contacted in this survey. Many researchers shared this concern with the growers. The growers using no-till systems said they would not consider using R-R Wheat if there wasn't an inexpensive and highly effective substitute for Roundup(for controlling volunteers. Because a number of growers are already planting other R-R crops such as corn or canola, there was much concern about controlling volunteer R-R Wheat in other R-R crops.

Volunteer wheat can be troublesome in any crop or fallow following winter wheat, but can be especially troublesome in any grain crop that follows winter wheat. Several people thought that volunteers were most troublesome in a winter wheat-fallow rotation. Others disagreed, saying that because tillage is still use in this rotation, volunteers are not a big problem in wheat-fallow. The majority thought that volunteers were more troublesome in annual cropping systems compared to wheat-fallow systems. Several people commented that volunteer wheat was a major problem where double-cropping systems were used and cited soybeans or grain sorghum after winter wheat as an example. Most agreed that volunteers were a bigger problem in no-till compared to reduced tillage or conventional tillage systems. The worst-case scenario for volunteer wheat is continuous no-till winter wheat. Another especially troublesome situation with volunteers would be R-R Soybeans after R-R Wheat.

Published information on the biology and ecology of volunteer wheat is scarce. In 1993, Anderson and Nielsen reported that at Akron, CO, fall emergence of volunteer wheat followed a pattern very similar to that of downy brome and jointed goatgrass. Emergence of all three species began about 15 days after the first fall rain on September 17 and continued for 65 days until December 6. There were three similar emergence peaks for each species, October 18, November 8 and November 29. In another study, Anderson and Nielsen (1996) found that volunteer wheat emerged continuously from April 1 to November 1 in either fallow or in summer crops. They also found more volunteers in no-till than in conventionally tilled systems and more volunteers in corn than in proso millet. Dewey and Baker (1978) reported that volunteer wheat averaged 17 heads/square meter in no-till plots versus 119 heads /square meter in conventionally tilled plots, contradicting the opinion of many that volunteers were more troublesome in no-till compared to conventionally tilled systems.

Many of those contacted had observed that winter wheat seed could persist in the soil through a summer fallow year, although all thought the amount was very small, probably less than 1%. DeMacon (1995) working at Washington State University found that initial seed dormancy varied greatly among wheat genotypes. Whereas some genotypes reached 50% germination in 2.5 days, other genotypes took as long as 56.4 days. Wheat varieties Brevor and Tom Thumb had little loss in dormancy after 6 weeks. Several people commented that the carryover of winter wheat seed was more noticeable in dry years compared to years with normal rainfall. Anderson and Nielsen (1996) working in Colorado showed conclusively that winter wheat seed could persist through summer fallow or summer crops and emerge in the fall. Contrary to what many weed scientists thought, Anderson and Nielsen found that as much as 15 to 20% of the total volunteer wheat emergence between April 1 and November 1 took place after September 1. Scientists who were working with variety testing programs commented that they have seen the seed of some varieties persist through two summer-fallow years. Plant breeders usually double fallow (2 years) or have two rotational crops between wheat crops to reduce the risk of volunteer wheat. Several people commented that carryover of winter wheat seed was greater in no-till systems than in conventionally tilled systems. Carryover of R-R Wheat seeds would present some special problems for growers who raise foundation seed. Also, if R-R Wheat was planted one year and Clearfield Wheat((imadazolinone-resistant) was planted the following year, conceivably, a grower could have a field with volunteers resistant to both classes of herbicides.

Before Roundup(was available, growers controlled volunteer wheat mainly with tillage. Several growers stated that volunteer wheat, unlike downy brome or cheat, was easy to control with tillage. However, for many areas of winter wheat production in the western US, tillage to control weeds in fallow is not feasible nor something that growers want to return to.

Two of the earliest reports of using herbicides for chemical fallow were by Alley (1961) in Wyoming and by Phipps, Swan and Furtick in 1961 in Oregon. Alley found that atrazine would control all weeds for the entire fallow period. Phipps, Swan and Furtick found that amitrole + 2,4-D would control emerged volunteer wheat and other weeds in fallow. For residual weed control, they found that atrazine + amitrole or dalapon gave good control of volunteers and other weeds. For chemical fallow, several products were labeled in the 1960s and 1970s including atrazine, paraquat, atrazine + paraquat, amitrole, amitrole + atrazine, dalapon, cyanazine, IPC (propham) and metribuzin. Some of these products or combinations such as atrazine + amitrole, were effective in some locations. There are numerous reports in the literature documenting the control of volunteer wheat with these products. Representative references were selected and are cited here (McMackin, 1973; Eldredge, Lee and Mundt, 1980; Callihan and Leino, 1981; Lish, Thill and Callihan, 1983; Lish and Thill, 1988,). Amitrole, dalapon, and IPC are no longer available commercially. Paraquat has been used for the control of volunteer wheat, and in some instances has given high levels of control (McMackin, 1972). However, frequently volunteer wheat recovers from treatment with paraquat and final results are poor (Lish and Thill, 1988; Lish, Thill and Callihan, 1983). Anderson and Nielsen (1991) found that paraquat was most active on volunteer wheat treated in the 1 to 3-leaf stage. If the application was delayed until the volunteer wheat began to tiller, control was reduced significantly.

In the 1980s and 1990s, pronamide and paraquat + diuron were also registered for chemical fallow. Although pronamide is quite effective for control of volunteer wheat (Neidlinger, 1983; Lish, Thill and Callihan, 1983; Ogg, 1993), small grains cannot be planted for nine months after application. In the Pacific Northwest during years of very dry weather, pronamide appeared to carry over and stunted winter wheat planted 12 months after pronamide was applied. Many of the products registered for use in fallow (atrazine, cyanazine, diuron and pronamide, for example) have restrictions on crops that can be planted after wheat. Clomazone was evaluated for control of volunteer wheat and found to be effective (Dalrymple and Miller, 1990). In Wyoming, the combination of clomazone + atrazine was very effective on volunteer wheat. Partly because of problems related to drift and injury to nearby crops, clomazone was not registered for use in fallow. In summary, none of these products or combination of products is as effective, safe and dependable as Roundup(for the control of volunteers and weeds in fallow.

During the past year, weed scientists in the western US have evaluated several of the newer graminicides for their effectiveness for controlling volunteer wheat. Clethodim, sethoxydim, and quizalofop were mentioned most frequently. Results varied depending on the location. Quizalofop and clethodim were found to control volunteer wheat reasonable well in most tests, however these products were seldom as effective as Roundup((which usually gave 100% control) and they took about twice as long to achieve control compared to Roundup(. The slowness of these products was especially noticed when they were applied early when temperatures were cool. In 1989, Brewster and Spinney at Oregon State University published a paper in Weed Technology reporting five years results of evaluating the control of grass weeds, including wheat, with sethoxydim, fluazifop, haloxyfop and quizalofop. Clethodim was evaluated in 1986 only. Control of wheat with these herbicides applied to 1 to 4-tiller plants varied from year to year. Control was 100% with fluazifop, quizalofop, and haloxyfop in 1984, but was only 67 to 88% in 1986, and confirms the results of recent tests. Clethodim controlled wheat 67% in 1986. Sethoxydim was significantly less effective than the other herbicides. In 1985, Yenne, Thill and Callihan reported that fluazifop-p-butyl applied March 30 at 0.25 lb ai/A with crop oil + surfactant controlled volunteer wheat 100%.

The slowness and less effectiveness of these products in controlling volunteers could be a factor in managing the "Green Bridge", that is a significant problem in the Pacific Northwest. Research in the Pacific Northwest has shown that when spring grains were planted three days after applying Roundup(to volunteer wheat and weeds, Rhizoctonia root rot was severe in the planted crop (Smiley et. al., 1992). If planting was delayed until three weeks after applying Roundup, the disease was greatly reduced. As weeds begin to die after Roundup is sprayed, the pathogen, *Rhizoctonia solani*,Kuhn attacks these weeds and its populations peak about three days after the herbicide is applied. By three weeks after Roundup application, the organism population has returned to near pre-treatment levels. Thus, when spring cereals are planted three days after applying Roundup, the seeds are placed into a high concentration of the pathogen and the developing roots are rotted, whereas, waiting until three weeks after application before planting the crop eliminates the problem. The point to this discussion is that if the graminicides such as clethodim and quizalofop take longer to control volunteers or they are less effective than Roundup, their application may extend the time period in which *Rhizoctonia solani* populations remain high and thus require delaying planting of spring crops or requiring that that the herbicides be applied earlier. Either of these situations would not be desirable. Also, if alternative herbicides take longer than Roundup(to kill volunteers, more soil water could be lost and crop yields could be reduced.

A similar situation could occur with the volunteer wheat and the wheat streak mosaic problem that is prevalent in the Central Great Plains. Volunteer wheat is the preferred host for the wheat curl mite (*Aceria tulipae*), which is the vector of the wheat streak mosaic virus (Chubb, 1981; Lamey and Timian, 1979). To control wheat streak mosaic in winter wheat, there needs to be a 2-week clean break between summer volunteer wheat and planting of the fall wheat crop. If the newer graminicides take longer than Roundup(to kill volunteer wheat and they do not give 100% control, then there could be problems with wheat streak mosaic in the winter wheat crop.

Researchers were questioned as to other herbicides they thought might be effective for the control of volunteer R-R Wheat. Several commented that glufosinate might be a possibility. Only a few weed scientists working in wheat had actually tested glufosinate on volunteer wheat. Not only were results with glufosinate highly variable among the scientists, but results varied widely from year to year. Anderson, et al. al. (1993) have shown that glufosinate activity is influenced significantly by changes in temperature and relative humidity, and this may explain why glufosinate results have been so variable. Most weed scientists did not consider glufosinate a viable alternative to Roundup(for the control of volunteers.

A couple of researchers mentioned "EndGame(" technology as a possible method to enhance the effectiveness of herbicides that already had some activity on volunteer wheat. EndGame(is being developed by United Ag Products and is a formulation change whereby herbicides are dissolved in a mixture of sulfuric acid and liquid urea. In this mixture, the solution is no longer caustic and herbicide activity is enhanced greatly. Molin (2000) reported that EndGame(Technology reduced the I-50 at three weeks for Roundup Ultra(by 2 to 4 times. Although no data are available, at least one researcher thought EndGame(technology should be tested with the graminicides such as quizalofop and clethodim for the control of R-R Wheat volunteers.

To summarize the situation on alternatives to Roundup for the control of volunteer wheat, at this time there doesn't seem to be a commercially available practice that has the effectiveness or utility of Roundup(.

Increased Selection for Glyphosate-Resistant Weeds. Among both growers and weed scientists there was a large concern that increased use of Roundup(in R-R Wheat could lead to the appearance of glyphosate-resistant weeds. Several researchers mentioned the discovery of glyphosate-resistant rigid ryegrass in California (Dill, 2000; Prather, DiTomaso, and Holt, 2000) as an example that glyphosate resistance can happen. Growers using no-till systems were very concerned about weed resistance and commented that the appearance of glyphosate-resistant downy brome (for example) would devastate no-till wheat production systems in the western US. A number of producers are already using R-R Corn or R-R Canola in their cropping systems. There was concern that adding R-R Wheat would increase the risk for the development of glyphosate-resistant weeds. A number of researchers expressed concern that glyphosate-resistance might some how be transferred to jointed goatgrass, and thus make jointed goatgrass resistant to Roundup. Several researchers commented that the glyphosate-resistant gene needs to be on a genome in wheat other than 'D'. Wheat and jointed goatgrass both have the 'D' genome and hybrids between these two occur naturally under field conditions. The occurrence under field conditions of imidazolinone-resistant wheat x jointed goatgrass hybrids has been documented (Seefeldt, et al., 1998). Furthermore, it has been shown that some wheat x jointed goatgrass hybrids can produce viable seed, and that self-fertility can be partially restored after one backcross to jointed goatgrass (Zemetra et al., 1998). Wheat breeders felt that placement of the resistance gene on a genome other than the 'D' genome would greatly reduce, but would not guarantee 100% that the resistance gene could not be transferred to jointed goatgrass. Several researchers thought, that in wheat cropping systems, the weeds most likely to develop resistance to Roundup(were jointed goatgrass, downy brome, field pennycress and kochia.

Increase in Weed Species Shifts. Most weed scientists felt that if R-R Wheat was widely used that there would be an increase in the rate of weed species shifts. Many felt there had already been some weed species shifts from the use of Roundup(over the past 20 some years. Weeds mentioned as having increased after repeated use of Roundup(include wild buckwheat, kochia, prairie cupgrass, plains coreopsis, prickly lettuce, and prostrate knotweed. One wheat grower who has been no-tilling for 30 years and has used Roundup(for 13 years says he has to use 14 to 16 oz/A now to get the same level of weed control he used to get with 12 oz/A.

Roundup Drift to Nearby Fields. Another frequently mentioned concern was drift of Roundup(to nearby fields. Because Roundup(will be applied to R-R Wheat at times when non-resistant crops are growing in most nearby fields, the potential for drift damage will be great. In many areas where winter wheat is grown, fields of wheat are separated by 5 feet or less and the potential for drift damage is high, even with ground applications. Also, this problem will be of great concern where R-R Wheat is grown under irrigation, again, because of the nearby susceptible crops.

Slow the Adoption of Conservation Farming Systems. If wheat growers have to use tillage to help control R-R volunteer wheat or glyphosate-resistant weeds, adoption of conservation farming systems such as no-till/direct seeding will be reduced and soil erosion by wind and water will increase. At the same time, tillage needed for control of volunteers may increase soil water evaporation, thus potentially reducing crop yields.

Require Better and More Detailed Recording Keeping. Growers will have to keep better and more detailed records of which fields are Roundup(resistant and which ones are non-resistant. Herbicide applicators will have to be especially careful to be sure that Roundup(is being applied to the right field of wheat.

Increase in Disease and Insect Problems. If volunteer R-R Wheat is harder to control or if it takes longer than control than with current practices, diseases such as wheat streak mosaic and Rhizoctonia root rot, and insects such as the Russian wheat aphid may be greater problems, thus reducing crop yields.

Reduce the Use of Good Weed Management Practices. Several researchers expressed concern that R-R Wheat would make weed control in wheat too simple and would reduce the use of good weed management practices. Others stated that this technology would make farmers 'lazy', and would benefit poorly managed farms the most. The scientists were concerned that wheat producers would come to rely solely on Roundup(for weed control and would not use good farming practices such as crop rotations that suppress weeds.

Lack of Timely Weed Control in Wet Springs. If Roundup(cannot be applied by air to R-R Wheat (as is the current restrictions with other R-R crops), then herbicide application may be delayed when soils are wet or when there are extended windy periods. If herbicide application is delayed too much, wheat yields may be reduced by weed competition.

Limited Variety Selection. At least initially, the growers would have perhaps only one or two locally adapted varieties of R-R Wheat that could be planted. Also, Roundup(resistance may not be available in the most recently released disease- and insect-resistant wheat varieties.

Grain Blowing off Trucks Will Spread R-R Wheat Along Roadsides. Wheat kernels frequently blow off of trucks as the trucks travel on country roads and highways. If the wheat is R-R Wheat, then this will spread the genetically modified wheat to roadsides and perhaps to fields where the R-R wheat was not planted. Requiring tarps on all trucks hauling R-R Wheat would reduce greatly the spread of the genetically modified wheat.

Movement of Pollen from R-R Wheat to Conventional Wheat. A couple of researchers expressed concern about the spread of genetically modified genes by pollen from R-R wheat to conventional wheat. The agronomic consideration here is the need for a buffer zone around each R-R Wheat field to reduce the possibility of cross pollination between R-R Wheat and a neighbor's conventional wheat, if he, for what ever reason, doesn't want any genetically modified genes in his crop. Several wheat breeders were asked how far wheat pollen could move and remain viable. None of the breeders could give a definite answer; as such movement was highly dependent upon environmental conditions, such as wind speed, humidity and temperature. Several said that some studies had shown pollen could move 0.25 mile and still be viable. Several states require 90-foot wheat-free buffers around foundation wheat fields. At least one state requires a 0.25-mile buffer around foundation seed fields. Dafni and Firmage (2000) reported that airborne wheat pollen could remain viable for 5 minutes under greenhouse conditions. Boinnet (1983) found that viable wheat pollen cross-pollinated plants 25 feet away in a field study, but also found that the pollen cross-pollinated plants in another set of research plots 125 feet away. All breeders felt that the movement of viable pollen beyond 15 to 25 feet and the chance of outcrossing between two different wheats was very remote, but that it would be impossible to guarantee 100% that such outcrossing could be prevented regardless of the width of the buffer zone between wheat fields.

SPRING WHEAT

Agronomic Benefits/Advantages of R-R Spring Wheat.

The agronomic benefits of R-R Spring Wheat mentioned were similar to those mentioned for R-R Winter Wheat. Those that differed from the benefits mentioned for R-R Winter Wheat are discussed below. Most of these benefits fall under the general heading of more effective weed management.

Control of Herbicide-Resistant Weeds. Because Roundup(has a different mode of action from the other herbicides currently used in spring wheat, R-R Spring Wheat technology would be very useful for the control of herbicide-resistant weeds such as wild oats, kochia, and Russian thistle. Almost all individuals interviewed about R-R Spring Wheat mentioned this benefit.

Better Control of Perennial Weeds. Improved control of perennial weeds such as Canada thistle, field bindweed, quackgrass, foxtail barley, and perennial sowthistle was mentioned frequently as a major benefit of R-R Spring Wheat technology. Several individuals thought that it would require a different timing of application of Roundup(to control the perennials compared to the timing to control the annuals such as wild oats.

Better Control of Wild Oats. Because Roundup(will control wild oats over a wide range of growth stages, control of this weed will be more complete with Roundup(compared to currently available herbicides.

Improved Crop Safety. Many of the herbicides currently used in spring wheat cause some level of injury symptoms, especially when temperatures at night drop below freezing. Occasionally, grain yields are reduced significantly when injury symptoms are severe. Apparently, R-R Spring Wheat is very tolerant to Roundup(and the herbicide does not injure the crop even under adverse conditions.

Control of Downy Brome, Jointed Goatgrass and Cereal Rye. Growing spring wheat instead of winter wheat is often recommended as a cultural practice to control winter annual grasses such as downy brome, jointed goatgrass, and cereal rye. However, recent research has shown, and growers have verified, that in dry years or when spring wheat is planted early, these weeds can emerge, grow and produce seed in spring wheat. With R-R Spring Wheat technology, these weeds can be controlled 100% in spring wheat and the effectiveness of spring wheat as a rotational crop to reduce the seed population of these weeds in the soil bank will improve greatly.

Broader Tank-Mix Capability. Compatibility of currently used wild oat herbicides with herbicides used to control broadleaved weeds can be a problem. Roundup(has very few tank-mix restrictions and thus would give producers more flexibility in tank mixing herbicides.

Wider Window of Herbicide Application. Because Roundup(will control weeds over a broad range of growth stages, there will be a wider window for effective weed management. This is especially important in the spring when weather conditions may be unfavorable (wind, rain) or if soils are too wet for spray equipment.

No Plant-back Restrictions. Because Roundup(has no plant-back restrictions this would be advantageous to growers who double crop within a single year. For example, in California, spring wheat is actually sown in the fall, and as soon as the wheat is harvested, another crop is planted. Also, some currently available herbicides for spring wheat have enough residual activity to restrict the choices of crops that can be planted within one year of the herbicide application.

Broad Spectrum Weed Control. Similar to the situation in R-R Winter Wheat, the use of Roundup(in R-R Spring Wheat gives control of a very broad spectrum of weeds. Usually, there are more weed species found in spring wheat than in winter wheat, so a treatment that controls nearly all weed species is desirable.

Plant Spring Wheat in the Fall. Several people mentioned that given the right variety, R-R Spring Wheat could be planted in the late fall. Apparently, in some areas where winters are mild, fall-sown spring wheat will out-yield winter wheat. Also, in years with very dry or very wet falls, growers may not be able to plant winter wheat, but still want to have a wheat crop. With currently available herbicides, winter annual grasses can't be controlled in fall-sown spring wheat. R-R Spring Wheat would provide the technology to control winter annual grasses and other weeds in fall-sown spring wheat.

Could Inter-plant R-R Spring Wheat with R-R Winter Wheat. In wheat producing regions of the western U. S., winter wheat may suffer winterkill. Also, there may be areas within a field where there the plant population of winter wheat is poor. If both R-R winter wheat and R-R Spring Wheat were available in the same class of wheat, R-R Spring Wheat could be inter-planted in those areas of the field where the stand of R-R Winter Wheat was poor.

Improve the Transition from Summer Crops Back to Winter Wheat. If spring wheat could be planted early without concern for controlling downy brome and jointed goatgrass that can emerge in the spring, this would improve the transition from summer crops back to winter wheat without the use of fallow. This would improve farm productivity and perhaps reduce soil erosion associated with fallow.

Agronomic Concerns/Disadvantages of R-R Spring Wheat.

There were fewer concerns expressed about R-R Spring Wheat compared to the number expressed about R-R Winter Wheat. Many of the concerns expressed about R-R Spring Wheat were similar to those expressed about R-R Winter Wheat.

Control of Volunteer R-R Spring Wheat. Although some were less concern about the control of volunteer R-R Spring Wheat than R-R Winter Wheat, this was still the most frequently mentioned concern about R-R Spring Wheat. Specific situations mentioned were how to control volunteer R-R Spring Wheat when the next crop to be planted was malting barley; how to control volunteer R-R Spring Wheat when the next crop was winter wheat; and how to control volunteer R-R Spring Wheat when grown in rotation with other R-R crops. Tillage is used more frequently in spring wheat cropping systems than it is in winter wheat cropping systems. Some respondents had little concern about volunteer R-R spring wheat because tillage was used and because crop rotations were longer in spring wheat cropping systems. The most common methods used to control volunteer spring wheat in fallow or between crops were tillage and Roundup(. In broadleaved crops, the graminicides such as quizalofop, fluazifop and clethodim are used to control volunteer spring wheat.

There were no known references on the biology or ecology of volunteer spring wheat.

Increased Selection for Glyphosate-Resistant Weeds. Many were concerned that increased use of Roundup(in R-R Spring Wheat would increase the probability of the appearance of glyphosate-resistant weeds. The occurrence of herbicide-resistant wild oats and problems these plants cause spring wheat producers and weed scientists has heightened their concern for glyphosate-resistant weeds.

Increase in Weed Species Shifts. Several researchers expressed concern that the increased use of Roundup(in R-R Spring Wheat would increase the occurrence of weeds tolerant of glyphosate. Weeds of spring wheat mentioned as being of increasing tolerance to glyphosate included wild buckwheat, foxtail barley, and tall waterhemp.

Lack of Residual Weed Control. One respondent thought that lack of residual weed control with Roundup(in R-R Spring Wheat was a disadvantage. This person cited the wild oats with its multiple flushes of emergence as an example of where a non-residual herbicide was a disadvantage.

Other Concerns/Disadvantages. Roundup(drift to nearby crops, requirement for better and more detailed record keeping, lack of timely weed control in wet springs, limited variety selection, and movement of pollen from R-R Spring Wheat to conventional wheat were mentioned also, and the concern was the same as that already discussed for R-R Winter Wheat.

NON-AGRONOMIC ISSUES

During the course of the interviews there were a number of non-agronomic issues expressed. Although these issues do not have a direct bearing on agronomic considerations for R-R Wheat, they will in the long run, affect wheat production and perhaps the acceptance of R-R Wheat.

Effect of Genetically Modified Wheat on Market Acceptability. Several of the wheat producers and researchers raised this concern. Segregating genetically modified wheat from conventional wheat at the grain elevator would be very difficult at this time. If major foreign wheat buyers (for example, Japan) won't accept R-R Wheat or other genetically modified wheat, then growers won't adopt the technology. Most who raised this point felt that this issue needs to be resolved before R-R Wheat is made available to producers. Once a foreign market is lost to a competitor, it is very difficult to re-establish.

Elimination of Alternative Herbicides. Several people expressed concern the R-R Wheat technology would eliminate many of the herbicides currently used for weed management in wheat, and if glyphosate-resistant weeds appeared there wouldn't be any herbicides to control them. Along this same line, the emerging dominance of Monsanto in the herbicide market with R-R crops and Roundup(herbicide was viewed with concern by both researchers and growers. They considered competition in the herbicide market as a necessity to control production costs.

Increase in the Cost of Fallow Weed Control. The current use of Roundup(for the control of volunteer wheat in fallow gives growers an effective and relatively inexpensive way to manage fallow with either reduced or no tillage. If an inexpensive and effective alternative to Roundup(for controlling volunteers cannot be found, many would not use R-R Wheat technology. Growers practicing no-till farming were very adamant about this concern.

If and How Will Technology Fees be Collected. Several growers expressed concern about whether and how technology fees for R-R Wheat would be collected. At the present time, wheat prices are very low and growers are struggling to pay the current expenses involved with wheat production. A technology fee associated with R-R Wheat would meet with much resistance. Also, the issue of the R-R gene being placed in public wheat varieties, whose development was supported financially by wheat growers, needs to be resolved before this technology is made available to growers. [Paper Number 124]

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MANAGING VOLUNTEER FOLLOWING HERBICIDE RESISTANT CROPS. Curtis R. Rainbolt*, Donald C. Thill, Dan A. Ball, Joe P. Yenish, and Frank L. Young. Graduate Research Assistant and Professor, Plant Science Division, University of Idaho, Moscow, ID 83844, Associate Professor, Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, OR 97801, Assistant Professor and USDA-ARS Research Agronomist/Weed Scientist, Department of Crop and Soil Sciences, Washington State University, Pullman, WA 99164.

Abstract. Herbicide-resistant wheat will be available soon, and other new herbicide-resistant crops (HRC) will continue to be introduced during the next several years, which may result in crop rotations containing mostly or all herbicide-resistant cultivars. However, there is little or no information on how to safely and effectively incorporate them into Pacific Northwest direct-seed, dry land cropping systems. Traditionally, growers have relied on glyphosate to control volunteer crops and weeds during fallow periods in direct-seed systems. This poses a problem for control of volunteer HRC such as glyphosate-resistant spring wheat and canola. Studies were established near Moscow, ID at the University of Idaho Parker Research Farm and near Ralston, WA at the USDA Ralston Direct Seed Project site to evaluate alternatives to traditional treatments (glyphosate) for control of volunteer HRC. In spring 2000, glyphosate-resistant spring wheat (RRW), glyphosate-resistant spring canola (RRC), imidazolinone-resistant wheat (CFW), imidazolinone-resistant spring canola (CFC), and glufosinate-resistant spring canola (LLC) were seeded to simulate HRC volunteer. RRW was best controlled and its biomass reduced most by paraquat + diuron, and treatments containing clethodim or quizalofop. CFW was controlled best with quizalofop, clethodim, paraquat + diuron, and all treatments containing glyphosate. RRC was controlled best with glyphosate/2,4-D, glyphosate/dicamba, and treatments containing paraquat. Control of CFC and LLC was greatest with paraquat + diuron, and all treatments containing glyphosate. In spring 2000, glyphosate-resistant spring wheat was seeded to simulate volunteers near Genesee, ID, Pendleton, OR, and Pullman, WA. Graminicides were applied when the wheat was in the 3 to 4 and in the 5 to 6 leaf stages. At Genesee, control of RRW was 90% or more with all treatments containing quizalofop, clethodim, or sethoxydim applied at either timing, while at Pendleton and Pullman, control was better with these treatments applied at the 3 to 4 leaf stage, compared to those made at the 5 to 6 leaf stage. [Paper Number 125]

WEED POPULATION DYNAMICS IN GLYPHOSATE-RESISTANT CORN AND SOYBEAN CROPPING SYSTEMS. D.E. Stoltenberg. University of Wisconsin, Madison.

Abstract. Cropping systems are changing rapidly in the upper Midwest. Growers are increasingly adopting herbicide-resistant crop cultivars, particularly transgenic crops with resistance to glyphosate. Grower interest in

glyphosate-resistant corn and soybean has rapidly and dramatically changed weed management practices. The potential exists on many acres where glyphosate is the primary, if not only, herbicide used for weed management in both corn-soybean rotation and in continuous-corn cropping systems Although growers are implementing these new technologies, many questions remain about the long-term impact of glyphosate-resistant cropping systems on weed management. Little or no research information has been available to growers about the potential for new weed problems, weed resistance to glyphosate, or the integration of glyphosate use with other cultural, mechanical, and chemical practices. Therefore, research was initiated in 1998 and conducted through 2000 at the University of Wisconsin Arlington Agricultural Research Station to determine the weed management and agronomic risks in glyphosate-resistant corn and soybean cropping systems as influenced by primary tillage, crop rotation, and intensity of glyphosate use. Specific objectives were to determine changes over time in the number and type of weed species, weed plant density and biomass, soil seed bank density, and crop yield. Tillage treatments included moldboard plow, chisel plow, and no-tillage systems. Cropping system treatments included continuous corn and corn-soybean rotation. Weed management treatments included glyphosate only, glyphosate use integrated with other chemical and mechanical practices, and conventional herbicide programs. Among weed management treatments, glyphosate applied sequentially or glyphosate plus inter-row cultivation were among the most consistent and effective treatments in continuous corn. Results for these particular treatments from 1998 and 1999 in continuous corn suggested that weed population densities decreased over time. In corn-soybean rotation, most treatments that included glyphosate were effective, particularly in moldboard plow and chisel plow systems. Common lambsquarters (*Chenopodium album*), giant foxtail (*Setaria faberi*), and velvetleaf (*Abutilon theophrasti*) were the dominant weed species in most treatments in each cropping system. However, in treatments that included broad-spectrum soil-residual herbicides, giant ragweed (*Ambrosia trifida*) and shattercane (*Sorghum bicolor*) populations increased dramatically. After three years of research, results suggest that the weed management and agronomic risks associated with glyphosate use in glyphosate-resistant corn and soybean may be no greater than those associated with conventional herbicide programs. However, to more thoroughly assess the weed management and agronomic risks associated with these systems, this research should be continued for several more years. [Paper Number 126]

HERBICIDE TOLERANT CANOLA IN CANADA - FIVE YEARS ON. Linda Hall and Keith Topinka, Alberta Agriculture, Food and Rural Development, Edmonton, and Allan Good, University of Alberta, Edmonton.

Abstract. Of the 5.5 million ha of canola (*Brassica napus*) grown in Canada in 1999, 57% was herbicide tolerant. Four types of herbicide tolerant canola are currently available: glyphosate, glufosinate, imidazolinone and bromoxynil. Volunteer canola is a common weed in western Canada, occurring in 10 to 15% of cereal fields. Between adjacent canola plants there is 20% outcrossing. Therefore, both herbicide resistant volunteers and cross-resistant volunteers were anticipated prior to the release of herbicide tolerant varieties. In a field in Northern Alberta, canola volunteers resistant to glyphosate, glufosinate and imidazolinones were identified and their genesis by pollen flow confirmed. It is anticipated that many similar multiple resistant volunteers exist, but remain undetected because alternative herbicides and management practices control them. Introgression of herbicide resistant genes into Brassicaceae weeds has yet to be reported and is considered less likely. In many cases, the use of herbicide resistant canola has decreased yield losses due to weeds. However, changes in herbicide use have altered weed species composition, suggesting that continuous use of a single herbicide tolerant canola system will decrease the usefulness of these varie. [Paper Number 127]

WEEDS OF RANGE AND FOREST--KNAPWEED SYMPOSIUM

KNAPWEED MANAGEMENT: ANOTHER DECADE OF CHANGE. Celestine Lacey Duncan, Weed Management Consultant, Weed Management Services, Helena, MT

Abstract: Significant progress in knapweed management has continued to occur within the western region during the past decade. The number of biocontrol agents established on the knapweeds and yellow starthistle have more than doubled. Integrating management techniques such as herbicides with biocontrol agents and grazing animals, fertilization, and restoration efforts have expanded. Legislation, public education programs, research, and expanding cooperative weed management programs has slowed spread of the knapweeds. However, expanding and improving current programs is needed to adequately address the magnitude of knapweed infestations. The key to long-term management is gaining a better understanding of the biology and ecology of these species, improving restoration techniques, expanding inventories to more accurately track infestations, increasing public awareness and education, and implementing cooperative integrated weed management programs. [Paper Number 128]

KNAPWEED ERADICATION PROGRAM IN ALBERTA. Shaffeek Ali, Alberta Agriculture, Food and Rural Development, Edmonton, Alberta, Canada T6H 5T6

Abstract: Diffuse and spotted knapweed (*Centaurea diffusa* and *C. maculosa*) are major problem weeds on the rangelands of the north-western United States and western Provinces of Canada. These weeds form solid stands which reduce forage production and thereby reduce carrying capacity. Diffuse and spotted knapweed were first found in Alberta in 1974. To protect the 2.5 million acres of susceptible rangeland, an eradication program was undertaken in 1975. A search and destroy program was launched and by 1985 infestation levels were reduced to scattered plants. Program awareness and eradication measures have been maintained and Alberta is virtually knapweed-free. [Paper Number 129]

BIOLOGICAL CONTROL OF RUSSIAN KNAPWEED – STATE OF THE ART. Urs Schaffner, J. Lars Baker, David J. Kazmer, Paul E. Parker, Robert D. Richard and M. Wille, Research Scientist, CABI Bioscience Centre, Delémont, Switzerland, Wyoming Biological Control Steering Committee, WY, USA , University of Wyoming, Laramie, WY, USA, USDA-APHIS-PPQ, Mission, TX, USA, USDA-APHIS-PPQ, Bozeman, MT, USA

Abstract: First investigations on the prospects of classical biological control of Russian knapweed started in the 1970s and led to the release of a gall-forming plant parasitic nematode, *Subanguina picridis*. Although this nematode can have considerable impact on Russian knapweed under specific conditions, it did not prove to be an effective agent under field conditions. Starting in 1996, new efforts have been undertaken to find and study biological control candidates originating from various parts of the native range in Asia. An overview will be given on the results of the first four years of the "new" biological control program, addressing the following aspects: a) what type of herbivory is likely to affect Russian knapweed population dynamics, b) what herbivores are associated with Russian knapweed in its native range, and c) what is known about the biology and host-specificity of the first three shoot- or root-attacking herbivores under investigation (i.e. the gall-wasp *Aulacidea acroptilonica* (Cynipidae), the fly *Napomyza* sp. near *lateralis* (Agromyzidae), and the moth *Cochylimorpha nomadana* (Cochylidae)). [Paper Number 130]

ECOLOGICAL PRINCIPLES FOR MANAGEING KNAPWEED. Roger Sheley, Department of Land Resources and Environmental Sciences, 334 Leon Johnson Hall, Montana State University, Bozeman, MT 59717

Knapweed management must move from temporary prescriptive control toward sustainable management based upon ecological concepts and principles. Site-specific prescriptive management often fails because prescriptions were developed under circumstances different from those of the management area. In addition, prescriptions are aimed at treating the symptoms, weeds. Sustainable knapweed management requires employing strategies aimed at manipulating the mechanisms and processes directing plant community dynamics. Less that 10% of our land is dominated by invasive plants, such as knapweed. Although preventing weed movement is commonly mentioned as an important part of weed management, few programs successfully implement effective prevention program. For example, most county programs keep knapweeds from spreading along roadways, but they continue to rapidly move along waterways. Another important consideration is early detection, which at this point is poorly organized and lacks a systematic approach that maximizes the potential for detection. On large-scale infestations, weed management must focus on developing ecologically healthy, weed-resistant plant communities that meet other land use objectives. Successional knapweed management attempts to understand the general causes of plant community change. They are site availability, species availability and species performance. Knowledge of these three causes and their modifying factors provides a basis for ecologically based, integrated knapweed management. Understanding plant demographic data provides ecological information essential to understanding the cause and solutions for weed management by identifying key mechanisms and processes directing plant community dynamics, and allowing the prediction of plant community response to management. This information is central to making wise decisions about knapweed management. Finally, R* theory offers the potential for useful principles based on how the competitive relationships among species are changed by various management practices. Ultimately, the goal is to use technology to manipulate the mechanisms directing succession toward a desired plant community based on ecological principles. [Paper Number 131]

INTEGRATED APPROACHES FOR THE MANAGEMENT OF YELLOW STARTHISTLE. Joseph M. DiTomaso and Steven F. Enloe, Weed Science Program, University of California, Davis CA. 95616, Dept. of Veg Crops, University of California, Davis, CA. 95616

Abstract: A number of control options are available for the management of yellow starthistle, including grazing, mowing, clover or perennial grass reseeding, burning, chemical, and biological control. Recent studies have emphasized the development of integrated systems for the long-term sustainable management of yellow starthistle. Such systems include various combinations of a number of these newly developed techniques. The objective of using an integrated approach is to provide ranchers and land managers with economical and sustainable management programs that maximize forage quality and quantity or preserve ecosystem integrity, while also reducing the susceptibility of their lands to re-invasion or invasion by other noxious weeds. One such study combines herbicides, biological control, and competitive perennial grass reseeding. The goal of this revegetation project is to develop sustainable high quality range conditions and improved wildlife habitat capable of providing long-term starthistle control without the need for continued herbicide treatments. Based on the findings of findings of this study, yellow starthistle seedbanks might allow infestations to readily overcome one and possibly two years of clopyralid treatment. However, on severely degraded rangeland an integrated combination of clopyralid treatment and wheatgrass seeding can be very effective in suppressing yellow starthistle seed production and may provide a more effective long-term solution than applying clopyralid alone. This strategy is also compatible with the survival of yellow starthistle biocontrol agents. It is hoped that the insects will maintain low starthistle seed production, further slowing the re-infestation rate. Other integrated studies are investigating the effectiveness of integrating summer prescribed burning and clopyralid treatment into yellow starthistle management programs. [Paper Number 132]

EDUCATION AND REGULATORY

Chairperson: Richard Zollinger

Topic 1: The genealogy of chemical company mergers/acquisitions and buy-outs. Implications of merger-mania. Arnold Appleby, Oregon State University, Corvallis, OR.

Topic 2: Industry's expectation for university and training of graduate students. Vince Ulstad, BASF, Fargo, ND

Topic 3: University expectations of industry. Steve Miller, University of Wyoming, Laramie, WY.

Topic 4: The university's role in training graduate students for employment in academia. Carol Mallory-Smith, Oregon State University, Corvallis, OR.

Topics were selected to help weed scientists employed by public and private organizations in the transition of mergers and buyouts of chemical companies. Fewer chemical companies mean few grant dollars which means fewer graduate students. Previously, chemical companies enlisted the help of university researchers to develop products as they move through the development and registration hurdles. University researchers has had access to test products four to five years before registration. Presently, universities get new active ingredients two years before expected registration or in some cases not at all.

Speakers discussed several topics in their presentations. Below are questions that were addressed:
1. Do chemical companies really need universities to test their compounds?
2. Does industry value university expertise and experience with new ai's in developing use label information, guidelines and restrictions?
3. What should university expect from industry in the from of grant dollars?
4. How should confrontations be handled when university recommendations (application timing, rates, adjuvant use, weed control ratings, length of residual, rotation crop restrictions, etc.) differs substantially from industry guidelines?
5. Does industry expect university to help in unbiased diagnostic analysis of field problems and plants samples?
6. Does reduction in number of chemical companies and fewer jobs available mean university should put out fewer graduate students?
7. Should university discourage students to go into industry for jobs because of insecurity in duration of employment?
8. What does industry expect from university in training graduate students?
9. What does university expect from university in training graduate students?

All speakers offered to send interested people a copy of there PowerPoint presentation and/or a summary of there survey findings.

RESEARCH PROJECT MEETINGS

PROJECT 1: WEED OF RANGE AND FOREST

Chairperson: Linda Wilson

Topic: Knapweed Symposium

The First International Knapweed Symposium of the 21st Century was held in place of the Project 1 Discussion Session. The planning committee included Linda Wilson, Lincoln Smith, Celestine Duncan, Jim Story, Barbra Mullin, Vanelle Carrithers and Cindy Roché. During the initial planning stages of the symposium, it was generally felt that the symposium would attract about 150 attendees, both from within and outside the WSWS membership (non-members of WSWS were encouraged to also attend the preceding WSWS Annual Meeting). The symposium commenced Thursday at 9:15 immediately following the WSWS Business Breakfast. By noon, a total of 350 people were in attendance; coming from eleven western states, two Canadian provinces and 4 additional countries. Sixty-seven presentations, split between oral and poster format, covered such topics as recent advances in field-based knapweed research, integrated knapweed management within the framework of multi-disciplinary, multi- agency, cooperative programs, applying ecological principles of knapweed management, recent advances in biological control, new approaches to technology transfer, mapping and database management, restoration and revegetation, including the planned use of livestock to manage weeds, and current taxonomic research. Participants came from equally diverse areas of the knapweed world, with federal and state agency resource managers and field personnel, county weed supervisors and field personnel, university and institutional researchers, private landowners, industry representatives, and resource-based organizations. The symposium concluded at noon Friday with a General Session led by Vanelle Carrithers that was an exciting, open discussion around the topic of "Where do we go from here". Concluding the morning session was the election of Barbra Mullin, Montana Dept. Agriculture, as chair-elect of Project 1.

PROJECT 2: WEEDS OF HORTICULTURAL CROPS

Chairperson: Ed Peachey

Topic: The Future of Minor Crop Registrations in Horticultural Crops

Approximately 30 people attended the discussion section. Five discussion topics were introduced by invited speakers.

Improving the Minor Crop Registration Process: an IR-4 Perspective

Fred Salzman (Weed Science Contact in IR-4) briefly summarized key objectives of the IR-4 program. These included promoting reduced risk pest management, development of risk mitigation strategies, promotion of biologically based strategies, and development of partnerships with key agencies such as EPA and the crop protection industry to help streamline registrations and reduce duplication.

Dr. Salzman encouraged those in minor crop registration to remember that this is a national process and that we should keep in touch with growers and researchers from other area. Submission of data with clearance requests is very important.

Discussion focused on the best process for identifying candidate herbicides. It is important that consistent funding be made available for this critical function. Funding is always a factor and the university system does not reward efforts.

Regional Environmental and FQPA Impacts on Minor Crop Registrations

Sandy Halstead (Regional EPA contact from Prosser WA) outlined her new position and the intent of EPA to establish three other positions like hers. Sandy acts as regional liaison for EPA to connect with agriculture, industry and university. EPA currently is indirectly supporting minor crop research through grants that are channeled through IPM programs at Universities.

Discussion focused on funds that go to IPM programs. Funding for minor crop research and identification of potential pesticide registrants is difficult to procure because of the very small acreage for some crops. EPA's desire is to support integrated programs of research, rather than directly supporting minor crop registration. Several questioned whether this would have any practical value for many of the very small acreage crops. Further, with the exception of Washington, those responsible for minor crops and IPM research efforts have very little contact.

Specific Chemistries Relevant to the West

Robert McReynolds of the NWREC of Oregon State University reviewed the status of pesticide registrations on minor vegetable crops of Western Oregon. Many crops have no registrations because of the very small acreage. New candidates for registration are not effective such as halosulfuron, fluoxypyr, and pyridate. The Minor Crops Advisory panel of the Oregon Department of Agriculture advises on how to spend the funding set aside for minor crops registrations but does not support screening trials. Funding for screening trials is a major area of concern for the very small acreage crops that do not have commodity support groups.

Impact of Transgenics on Future Efforts, Steve Fennimore

There are many potential herbicide tolerant vegetables including asparagus, carrot, lettuce, spinach and tomato. For many crops the critical period of weed control is not well defined. Time of application studies can help define the critical period of weed control in vegetables as well as define the period when the herbicide should be used to provide effective weed control. Other potential topics of research are persistence of crop seed in the seed bank and pollen flow.

Role of the IR-4 Liaison in the Minor Crop Registration Process,

Sandra McDonald (state liaison and study director in Colorado) reviewed and compared the role of the USDA regional liaison and the state liaison. Food use workshops are used to prioritize herbicide tolerance projects for minor crops. Concern was raised about the location of the workshops and whether location skewed the decision making process.

The session concluded with summary and actions to be taken. These included:

- Review of locations chosen for the IR-4 food-use workshops.
- EPA will review funding to regional IPM research coordinators and the impact on minor crop registrations.
- Attendees were encouraged to make use of Vegweeders@ag.arizona.edu
- To continue to meet in conjunction with the WSWS as well as the IR-4 Food Use Workshop to discuss relevant issues for weed control in horticultural crops
- The availability of federal funds to support herbicide screening in minor crops is critical

2002 Officers of project 2:

Chairperson:	Steve Fennimore Univ. of California 1636 Alisal St. Salinas, CA 93905 831-755-2896 831-755-2814 safennimore@ucdavis.edu	Chairperson-elect	Tom Lannini Univ. of California 124 Robbins Hall Davis, CA 95616 530-752-4476 530-752-4604 wtlannini@ucdavis.edu

PROJECT 3. WEEDS OF AGRONOMIC CROPS
Chairperson: Bob Stougaard

Topic 1: Reduced Rates: Reasonable or Reckless

Bob Stougaard introduced the subject on reduced rates. Dale Shaner (BASF) and Neil Harker (Agriculture and Agri-Food Canada) presented their views on the pros and cons of reduced rates.
Dale Shaner presented the following points for discussion as to why full herbicide rates should be used:

Why use full herbicide rates?

- Lowest effective rate determined during herbicide development
- Control broadest stages of growth of weeds
- Highest rates set to control most tolerant weeds
- Rates are varied by species
- Efficacy under varying environmental conditions
  - Rates picked to proved acceptable control 95% of the time
- Customer satisfaction
- Liability for non-performance/complaints
- Time management
- Reduced build up of weed populations

Neil Harker presented the following points for discussion on why reduced rates may be appropriate:

Impact of Reduced Rates - "Lower"
- Lower herbicide costs
- Lower environmental impact
- Lower selection pressure for target-site resistance
- Lower weed control
- Lower reliability

Questions
Are clean fields the best management system?
If weeds are left in the field after a low rate of herbicide:
- Will weed competition lead to a yield loss?
- Will the weeds cause harvesting problems?
- Will weed infestations be worse next year?
- Will cost of lower rates compensate for the above?
- Will selection pressure be significantly reduced?

Quotes from Europe:
- "Use of reduced [herbicide] for 3 years in the same field caused neither an increase in the subsequent weed infestation nor changes in the species composition of weed populations compared with the treatment at [recommended]."
- "...1/4 - 1/2 of the approved dose of almost all of the herbicides tested reduced weed seed production sufficiently to prevent any increase in the seed reserves in the soil"
- "Adequate weed control was achieved at the majority of the sites with most herbicide combinations at concentrations below half of that recommended."

Lower rates may be appropriate when:
- Crops are Competitive
  - Competitive Species or Cultivar
  - Crops Emerge Early
  - Higher Seeding Rates are employed

- Weed Susceptibility is High
    - rate is high for other weeds
    - less herbicide required for small weeds
    - weeds are actively growing

Summary

- Many herbicide rates are high so herbicides will perform at unnecessarily high expectation levels
- Many herbicide rates are high so that competitive products will not be able to compete in the marketplace
- In some cases, continued emphasis on high rates will accelerate weed resistance to herbicides
- Continued emphasis on high rates is detrimental to the development of IWM systems
- Lower expectations for herbicide performance and lower rates are necessary for the economic and environmental sustainability of agriculture
- In Europe, research emphasis on herbicides is devoted to understanding the conditions that optimize herbicides at low rates.
- In North America, it seems that research emphasis remains focused on high herbicide efficacy; "weed control" is emphasized over "weed management"

Following Dale and Neil's presentations these points were made regarding reduced rates:

Pros for using full rates:

- Company sets rates to ensure control - may lose grower confidence due to failures
- Reduced rates may work 3 out of 4 years - seed bank may go to pot in that 4^{th} year
- Farmers in different areas of the country won't accept less than 90% control

Pros for using reduced rates:

- Reduced rates in more competitive crops not as risky. Seeding rate can help competition.
- Industry sets rate to meet or beat competitor rather than to reduce weed competition
- Rate may be too high to just eliminate yield loss

Other comments: A lot of work has been done of how adjuvants affect herbicide efficacy and may increase efficacy when rates are reduced. Additional information on where/when/why herbicides are most effective would be useful for growers. Do high efficacious herbicides cause resistance? Some information was presented to support this. Liability issue - Who is responsible when reduced rates are used and fail? Univ who has data may not be liable

Topic 2: Weed Economic Thresholds: Useful Tool or Pipedream?

Robert Norris, UC-Davis, gave a presentation on this topic in the General Session. He reviewed the same points in this discussion session. His entire talk is available in these proceedings.

The following discussion was presented by Bruce Maxwell, Montana State University:

The trend in decreasing net returns to most agricultural producers has increased the need to justify weed management. Economic justification for weed management has also been required to ensure that potential pollution side-effects from management are minimized. However, the utility for using weed management thresholds has been challenged, because of specific case studies that have indicated that thresholds that include potential future impacts of the weeds are so close to 0 that for all practical purposes the weeds should never be left uncontrolled (Norris *et al*., 2001). I argue that this conclusion is strictly based on a special case and that it raises the importance of identifying the interacting factors that will determine the utility of the threshold concept in any particular system.

First, one must differentiate between the single year/crop threshold, otherwise known as the economic injury level (EIL), and a long-term threshold that has a range of names. The definition for EIL is the weed density at which the value of the crop loss from the weed is equal to the weed control cost (Stern *et al*., 1959). Long-term thresholds are generally defined as the density of the weed that will maintain the potential increasing population below the EIL. A common modification to the long-term threshold is the density at which a weed population be maintained to maximize net returns to the producer of the crop. Farmers inherently manage according to long-term thresholds and seem to be extremely risk averse with regard to weed management which is indicative of a belief that weed population growth is exceedingly high. The question for applied research becomes: Are farmers correct in their assumptions about weeds?

I will list the interacting factors that I think should be considered in order to make an objective assessment of the utility of log-term weed thresholds.

1. One must first quantify the impact of the weed on the crop across a range of weed abundance that will allow accurate parameterization of a logical function (e.g. the egative hyperbola damage function described by Cousens, 1985, and modified to include crop density by Jasieniuk *et al*., 2001). Then one must determine the variation in the damage function over time, because with the long-term threshold we are considering, not just the impact in the current crop/year, but also the impact in future crop/years. In addition, one must determine the spatial variability of the damage function which may vary extensively even within a field.

2. Accurate quantification of the weed population growth rate and its spatial and temporal variability is essential for determination of the long-term threshold. Estimating weed population growth rates based on fecundity alone is in error and will almost always result in concluding that there is a 0 economic threshold for weeds. Population growth rate (_) is most simply stated as the current weed population (N_t) divided by the previous population (N_{t-1}), where N is a measure of abundance , i.e. density (plants/m^2). If _ is greater than 1.0 then the population is growing and if _ is between 0 and 1.0 then the population is in decline. Thus,

   $$N_t = N_{t-1} + F - M + I - E$$

   where F is previous year fecundity, M is all mortality events throughout the previous year and up to the point in time when N_t is measured, I is the number of individuals that have immigrated into the population and E is the number emigrants that have left the population.
3. Costs associated with management and their temporal variability are required to accurately determine long-term weed management threshold. This includes the cost of detecting the weed (e.g. the cost per weed increases sharply at very low densities) and, because weeds tend to be patchy, determination of the spatial distribution of weed density (Maxwell, 1992).
4. We have not yet even considered how to bring the potential direct or indirect costs associate with ecosystem impacts (other than crop damage) of the weed or the control measures (e.g. ground water pollution with herbicides) into the calculation of economic thresholds. The health costs associated with hand-weeder exposure to unhealthy conditions are another factor that may be logically included in the threshold equation for that particular management approach (NRC, 2000).

There are few if any cases where these pieces of information that are required to truly determine the weed management threshold, have been fully identified. I find it particularly disturbing that we have such poor information on weed population growth rates under different cropping systems. Are we satisfied that the farmer's intuition that all weed population growth rates are high enough to always require management inputs? Just consider if _ = 2.0 (not 4000-12000 as Norris *et al*., 2001, suggests for barnyardgrass) and the size of the seed is 1 mm^3, then after 20 generations, starting with a seed bank of 1000, the seed from this weed would be approximately 1 m deep on the soil surface. Under the same conditions, except with _ = 10.0 we would be 10 m deep in seed after 7 generations. I think that we can safely conclude that we are not considering all of the factors involved with determining weed population growth rates, much less, their spatial and temporal variability. Population growth rate is just one element of the problem. I believe that we are far from drawing any conclusions on the utility of thresholds.

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PROJECT 4: TEACHING AND TECHNOLOGY TRANSFER
Chairperson, Pamela J.S. Hutchinson

Topic: Expert Witness: Policies and Perspectives.

Eight speakers briefly gave an overview of their experiences and advice and being an expert witness. Brief discussions followed after each speaker.

Randy Geller, Senior Associate University Counsel, University of Idaho – University Policies
Getting involved in litigation on pesticide issues is mainly a concern to the policies of the University in two areas; consulting and conflict of interest. The general policy of University of Idaho is that employees owe primary work duty to the University, but are allowed to do a limited amount of private consulting. University's general policies can be found on their website. Employees should inform prospective clients they are acting as a consultant and not as a University employee. Employees should get prior approval from department head or dean of college. Some primary factors that should be met: the activity is relevant to employee's professional development, the activity doesn't constitute unfair competition with existing university services, the activity doesn't impair employees ability to perform assigned duties, and the employee can't use university resources in performing the activity.

Extension personnel also fall under USDA policies, which supplement the university's general policies. Notice of activities must be given to the Dean and Extension Director. A properly issued and served subpoena is required before a deposition is made or before appearing in court. The employee testifies as an employee of the institution. Any fees for being an expert witness are paid to university and not to the employee. Serving as an expert witness out of state can be done on employee's private time. The University's general policies then apply.

One should avoid exclusivity clauses. Follow your employer's policies when serving as an expert witness. A factual witness is one with direct knowledge of the facts (on the ground). An expert witness is one with knowledge or opinions other than direct knowledge of the facts. You can be, and often are, both a factual and expert witness.

Rich Zollinger, North Dakota State University – Role of Extension Service
The role of extension service is education and not to make enemies. Serving as an expert witness could put you in a no-win situation. The extension service is often the first line of defense for the farmer. If they don't side with the farmer it puts them in a difficult position. Serve as an expert witness only when forced to with a subpoena. When extension personnel act as paid expert witnesses there is a credibility issue. Use a crop consultant as expert witnesses instead of extension personnel.

University lab diagnostics often become legal documents so possibilities should be kept open rather than to make specific and immediate conclusions. Also, when investigating pesticide issues, don't jump to conclusions in the field. Take good notes and take it back to the office and give it more thought before coming to a conclusion. Make it known to the lawyer that what you have to say may not help their case.

Each state has policies on whether you can get paid to be an expert witness within or outside your state. Extension personnel can't be an expert witness for pay within their state. If a grower calls with a problem on a recommendation that you made – call your institution's lawyer.

Gil Cook, DuPont Co. – Role of Agrichemical Company Rep
You will be asked as an expert witness for circumstances that deal with complicated technical issues and you must become both a translator and educator of the jury. An expert witness must volunteer unlike a fact witness who is served a subpoena. Several recommendations; don't underestimate opposing attorneys, always ask what the purpose of your testimony is, ask if the purpose of you being a witness is about technical issues or something you have witnessed, never conduct a deposition over the phone – have council at your side at all times, if you need a technical opinion a neutral viewpoint (University or Extension) is more credible than someone in your company.

Always tell the truth, be consistent and honest, use good science, understand the facts and the purpose of your testimony, avoid speculation, question factual situations (are they plausible?), listen to entire question before answering, don't volunteer information that is not asked for, look and dress appropriately, remain calm and collected, don't argue with lawyers, be pleasant, be humble and not arrogant, and stay within your area of expertise.

Tim Schultz Washington State Department of Agriculture – Role of Regulatory Agencies
Washington State Department of Agriculture has standard policies set by the state that inhibit employees from freelance consulting (even in your off hours) and conflict of interest activities when acting as an expert witness. Their role is in enforcing and getting compliance with the statutes in place. They deal with many pesticide drift and damage issues and they have the authority to do search warrants. If called as a witness (subpoena required) just give the facts and stay within your area of expertise.

Currently much of their job deals with diplomacy and less with technical skills. The department is concerned with their level of expertise and has begun to hire people with specific areas of expertise, such as those dealing with salmon issues. The department must deal with many issues including licensing and registration of pesticides. They often must deal with antigovernment types. He recommended gathering all the evidence and taking time to think the situation over and to not jump to conclusions. They conduct about 200+ case investigations/year. About half of those lead to no action, in which the accusing party cannot substantiate a claim or the actions are not a violation of state rule or FIFRA.

Andrew Bohrnsen, Attorney – What an Attorney expects of a Witness
University employees should defend agriculture and fight against junk science, and become actively involved with good science. Accepting money for being an expert witness is not a credibility issue. Disclose that you are being paid upfront before they have a chance to ask you. When looking for an expert witness he looks for the following; someone with special knowledge and education in a specific area above the normal population, someone who can teach the jury and relate well to the jury, someone who can simplify a complex, technical situation so the jury can understand it.

Keep within your area of expertise and be intellectually honest. Don't speak down to the jury – be respectful. Tell the lawyer what the truth is. In court you don't have to be 90% correct as in science. Your explanation just has to be more probable than not (51%). They use the Fry standard – you must show there is a significant body of evidence to support your claim.

Kathleen Parrish, Express Your Point – How to Present Evidence
Most scientists and technical people tend to be boring to the jury. The importance of visuals and graphics was emphasized. Don't be boring or go on too long. Make your important points before you loose your audience or find a way to keep their attention. Isolate and focus on your main points using graphics. Find data and facts that support your main points. Use technology that you are comfortable with and that fit your audience. Charts can be put on corrugated plastic that folds up and travels well. Use acetate overlays if appropriate (chart examples were shown). When you have lots of numbers in charts and tables, highlight the important ones. Blow up photos and bring negatives or original prints if possible. Use short video clips if they are appropriate. Digital photos are OK, but are easy to tamper with and currently may be less credible to the jury. However, as digital technology evolves, so will acceptance of digital photography.

Phil Banks, Marathon-Ag Environmental Consulting – Expert for the Defense
Testify truthfully. You are the educator of the jury and judge. When doing an investigation you can often end up being involved and get called in to testify. Testimony can often take place well after the investigation so take good notes. It is easier to use your own data than to be called in and dealing with other's data. Be clear, accurate, and responsive to the attorneys on both sides. Know all the facts you can. Listen carefully to the questions and don't answer before the question is finished. Don't volunteer additional information than is asked for. Be understandable, simply for the jury, and use visual aides that can clarify your points. Make eye contact with the attorneys and jury. Have alternative explanations ready as to what happened (what went wrong) if you are on the defense. Use good science. Consider being professionally certified so your credibility and ethics cannot be questioned.

Bill Cobb, Cobb Consulting Services – Expert for the Plaintiff
Being expert for the plaintiff sometimes gives you the advantage of unfettered access to the field. Liability does not always equal damage. It is not about winning or losing. Your contribution is probably pretty small compared to the entire case and you can't single handedly win the case. However, make sure you don't single handedly lose it.

Assume it's going to court if you are called out to look at a field (take good notes, photos, draw maps), stay in your field of expertise, you call the shots on when and where you make a deposition, be prepared when making a deposition and prepare your lawyer by anticipating the opposing side's strategies and questions. Write up your own testimony outline to make your points and give to your lawyer, tell the bad news first (any holes in your case) so the other side doesn't appear to expose your weaknesses, and tell the truth – be true to your science.

Rick Boydston is next years chair and Mack Thompson was elected chair-elect.

PROJECT 5: WETLANDS AND WILDLANDS

Chairperson: Glen Secrist

Subject 1: The National Invasive Species Management Plan

Discussion Leader: Lori Williams, National Invasive Species Council

Recent events that make this a critical time to raise awareness about invasive species and suggest that invasive species scientists may play a critical role in shaping future management efforts:

- Popular press coverage is increasing as is the type of press coverage. Articles appeared in many mainstream, widely read publications last year. But is the link being made between invasive species 'horror stories' and causes and solutions of broader problem? This suggests a need for scientists to weigh in and provide facts and context. It also identifies an opportunity for scientists to educate policy makers and the public.

- Private sector engagement is now more significant. Industry is better engaged through groups like ISAC and have developed codes of conduct. There are numerous opportunities for the private sector to help with outreach and education of the public as well as to participate in international efforts to stem the spread of invasive species.

- Activities at state level are increasing substantially. States play an increasingly critical role, particularly in early detection and rapid response efforts, in the development of invasive species programs and have developed coordinating mechanisms within and among states (e.g., WWCC). Furthermore, the views and interests of states are important to Congress.

- Congressional interest has also been enhanced in recent years. The Congress has recently passed the Plant Protection Act, introduced S. 198 – the Harmful Non-Native Weed Control Act of 2000, and is preparing to reauthorize the National Invasive Species Act. Constituent support for coordination and increased funding is critical, particularly in light of the many changes in Congress and its staff. There is a great need to educate new members and new committee members on the economic and environmental impacts of invasive species.

- Increasingly, the Executive branch has also become more involved with this issue. A letter from 500 scientists and land managers inspired an Executive Order (EO) to improve coordination among over 20 Federal agencies with responsibilities relating to invasive species. The EO established the National Invasive Species Council and called for a National Invasive Species Management Plan. It also established the Invasive Species Advisory Council, a 32 member non-Federal committee of diverse stakeholders that advises Council.

Costs to U.S. Economy

Invasive species cost over $130.2 billion per year:

- The cost of introduced weeds to U.S. agriculture is $13 billion per year.
- The control of aquatic weeds costs $100 million per year.
- The control of zebra mussels costs $200 million per year;
- Leafy spurge infestations in Montana, Wyoming & the Dakotas costs agriculture & taxpayers more than $144 million per year.

Lori provided some charts of impact by taxonomic group as well as some illustrations to demonstrate federal agency expenditures (copies available from the Chair-Elect 2002, Eric Lane, eric.lane@ag.state.co.us).

Executive Order 13112 - Issued in February of 1999

Established the National Invasive Species Council to ensure that federal agency activities are coordinated, complementary, cost-efficient and effective.
Council's co-chairs: Interior, Agriculture and Commerce
Other members: DOT, DOD, Treasury, State, and the EPA

Established the Invasive Species Advisory Committee under FACA to provide information and stakeholder input for consideration by the Council.
Represents a balance of non-Federal expertise, localities, and stakeholder interests

Together, these groups developed the National Invasive Species Management Plan. The key areas addressed in the plan and some of its recommended actions are:

Coordination and Leadership: More than 20 Federal agencies share responsibility and authority over some facet of invasive species management, along with all 50 states and territories.

Actions:

- **Establish oversight policy to ensure EO is followed**
- Adopt informal dispute resolution procedure
- Put together a cross-cut budget to highlight cooperative efforts for use as a planning tool

Prevention: The first line of defense and most cost effective approach

Actions:

- Develop & test a risk assessment screening system for evaluating intentionally introduced invasive species and reducing risk of establishment
- Identify & rank key pathways by which invasive species move & develop mechanisms to reduce movement through these key pathways
- Take action on known high-risk pathways

Early Detection and Rapid Response: Finding invasive species early may provide the only opportunity to eradicate or contain them.

Actions:

- Improve detection methods to speed up the process
- Seek a flexible funding source for rapid response contingencies
- Establish rapid response teams with local/state organizations

Control and Management: Reducing established invasive species and limiting their spread can dramatically decrease negative impacts.

Actions:

- Increase funding for control and management on Federal lands
- Seek legislative authority to establish matching grants to assist state, local, and regional control efforts
- Work with state and local entities to determine and coordinate control priorities

Education and Public Awareness: Scope of the invasive species problem, their impact, and how to help must be communicated to the general public.

Actions:

- Develop a National Invasive Species Awareness Campaign in cooperation with states, tribes, local governments, civic organizations and industry
- Work to increase public cooperation in counter invasive species

For more information about the Council, contact:

National Invasive Species Council
1951 Constitution Ave, N.W.
Suite 320 – South Interior Building
Washington, DC 20240

Or visit www.invasivespecies.gov

Q: What is the role of WSWS relative to working with the Council to develop and implement the invasive species management plan?
A: Lori recommended creating small task groups to implement specific actions. Established under the auspice of the advisory committee, WSWS can provide valuable expertise. WSWS should identify the specific portions of the plan that should be implemented most rapidly.

Q: Can portions of the Federal Noxious Weed Act that were removed by the Plant Protection Act be reinserted into the National Invasive Species Act during reauthorization?
A: Perhaps but this may not be the most appropriate vector for achieving the same outcome.

Q: Comment about the restoration of natural areas and related seed trade concerns.
A: The seed trade has been more challenging to involve. The Council has involved the industry in task groups to address specific issues related to using native and/or non-native seeds for restoration, with an emphasis on using non-invasive species.
This began a small discussion related to the question: What is native? What about phasing in natives after establishment of cover, often non-natives, in a step-by-step process.

Q: Please elaborate more on the dispute resolution process for federal agencies.
A: This will be a very involved and complex issue to develop and resolve. It is in the preliminary stages now and the Council is looking for suggestions on the development of this process. Lori suggested that specific examples of such examples be sent to www.invasivespecies.gov.

Q: Can the Council help coordinate or standardize management policies so they don't change every time the staff turns over?
A: The plan references the need to remove obstacles to effective management. Improved coordination and dispute resolution may help to improve this situation.

Q: The EO has a provision for including invasive species in NEPA work. How is this proceeding?
A: The Council will be putting together NEPA guidance for the federal agencies, different for each agency, that will be out for public comment later this year.

Q: Will the plan accelerate Pesticide Use Proposal procedures for rapid response activities?
A: The plan focuses on expediting the use of pesticides – as a specific recommendation.

Q: The rapid response teams seem expensive. Can we afford this method on a national scale?
A: There may be other methods. Sometimes a team isn't necessary but sometimes that sort of firepower is required to eradicate a given species occurrence. However, the cost of successful eradication will be less than prolonged management if eradication is skimped on.
This began a small discussion. Will the team be from Washington DC or team from the local level? Perhaps a rapid response process is required but there is not a single solution.

Q: Is there a web-site that shows what task forces have been established in the country to address specific species?
A: Not yet but it's something that www.invasivespecies.gov should have posted in the future.

Q: Can the Council issue newsletters to update people on opportunities to contribute information and comments?
A: Good suggestion. They'll look into it.

Q: How can WSWS address the slowing that occurs through NEPA?
A: Work with CEQ and others to streamline the process and plan through it.

Q: Is there an emergency exemption to NEPA?
A: Not sure but there are examples of moving rapidly (FONSI, categorical exclusions, etc).

Subject 2: <u>Invasive Species as a National Economic and Environmental Priority</u>

Discussion Leader: Dick Ridgway, Riley Memorial Foundation

How can we ensure that the invasive species issue becomes a high national economic and environmental priority with the new administration?

The Riley Memorial Foundation serves to facilitate the development of wise, long-term programs related to food, agriculture, and the environment. The invasive species issue was identified by its Board of Directors in 1997. Thus far the Foundation has coordinated a database workshop, an issue-roundtable, a mapping workshop, a focus group on the transition of the executive branch, and a briefing paper for transition team members.

The briefing paper to the transition team members:

- Identifies that invasive species are costly to the economy and environment and consequently should be a national priority given the significance of these impacts.
- Identified increased coordination at local, state, and federal level as necessary.
- Identifies non-partisan support that focuses on most harmful issues as required.
- Highlights the national invasive species management plan as a framework for planning.
- Applauds previous invasive species management efforts.

In the past year, the GAO and OMB have made further inquiries about the issue. A forthcoming GAO report will focus on rapid response and a second report will be released in July. The objective of the report is to raise the visibility of the issue to Congress.

USDA/USDI will probably lead in policy-setting for invasive species. In a recent species by Secretary Norton, she identified the need to move past federal barriers to bring state and local issues into Washington DC and to rely upon science to make decisions/policy. Secretary Veneman listed pest/disease prevention as one of her 5 priorities that would be cornerstone to protecting production agriculture.

It will be difficult to influence the system until more people are appointed.

Q: What can be done while we wait for the Administration to set up shop? Does it makes sense to move on Congress during the interim?
A: Appropriation hearing testimony is an appropriate arena for testimony from WSWS.
Lori Williams noted that the development of a crosscut budget and general education to Congress can help identify areas that the federal agencies feel comfortable accomplishing in the plan based upon current budget projections.
Vanelle Carrithers suggested writing one's congressman.

Nelroy Jackson suggested looking at the national plan, deciding if there is something among the priorities that one can participate in, educating others, deciding what one wants and then contact WSWS or its four members that are ISAC members to see what can be accomplished.

Observation: Agriculture cannot carry the issue alone. There is a need to focus on the environment as well.

Subject 3: S. 198 – The Harmful Non-Native Weed Control Act of 2000

Discussion Leader: Glen Secrist, Idaho Department of Agriculture

S. 198 is bipartisan bill introduced by Senators Craig and Daschle with cosponsors Senators Baucus, Burns, Crapo, Johnson, and Gordon Smith. The bill establishes a program to provide financial assistance to the states via the Secretary of the Interior who shall appoint an advisory committee (10 members) to administer funds.

Available funding would go through states to "eligible weed management entities." Eligible presently means that the entity is established by local stakeholders, has developed a plan of action, and has addressed other requirements as determined by the state. Funding to entities would be based upon the seriousness of the problem, the extent to which funds will be used to leverage non-federal funds, and the extent of the state's progress to date.

This bill directs that states use 25% of their allocation for base payments to weed management entities, 75% for financial awards (competitive grants perhaps), and that a 50% non-federal match is required. S. 198 prohibits the use of funds for agricultural crop lands and aquatic weeds of a submerged or floating nature.

A House companion bill is presently being drafted by Congressman Joel Hefley (R-CO) that will address some of the concerns that have been raised thus far.

Discussion:

- Leveraged funding may be more difficult to obtain in areas of the West with significant federal holdings. A possible solution is to develop a formula based upon a land ownership matrix that weighs public and private lands.
- Funding through S. 198 should be in addition to the funding needs of federal lands that will help federal land management agencies to develop infrastructure and capacity to manage noxious weeds as a full partner with local communities and government. S. 198 should provide new funds, not from the same pie that funds management on federal lands.
- This is one piece of the solution to weed management, not the solution.
- How will monitoring be a part of this process? It is important to incorporate information gathering so we can look back to see what works and what does not.

Subject 4: Update on Federal Agency Invasive Funding and Initiatives

Roundtable Presentations

Gina Ramos – Bureau of Land Management: The National Weed Team has identified its priorities as:

- Program sustainability- ensure that invasive plants remain a long-term commitment
- Create data standards- adopt NAWMA inventory standards, adopt Boise/Vail mapping database to house information in one place
- Integrate weed management into all aspects of performance
- Inventory all BLM public lands and record treatments
- Identify new funding sources for federal efforts
- More fully develop education and outreach programs

Notes: The national fire management plan includes weed inventory and prevention efforts to the tune of $14 million. BLM is redoing its vegetation management EIS on herbicides for 13 western states. Its current budget is $7.5 million plus a $1.5 million add-on for watershed restoration, a pass-throughs for the Center for Invasive Plant Management, and a pass-through for the Idaho Department of Agriculture.

Rita Beard – U.S. Forest Service: News to report:

- Invasive species are now on the Service's top ten priorities

- National guidance is being provided on prevention practices in all aspect of USFS operations
- The Service is encouraging mapping of infested lands and reporting the percent of land infested. It is implementing inventory and monitoring standards as well as accomplishment accounting similar to the BLM.
- The budget has increased to $8 million and the Service is looking for $10 million next year. Infusions from fire budget in research and state/private lands are expected.

April Fletcher – USFWS: The Service will be:

- Reviewing the Pesticide Use Proposal process and guidelines
- Developing a national strategy for weed management on refuges, including BMPs
- Adopting NAWMA inventory and mapping standards

Jerry McCrea – NPS: News to report:

- The Natural Resource Challenge is successfully halfway through its 5 year program
- There are now four Exotic Plant Management Teams scattered across the nation.
- The Biological Resource Management Division has been created
- $400,000 has been made available through grants for park invasive species projects
- NPS has $2-3 million for park base funding for invasives and T/E species
- For FY02 – 6 EPMTs have been selected if funding is allocated (1.8 million annually for 5 years)

Chuck Quimby – ARS: News to report:

- FY01 sees ten new positions working on noxious weeds and noxious weed biocontrol (2 are 50/50 weeds and insect pests)
- FY00 added a plant pathologist to European biocontrol lab
- European Biological Control Lab (EBCL) has $2 million base funding with half going to weeds

Jim Parochetti - CSREES: Provided an overview of funding capacity and programs.

2001 Officers of Project 5:

Chairperson: Glen Secrist
Idaho Dept. of Agriculture
2270 Old Penitentiary Rd
Boise, ID 83701
gsecrist@agri.state.id.us

Chairperson-elect: Eric Lane
Colorado Dept. of Agriculture
700 Kipling St, Ste 4000
Lakewood, CO 80215-8000
eric.lane@ag.state.co.us

PROJECT 6. BASIC SCIENCES

Chairperson: Ian Heap

Topic: Roundup Ready Wheat - Agronomic Aspects

Academic Perspective
Alex Ogg
Weed Scientist
Ten Sleep, WY

Monsanto Perspective
Sally Metts, Paul Isakson
Monsanto
St. Louis, MO

This session was well attended, all seats were taken and most of the standing room was also taken. Sally Metts from Monsanto opened with comments on the introduction of Roundup Ready Wheat from Monsanto's perspective, touching on many of the marketing and public perception issues. Alex Ogg followed with a fine introduction to the agronomic pros and cons of Roundup Ready Wheat. The topic generated a great deal of interest from the crowd, with wide ranging questions and comments. Some of the issues discussed during this session were:

Agronomic Benefits of Roundup Ready Wheat

1. Improved control of grassy weeds.
2. Broadspectrum weed control.
3. Wide window of application.
4. Greater crop safety.
5. No soil residual problems.
6. Simple weed management decisions.
7. Control of perennial weeds.
8. Control of SU-resistant weeds.
9. Less risk of resistant weed populations.
10. Decrease weed seed soilbank.
11. Improved mgt. of herbicide-resistant wheats.
12. Easier to change classes of wheat grown.
13. Less dockage in harvested grain.
14. Increase soil moisture.
15. Reduced environmental hazard.
16. Less phenoxy-herbicide damage.
17. Easy and rapid adoption of R-R Wheat.
18. Roundup compatible with closed-injector systems.
19. Easy return of CRP to production.
20. Reduced incidence of other pests.

Agronomic Concerns about Roundup Ready Wheat

1. Control of volunteer R-R Wheat.
2. Increased selection for glyphosate-resistant weeds.
3. Increase in weed species shifts.
4. Roundup drift to nearby fields.
5. Slow adoption of conservation farming systems.
6. More detailed record keeping.
7. Increase in diseases and insects.
8. Reduce good weed mgt. practices.
9. Lack of timely weed control in spring.
10. Limited variety selection.
11. Spread of R-R Wheat on roadsides.
12. Pollen movement to conventional wheat.

The most vigorously discussed items were the concerns, and in particular control of volunteers and the potential for selecting glyphosate-resistant weeds.
Chair Elect : Kassim Al-Katib was elected as chair for the 2003 meeting. **Paul Isakson** is chair for the 2002 meeting.

WESTERN SOCIETY OF WEED SCIENCE
EXECUTIVE COMMITTEE MEETING
MONDAY, MARCH 12, 2001
COEUR D'ALENE RESORT—COEUR D'ALENE, IDAHO

Attendance: Don Morishita, Bob Parker, Mark A. Ferrell, Wanda Graves, Stan Cooper, Jeff Tichota, Bob Stougaard, Phil Stahlman, Rich Zollinger, Gill Cook, Donn Thill, Rod Lym, Vince Ulstad, Nelroy Jackson, Rob Hedberg, Ian heap, Jill Schroeder, Jim Oliveras, Joan Campbell, Jay Gehrett, Mack Thompson, Carol Mallory-Smith, Phil Banks, Steve Miller, Corey Ransom

Call to Order: President Don Morishita called the meeting to order at 8:00 am.

Approval of Agenda: Steve Miller is the WSSA 2000-2001 representative, not Donn Thill. ***It was moved and seconded to approve the agenda. Approved.***

Minutes: Mark A. Ferrell
It was moved (Bob Parker) and seconded to approve the minutes of the August 5, 2001, meeting as mailed. Approved.

Financial Report: Wanda Graves
The WSWS is in good financial standing with a current balance of $334,689.57. Revolving account balances are $159,637.53 of the total capital. Revolving accounts hold funds to support Weed of the West ($70,232.19), Noxious Weed Short Course ($25,543.32), Biological Weed Control Handbook ($53,062.02), and Knapweed Symposium ($10,800.00). Capital is distributed as follows: Merrill Lynch Funds ($260,365.99), Money Market Savings ($42,199.01), and Checking Account ($32,124.57). ***It was moved and seconded to approve the financial report. Approved.***

Immediate Past President Report: Jeff Tichota
The board has requested only one change in the WSWS Operating Guide. The proposed change alerts the WSWS secretary not to announce award winners of nominees when the WSWS summer board minutes are posted on the WSWS website.
It was moved (Bob Parker) and seconded to make these changes in the Operating Guide. Approved.

Member-at-Large: Bob Stougaard
Due to inactivity of the Resolutions Committee it was recommended that it be combined with the Necrology Committee. This would require a change in the WSWS constitution. The matter will be brought before the general membership and voted on at the General business meeting on Thursday March 15, 2001. ***It was moved (Phil Stahlman) and seconded to approve the report. Approved.***

Helms-Briscoe: Kathy Tatom
Don Morishita said Kathy could not attend due to a bad back. With the Board's approval it was agreed to move on to the Program Committee Report.

Program Committee: Bob Parker
The WSWS program was completed in January 2001. The general program speakers are Don Morishita, Rod Hedberg, Bob Stevens, and Robert Norris.
There are 50 posters, 14 of which are in the student competition. There are 78 oral presentations, 16 in the student competition. Due to lack of funds to attend the meeting one paper was dropped. One paper was added by request of The National Park Service. There are about 15 less presentations this year compared to the 2000 meeting in Tucson. No papers were submitted for Project 5, Weeds of Wildlands and Wetlands. Gus Foster deserves continued recognition for his service to the WSWS for arranging the sponsors for the Society events. Gus takes a great burden off the program committee with his willingness to serve. ***It was moved (Phil Banks) and seconded to accept the report. Approved.***

Research Section: Phil Stahlman
Memos were sent to Project Chairs providing directions for editing and indexing research reports in mid-November. Memos were also sent reminding them of deadlines for submissions and of their duties. Project chairs need to be reminded to leave time for discussion in the sessions.
Project Chairs edited research reports submitted to them in a timely manner. This allowed the Research Progress Reports to be completed in a timely manner. A list of current project chairs and discussion topics was provided and is included in the secretary's notebook.
It was recommended: 1) that the directions to authors be revised and updated. 2) Consider using electronic submission for research reports, and 3) Monitor and reemphasize the importance of discussion.
Bob Stougaard, Phil Stahlman, and Barbara Mullin will revise the directions to authors. ***It was moved (Bob Parker) and seconded that the report be accepted. Approved.***

Education and Regulatory: Rich Zollinger
The topics for the2001 meeting are as follows: What does industry expect from university/what does university expect from industry. The speakers are as follows: Arnold Appleby – The genealogy of chemical company mergers/acquisitions and buy-outs and the implications of merger-mania. Vince Ulstad, BASF, will represent the chemical industry to poll other chemical companies and develop a core set of standards/expectation for university and training of graduate students. Steve Miller, University of Wyoming, to represent the university system and poll other university faculty to develop a list of expectations for industry. Carol Mallory Smith to summarize university's role in training graduate students for employment in academia. Phil Banks is the Chair Elect of the Education and Regulatory Committee. ***It was moved (Bob Parker) and seconded that the report be accepted. Approved.***

Knapweed Symposium: Linda Wilson
President Don Morishita said we would skip this report until Linda arrives to present it.

Local Arrangements: Gil Cook and Chris Bellardi
Bob Parker and Gil Cook met with Chris Bellardi to work out details for the WSWS meeting at the Coeur d'Alene Resort. Gil also met with Chris on February 20, 2001 to continue to work out details with Chris. Local arrangements will be available in the Beauty Bay room to give any assistance that they can. ***It was moved (Phil Stahlman) and seconded that the report be accepted. Approved.***

WSSA Representative: Steve Miller
Donn Thill presented the report for Steve Miller. The 41st meeting of the WSSA was held in Greensboro, NC. Steve Miller took over WSSA Representative duties for Donn Thill at the WSSA Board meeting February 15, 2001. Highlights of the meeting included: Charlotte Eberlein taking over the Presidency from Dick Oliver. Scheduling the Summer Board Meeting for Reno, June 28 – 30, 2001, and an update on research priorities. The priorities are in the WSWS secretary's notebook. The society lost $25,000 on the annual meeting and $85,000 for the year. Anne Legere is stepping down as publication director. A mission statement will be developed for Weed Science and Weed Technology. The strategic plan will be revised based upon member participation in a survey. The meeting schedule will be modified beginning in 2002 to more closely fit member preferences. Existing contracts through 2004 may hamper these efforts. An Invasive species workshop is planned for Reno. Several Old Business items were discussed but no action was taken. The 2002 meeting will be in Reno, NV February 10-13. The 2003 meeting will be in Jacksonville, Florida. ***It was moved (Bob Parker) and seconded that the report be accepted. Approved.***

Cast Representative: Rod Lym
Rod attended his first CAST meeting in October 2000 in New Orleans. He became a member of the National Concerns Standing Committee and the Plant Protection Science Working Group.
The most significant news is that Richard Stuckey is resigning as Executive Director of CAST. Candidates are being interviewed and an announcement is anticipated at the March 15 board meeting. Kay Niyo retired as scientific editor and was replaced by Linda Chimentia in January.
The CAST spring, board meeting was held at the same time as the 2001WSWS meeting. Thus, WSWS will not be represented. Rod spoke to Dr. Harold Coble, current CAST president, and was assured it won't happen again. However, the 2002 CAST meeting is scheduled for March 14-16.
CAST has over 2000 individual members and 38 society members. CAST has operated in the black for the past four years.

CAST's reputation as a leading source for reliable information concerning the Agricultural Sciences continues to grow. Representatives of CAST are often called to testify at agricultural hearings in Washington, D.C. and reports written and edited by CAST are often sought out as sources of up-to-date, unbiased data.
Three names need to be submitted to attend a CAST leadership training conference in Colorado Springs, CO May 6-8, 2001. The cost is $200/person. **Jill Schroeder, Rob Hedberg, Phil Stahlman, Bob Parker, Don Morishita said they were interested in attending.** ***It was moved (Bob Stougaard) and seconded that the report be accepted. Approved.***

Committee Reports: [Board Contact]

Awards: Harry Agamalian [Don Morishita]
Presented by Don Morishita. There were 5 nominations for the Outstanding Weed Scientist Award. The winners were Public Sector: Dr. Phillip Stahlman, Kansas State University. Private Sector: John E. Orr, Syngenta Corporation. The WSWS society members need to make every effort to encourage more nominations to be submitted for consideration. ***It was moved (Rich Zollinger) and seconded that the report be accepted. Approved.***

Nominations: Robert Wilson [Don Morishita]
Don Morishita presented the report for Bob Wilson. 129 members cast ballots at this year's election. Some voters did not vote for all candidates. The following individuals were elected: Jill Schroeder - President-elect, Richard Zollinger – Secretary, George Beck – Research Section Chair-elect, and Bill McCloskey - Education and Regulator Section Chair-elect. The 5-year ballot submission history for the WSWS is as follows: 1997 – 130 ballots, 1998 – 148 ballots, 1999 – 152 ballots, 2000 – 127 ballots, 2001 – 129 ballots. ***It was moved (Rich Zollinger) and seconded that the report be accepted. Approved.***

Site Selection: Mick Canavari [Don Morishita]
Don Morishita presented the report for Mick Canavari. The association with Helms-Briscoe continues to work nicely and that relationship should continue. Detailed information is needed on WSWS conference expenses so that future bookings can be made as efficiently and economically as possible. In March 12-14, 2002 the Little America Hotel, Salt Lake City will be the location. March 11-13, 2003 the Sheraton Kauai, Poipu Beach, Koloa, Hawaii will be the location. It was recommended that at least three locations be considered for the 2004 meeting.
The site selection committee considered several locations for the 2003-meeting site. Among the locations considered were Albuquerque, NM; Oklahoma City, and Tulsa, OK; the islands of Hawaii, Maui, Oahu, and Kauai, HI; and Santa Barbara, CA. Based on the response of our membership this committee was instructed to investigate the possibility of returning to Hawaii. After much searching and discussion, it was decided and agreed upon by the Executive Board to select The Kauai Sheraton Hotel at Poipu. This is located very close to Lihue, HI. This hotel has excellent conference facilities and is steps from the beach. Room rates are going to be higher than desired at $160 per night. With the return of a strong Asian economy, room rates in Hawaii have increased since our last meeting there. All other locations investigated in Hawaii were either more expensive or lacked the meeting facility space to host our group. The former Royal Waikoloan Hotel near Kona, where we last met in Hawaii refused to consider our group because they said we were too large for their facility. They are under new management. Albuquerque, Oklahoma City, and Tulsa will be retained as possible future sites for our annual meeting. In addition to the site selection recommendation, this committee recommends that the WSWS continue to use the services of Kathy Tatom of Helms-Briscoe to locate future sites for the WSWS meetings. ***It was moved (Bob Parker) and seconded that the report be accepted. Approved.***

Fellows and Honorary Members: Doug Ryerson [Jeff Tichota]
Jeff Tichota presented the report for Doug Ryerson. The recipients for the Fellows awards are Dr. Jill Schroeder and Ms. Barbara Mullin. The Honorary Member award recipient is Mr. Darrell Hanavan, Administrative Director of the Colorado Wheat Administrative Committee. There was one carryover nomination for 2002. ***It was moved (Bob Parker) and seconded that the report be accepted. Approved.***

Sustaining Membership: Vince Ulstad [Jeff Tichota]
As of February 21, 2001, the WSWS has 19 paid sustaining members for the year 2001. A total of $6,200 has been received by the society from sustaining member dues. The WSWS had a net loss of five sustaining members from

2000, including American Cyanamid (acquisition by BASF), Ball Research, Inc., Patchen, Inc., and mergers of AgrEvo and Aventis to form Aventis CropScience, and Novartis and Zeneca to form Syngenta.
Letters were sent to all sustaining members and 39 prospective members, inviting them to renew or become sustaining members of the WSWS. Six organizations responded to become sustaining members who were not so in 2000, including Agriliance, LLC; AGSCO, Inc.; Electronic Data Solutions; Helena Chemical Company; ID State Dept. of Ag; and, Wendy Lopez & Associates Consulting.
Five sustaining members have requested booth space at the March 2001 meeting. The benefit of booth display space was important in the decision of three of the new companies to become sustaining members. ***It was moved (Jeff Tichota) and seconded that the report be accepted. Approved.***

Finance Committee Report: Nelroy Jackson
An audit will be made of the books. Three recommendations: 1) Investment guidelines need to be signed by the Executive Board. ***The proper individuals signed the investment guidelines so that the WSWS has a final approved copy.*** 2) Portion of the mutual funds need to be invested into bonds. 3) The salary of the business manager (Wanda Graves) be raised from $600 per month to $700 per month. It was moved (Bob Parker) and seconded to increase the WSWS business manager's compensation to $700 per month from $600 per month. Approved.

Don Morishita recommended that WSWS have written guidelines for handling the business manager's compensation for contractual services. Phil Banks suggested that the word salary not be used. Instead use the phrase compensation for contractual services. Nelroy suggested a subcommittee on bylaws handle this. He also suggested that the guidelines not be made too strict. Don said he would make this his responsibility.

Stan Cooper of Merrill Lynch provided a review of the WSWS portfolio. He also explained how the investment plan works and what bonds are.

Nelroy recommended that the WSWS put 50% of cash into bonds and 50% into money markets. Wanda said the WSWS is required to keep 1.5 years operating expenses in cash (approximately $20,000 to $30,000). ***It was moved (Jeff Tichota) to accept the recommendation of the finance committee to invest 1/3 of WSWS finances in money market and bonds (50% into money markets and 50% into bonds). Approved.***

Necrology: Steve Fennimore [Mark Ferrell]
Mark Ferrell presented the report for Steve Fennimore. The committee received notification of six deaths of people that were associated with the WSWS. Dan Hess, Louis A. Jensen, Larry Mitich, Clarence I. Seeley, Scott Stenquist, and Dean Swan.
Dan Hess passed away August 4, 2000. One of his last acts was to create an endowment fund for graduate study in applied agriculture at the University of California, Davis where he obtained his Masters (1973) and Ph.D. (1975) degrees in plant physiology. Dan was born March 22, 1946 in Tacoma, WA and grew up on a farm in central Washington. He was and will be remembered as a wonderful teacher, an outstanding research scientist, a good administrator, and a fine man. It is worthy to note that among Dan's last acts was one designed to benefit students that he will never know. Dan joined Colorado State as an assistant Professor in 1976, but his tenure was short there and he moved to Purdue in 1977. His research was on the modes of action of several important herbicide classes, and he taught advanced weed science courses on the physiology and mode of action of herbicides. In 1985 Dan was selected as the WSSA outstanding research scientist by WSSA. Dan left Purdue in 1985 to work with Zoecon in Palo Alto, CA as the director of Plant Science Research. After the merger with Sandoz, he became the director of Biology and Biochemistry research. In 1998 he began a new agricultural research unit, AffinityAgro. Throughout his career he was a dedicated weed scientist. He remained active as a teacher by continuing to teach at the Purdue Herbicide Action Course and the UC Davis Weed School. Dan was truly gifted at explaining very complex matters. Dan was the author of more than 50 journal articles and book chapters. Dan was the President of the WSSA in 1998, and WSWS Honorary Member in 1997. He was the WSSA outstanding graduate student in 1975. Dan is survived by his wife Deborah of Emerald Hills, CA and three children Tiffany Dodge, Scott Hess and Tonya Weaver as well as three grandchildren.

Louis Jensen passed away July 11, 2000 in Logan, Utah. He was an Idaho farm boy who never lost respect for the land or love for the people who tilled it. He graduated with a degree in agronomy from Utah State University just before World War II. He entered the military and served until he was honorably discharged as a Sergeant. Mr. Jensen began his career with the Utah State Extension Service as a County Agent in rural Utah in 1946 and became an Extension Agronomist in 1953. Lou continued graduate studies and received his MS in 1960. He was known for his long-term chemical weed control studies, especially on noxious perennial weeds such as field bindweed, Russian knapweed, quackgrass, and whitetop. He was the key figure in the introduction of *Rhinocyllus conicus* weevil for biological control of musk thistle in Utah. Lou should be regarded as the pioneer of biological weed control in Utah. Lou was a key organizer in the early years of the Utah Weed control Conference, an association that evolved into the Utah Weed Control Association. He was heavily involved with the WSWS and served as President in 1967, and was elected a Fellow in 1979. He is survived by his wife Alberta, son Richard, daughters Margaret, Dorothy and Barbara as well as 18 grandchildren.

Larry Mitich died August 16, 2000 in Davis, CA. Larry was a true Cooperative Extension Specialist. He believed that Extension was a fulfilling career path and a way to have a positive impact on the efficiency of our agricultural production system. He was a dedicated weed scientist. He firmly believed that the role the WSSA and the regional and state weed science societies play in weed science is critical to our discipline. Evidence of Larry's commitment to weed science societies can be seen in his active membership in numerous committee's and leadership positions. Larry was President of the WSSA in 1990-91 and President of the WSWS in 1987-88. He was reared on a ranch in northeastern Wyoming near the town of Newcastle. The bright flowers of *Opuntia polyacanth, O. fragilis* and *O. neobesseya* near his father's ranch sparked Larry's lifelong relationship with succulent plants. Larry attended the University of Wyoming where he received BS, MS and Ph.D. degrees. His graduate degrees were earned under the direction of Dr. Harold Alley. Larry served 4 years as an Assistant Professor of Agronomy at the University of Kabul in Afghanistan in the mid –1950s, in a project sponsored by the University of Wyoming. He joined North Dakota State University as an Extension Agronomist in 1963 and served as the first extension weed scientist in North Dakota. At NDSU Larry's research program focused on the control of leafy spurge, field bindweed and wild oats. He was a pioneer in the use of television to bring home weed control recommendations in North Dakota. His use of TV was considered a great leap in communication with rural areas. Call in radio programs were part of his outreach program as well, and with this tool he reached out to both rural and urban listeners. In 1980 Larry joined the University of California, Davis as an Extension Specialist. At UC Davis, Larry's research program focused on weed control in field corn, dry beans, and small grains. In his career he has written over 370 extension, applied research publications and research reports. He was a major contributor to the1985 and 1989 editions of *Principles of Weed Control in California*. Larry was actively involved in the North Central Weed Science Society where he served on many committees and as a member of the Board of Directors. He was editor of the *NCWSS Research Report* and *NCWSS Proceedings* for many years. For his years of service with the NCWSS Larry received the Distinguished Service Award in 1978 and was named an Honorary Member in 1981. In the Western Society of Weed Science, he served on several committees and on the Board of Directors. Larry was WSWS program chair, and society president during 1986-88. He was named a WSWS Fellow in 1991, and Outstanding Weed Scientist in 1995. Larry had been an active member of WSSA since 1963. He served as chairman of several committees, and as editor of the *WSSA Newsletter* and *Weeds Today*. He served as an associate editor for Weed Technology and until the time of his death he was a regular contributor to the feature article "Intriguing World of Weeds". Dr. Mitich received the WSSA Extension Worker Award in 1978 and was named a WSSA Fellow in 1983. He served as WSSA vice president, program chair and president between 1988 and 1991.

Clarence I. Seeley died Tuesday November 28, 2000, in Moscow, Idaho of causes related to age. He was 88. He received a Bachelors degree in 1933 from Washington State University and a Masters degree from WSU in 1935. Clarence started working for the USDA in 1936 and was one of the original four "weed investigators" employed by the USDA as a result of the historic Bindweed Investigations Appropriations Bill of 1936. In 1947, he joined the Agronomy Department at the University of Idaho as an agronomist and weed scientist and worked there until his retirement in 1976. Clarence was a charter member of the Weed Science Society of America and served on many committees, including four years on the executive committee. He had been a member of the Western Society of Weed Science almost since its inception and served as its president in 1954. He was elected a Fellow of the Society in 1975. He also was a member of the Idaho Weed Control Association and served on the Board of Directors for many years. His survivors include his wife, Helen; a son, Richard; a brother, seven grandchildren, and three great-grandchildren.

Scott Stenquist died Tuesday evening, January 23, 2001, in his Gresham home. It is our understanding that he died peacefully of natural causes. Scott valiantly struggled with the debilitating effects of diabetes for many years, and that disease may have been a contributing factor to his death. Scott will be fondly remembered by his friends and colleagues for many things. First, was his strong dedication to the work of the Service. Despite his regular frustrations with the pace of bureaucracy, funding limitations, and occasional diabetes-related setbacks, Scott maintained a positive attitude and pro-active philosophy. He routinely worked out of his home on evenings and weekends as he believed necessary to get the job done. He spent endless hours reviewing literature, participating in professional and interagency meetings, and consulting experts around the world in pursuit of the most efficient and least damaging means to address pest problems. He stubbornly stood his ground, and tenaciously pushed for decisions and commitments when needed to advance the program. He was also the first to reach out to others in need around the office. Scott's professional career stretched across the National Wildlife Refuge System including Fish Springs, Great Swamp, Tinicum, Upper Mississippi, Umatilla, and Ankeny NWRs. Most recently, Scott worked as the Pacific Region's Integrated Pest Management Coordinator addressing a variety of critical projects and issues. Of special note was Scott's leadership role in development and implementation of a formal integrated pest management program for the Klamath Basin Refuges in southern Oregon and northern California, a technically complex and politically very controversial issue. Although Scott was regionally based, he regularly operated outside of those boundaries and at the national level made significant contributions, including projects on the control of purple loosestrife, salt cedar and mosquitoes. Scott's family suggests that donations in his memory be made to The Nature Conservancy (821 SE 14th Ave., Portland, OR 97214). Remembrances in Scott's name may be targeted at specific lands TNC is attempting to protect, or donations may go to a land preservation endowment. Scott's death is a personal and professional loss for many. We will miss him greatly!

Dean Swan, retired Extension Weed Specialist at Washington State University passed away suddenly on October 1, 2000. Dr. Swan is survived by Rowena White Swan, his wife of 51 years, one daughter, two sons, and numerous grandchildren. Dean was born in Wheatland, WY on September 16, 1923. After being raised on the family farm, Dean served in the Army Air Corp from 1942 to 1945 earning the rank of Sergeant. He was stationed in the Panama Canal Zone during most of his military service. Dean married Rowena White on December 19, 1948 and together they had three children, Cynthia, John, and Daniel. Attending the University of Wyoming under the GI Bill, Dean earned a bachelor's degree in 1952, followed by a master's degree in 1954. Additionally, Dean taught high school in Chadron, Nebraska from 1952-1953. After earning his master's degree, Dean was employed by Oregon State University at the Pendleton Experiment Station from 1954 to 1965. He received his Ph.D. from the University of Illinois in 1965 and spent one year on the faculty at the University of Arizona in Tucson before returning to the Pacific Northwest in 1966 as the Extension Weed Specialist at Washington State University in Pullman. Dean stayed in this position until his retirement in 1989. In addition to his years of distinguished service to eastern Washington farmers, he is probably best known for his skill at preparing and photographing weed specimens. Many of his photographs were entered into the WSSA Photo Contest over the years and appear in Western Society of Weed Science and Weed Science Society of America publications. Together with Rowena, Dean spent an active retirement traveling extensively, working on various publications, and returning to WSU in 1996 to co-teach the introductory weed science course.

It was moved (Rich Zollinger) and seconded to accept this report. Approved.

Herbicide Resistant Plants: Ian Heap [Bob Stougaard]

1. Since the last meeting in Tucson, Arizona this committee has conducted an update survey of herbicide resistant weeds in the west. With the exception of increasing herbicide resistant weeds of rice in California there have been few new cases of herbicide resistant weeds reported in the west. The results of this survey are located at http://www.weedscience.com.
2. Due to a decline in research activities by WSWS members on herbicide resistant weeds over the last 5 years the interest in this committee has died down.
3. The committee is now placing greater emphasis on the potential rise of herbicide resistant crops in the Northwest Region, specifically Clearfield wheat and Roundup Ready wheat, and how they interact with the management of herbicide resistant weeds.
4. The committee has instigated a discussion group on the agronomic aspects of Roundup Ready wheat, which will occur at this meeting on Tuesday, March 14th.

It was moved (Rich Zollinger) and seconded to accept this report. Approved.

Resolution: George Beck [Bob Stougaard]
Bob Stougaard presented the report for George Beck. The Western Society of Weed Science Resolutions Committee did not receive any suggested resolutions from members. However, there is legislation pending in the U.S. Senate – S.198 the Harmful, Non-Native Weed Control Act of 2000 – and soon there will be a companion bill in the House of Representatives. If these bills are in final form before the summer Board meeting, a resolution for our society to

support them will be forwarded to the Board for consideration. ***It was moved (Bob Parker) and seconded to accept this report. Approved.***

Student Educational Enhancement: Jill Schroeder and John Fenderson [Bob Stougaard]
We received four applications for the 2001 program. There was a discrepancy in the due dates on the forms so we accepted applications until February 1 (postmark). We advertised the program by putting the forms on the WSWS web site, by notification in the newsletter, by notification over the WSWS and Western Weed Workers list serves, and by including the forms in the packet containing the Call for Papers that was sent to the membership. In our announcements, we also requested that individuals who would be willing to serve as a host for the program identify themselves. Jesse Richardson, Dow AgroSciences, responded that he will be willing to host 1 or 2 students.

The four students and their location requests are: Ken Deibert, NDSU, advisor: Rod Lym. 1st choice California, 2nd choice Arizona. Rick Walker, NDSU, advisor: Cal Messersmith. 1st choice California, 2nd choice Arizona (fruit and vegetable prod). Neal E. Hoss, KSU, advisor: Kassim Al-Khatib. lst choice California, 2nd choice Washington (fruits and vegetable prod). Justin Norsworthy, NMSU, advisor: Jill Schroeder. 1st choice southern California, 2nd choice the northwest (WA, OR).

Kirk Howatt informed the committee that a third student from NDSU expressed interest in the program. The student did not apply formally to the program because there were already two applicants from NDSU. The consensus of the committee appears to be that, once we have accommodated the first four students, we should try to place this third student from NDSU. We feel that the spirit of the program is to allow as many students as possible to participate in the program. Since we have only four applicants this year, the committee felt that we could probably accommodate this third applicant from NDSU. This will, however, depend on our success in placing the first four students.

John Fenderson, co-chair, is in the process of contacting other potential hosts for these students. The other committee members will forward names of potential hosts to John. ***It was moved (Donn Thill) and seconded to accept this report. Approved.***

Legislative: Jim Oliveras [Donn Thill]
The following is submitted to update the WSWS Board of Directors. Invasive Species: The second National Invasive Weed Awareness Week took place in February 2001. Senator Craig is sponsoring a bill titled harmful Nonnative Weed Control Act, to provide funds to State governments for management of Noxious Weeds. The bill is to provide money for cost share programs for groups wanting to initiate or strengthen activities of local weed management areas. There is a concern that this bill may take money away from existing federal land management agencies' noxious weed programs. The National Invasive Species Plan has been finalized and is on the web. Also, federal departments like USDA have been active in developing what has been titled, The USDA Crosscut Invasive species budget. The various department budgets are to display what department/agency initiatives and resources will be needed to implement the plan. They cover management, research and education needs. The next chairperson will be Roy Reichenbauch. ***It was moved (Bob Stougaard) and seconded that the report be accepted. Approved.***

Publications: Rich Zollinger [Donn Thill]

The Publications Committee was contacted by representatives of the Northern Plains Agricultural Research Laboratory in Sidney, MT seeking permission to add many articles on *Purge spurge: Leafy Spurge Database*, a CD-ROM IBM that incorporates technical and general articles, maps, graphs, illustrations, and photos of the noxious weed leafy spurge. The CD-ROM is being revised to include many additional articles from the Western Society of Weed Science printed in the last five years. They request an internet interface and to add a link to WSWS web site. They request nonexclusive world rights to use the material for all editions and future revisions of both the CD and internet posting. About 5,000 copies of the CD-ROM will be produced. Final editing and production of the CD-ROM is expected in 2001.

The Publications Committee was contacted by representatives of Clallam County Noxious Weed Control Board in Port Angeles, WA seeking permission to use some Weeds of the West pictures, mainly western hemlock, bur chervil in a education piece. I referred them to Tom Whitson who later supplied the pictures they requested.

Inventory of the 1[st] version of Weeds of the West is depleted. The new revised edition is available with 30 new plant species and contains over 300 new photographs. A major change in the new edition is the inclusion of seedling pictures for many of the annual plants in the book.

Barbra Mullin said all Bio Control of Weeds of the West have been sold. Barb does not have time to coordinate revising this publication for reprinting. She recommends that someone else be found to coordinate the revision of the publication. The Center for Invasive Plant Management at Montana State University may be willing to take over the publication. If the obligation to update this publication is not met by June 2001 $48,000 will need to be returned to the Montana Department of Ag. Barbara will contact the Center for Invasive Plants and see what the costs and other factors will be and get the information to the WSWS board. The report was interrupted by a fire alarm at 3:30 pm and was not voted on for approval.

Placement: Doug West [Phil Stahlman]
Don Morishita presented the report for Doug West. Placement forms received
Positions desired: 2 Positions available: 7 Public Sector, 0 Research Assistantship, 0 Private Industry. ***It was moved (Mark Ferrell) and seconded that the report be accepted. Approved.***

Editorial: Joan Campbell [Phil Stahlman]
Newsletter Report: Summary of Activities (Don Morishita): 1. Four newsletters were published this past year. Thanks to newsletter guidelines put together by Barbra Mullin, past newsletter editor, the newsletter was relatively easy to put together. 2. An attempt was made to publish the pictures of the WSWS award winners on the web site that would complement the listing of winners in the newsletter. However, this was unsuccessful.

Recommendations: 1. Post pictures of the award winners in the web site in addition to recognizing them in the newsletter. 2. After conferring with Bob Parker, Don Morishita volunteered to continue on as newsletter editor for at least one more year.

Web site report: Summary of Activities (Joan Campbell): 1. The major activity was a total rewrite of the on-line submission program. On-line submission was quite successful as there was only one resubmit compared to about 30 last year. Most of the abstracts were submitted as per directions and the new submission program is saving much time for the program chairperson and proceedings editor. 2. The events page is being reprogrammed to have instant posting. Results of improvements on use of web site: Usage increases in November and January which correlates with the annual meeting paper submission and the annual meeting program coming on line. Use continues to increase each year as shown from Jan/Feb 2000 to Jan/Feb 2001.

Month	Total requests	Total page requests	Unique hosts
January (2000)	10,511	4,369	1,089
February	13,934	5,137	1,369
March	12,759	4,907	1,567
April	8,851	3,382	1,332
May	10,386	4,024	1,528
June	6,332	2,572	983
July	7,328	2,999	1,117
August	7,925	3,117	1,154
September	8,129	3,041	1,231
October	10,863	3,780	1,554
November	16,591	4,256	1,618
December	11,472	3,567	1,315
January (2001)	14,426	4,626	1,723
February	12,660	4,020	1,615

Action items:
Discuss Affirmative Technologies contract for web hosting, site design, and maintenance.
Recommendations:
Renew Affirmative Technologies contract for another year.

A motion was made to renew the Affirmative Technologies for 2001-2002. The cost will be $500 for hosting and design of the WSWS web site. The motion was made by Phil Stahlman and seconded. The motion was approved.

Joan also reported that Affirmative Technologies would like a single point of contact for the WSWS website. The WSWS web editor will be the point of contact. Joan Campbell will remain as web editor for 2001-2002.

Proceedings Report (Joan Campbell): Summary of Activities: 1. The 2000 Proceedings (Volume 53) of the Western Society of Weed Science had 142 papers, six research section reports, the business report, awards, indices which totaled 174 pages, table of contents inclusive. Six long papers and four abstracts with one or two tables were printed (7% of total). 2. All abstracts for the 2001 Proceedings were submitted online this year with ease, except the knapweed symposium abstracts which were not submitted. There will be 132 abstracts printed, excluding general session speakers. 3. Format for the 2001 Proceedings will follow the WSSA Abstracts format which will indicate the abstract number from the program, print the abstracts in the order of the program and print all abstracts from a Project together. 4. We have received one full paper, one abstract that contained several tables, and two abstracts with one table (3% of total) for the 2001 Proceedings, 5. Size of the 2001 Proceedings and cost estimate will be available at the time of the meeting.
Recommendations: 1. Print only abstracts, no full length papers, no tables or figures. 2. Abstracts should be correct the first time they are submitted and discontinue resubmission of abstracts after the closing date. 3. Publish complete minutes (including motions, discussion and vote) of executive board meetings and business meeting. 4. Flexibility in formatting.

A motion to accept the WSWS Proceedings as written above was made. Motion by Rich Zollinger and seconded. The board approved the motion.

A motion was made to allow a summary title submission by December 1st and an abstract by February 1st. Motion by Rich Zollinger and seconded. The board approved the motion.

Rich Zollinger moved to recommend changing the editorial committee from ad hoc to a standing committee. This will be brought before the membership for a vote. Motion was seconded and approved by the board.

WSWS Research Progress Report (Barbra Mullin): The WSWS Research Progress Report is at the printing as you read this. We are of printing 350 copies at a cost of $11.41 each. We may need to look at finding another printer or increasing the price of the publication to also cover the shipping costs. Wanda will have a better handle on that end of it. I will ship 150 to Wanda in California and take 150 to Idaho for distribution at the meeting.

Project 1: Weeds of Range & Forest	20 reports
Project 2: Weeds of Horticultural Crops	14 reports
Project 3: Weeds of Agronomic Crops	93 reports
Project 4: Teaching & Tech Transfer	1 report
Project 5: Weeds of Wetlands & Wildlands	2 reports
Project 6: Basics Sciences	0 reports

Joan also said that verbiage needs to be developed for the WSWS operating guide to bring the newsletter, website, proceedings, research progress reports editors into one committee. Don Morishita volunteered to write the verbiage and present it at the 2001 summer business meeting. ***It was moved (Mark Ferrell) and seconded that the report be accepted. Approved.***

Poster: Jay Gehrett [Bob Parker]
At this time, 50 posters have been entered this year for display at the 2001 WSWS meeting at the Coeur d'Alene Resort in Coeur d' Alene, Id. Of those submitted, 14 are Student Posters. It has been recommended, that the sustaining membership displays and Coffee Breaks occur in the same room in an effort to increase the visibility / traffic for all. Poster set-up will be available to presenters on Monday Mar. 12 from 4:30 to 9:00 pm. Exhibitors are responsible for posting materials (pins, velcro, etc.) Authors must be present on Tuesday Mar. 13 from 7:45- 9:20 am. Posters must be removed by 4:30 pm on Wednesday Mar. 14th. The Poster committee in Coeur d' Alene will receive the easels and 4x4 foam core boards from Donn Thill who has stored and will transport to Coeur d' Alene. The equipment will be set up during the afternoon Monday after receipt. It is appropriate for the WSWS to acknowledge Donn's efforts to store and deliver this equipment to Coeur d' Alene. The International Knapweed Symposium on Mar. 15 and 16 will be using approx. half of the equipment for displays. At this time, Don Morishita has agreed to store the equipment for delivery to the 2002 meeting in Salt Lake. Jay will arrange to ship or have these shipped to Don. The 2002 Chairman for the Poster Committee will be Marvin Butler. ***It was moved (Bob Stougaard) and seconded that the report be accepted. Approved.***

Student Paper Judging: Mack Thompson [Bob Parker]

Poster Contest: There are 14 posters entered in the contest. The poster contest was divided into two sections. The WSWS 2000 Guidelines indicate that the contests should be split if the number of contestants exceeds 14; however, it is almost impossible for the judges to visit every contestant within the time allotted and several judges indicated that was a problem last year (only 9 posters in the contest in 2000). I think this arrangement will serve the students and judges better than rushing their conversations. According to the guidelines, only two places will be given in sections of 5-8 participants. We will be awarding two $100 winners and two $75 second places for the poster contest.

The posters seemed to fit relatively well into two categories: applied and ecology/ resistance studies. The university affiliations also divided well between the two groups so that there is competition between universities rather than within a school.

Paper Contest: Bob Parker did an excellent job of organizing the student papers within the program. The papers in each section are consecutive and do not overlap with student papers in other sections, to the extent that they are on separate days. This made organizing the contest very simple. There are 16 papers entered in the contest: 5 Basic Sciences, 1 Teaching and Technology, and 10 Weeds of Agronomic Crops. The Basic and Technology papers are Tuesday afternoon and the Agronomic papers are Wednesday morning. Although the sections are not even, I suggest splitting the groups based on Project (and therefore day), thus combining Basic and Technology for 6 papers on Tuesday which leaves 10 Agronomic papers on Wednesday. This division also splits the university affiliations acceptably. Under this arrangement, CSU is the only school with multiple presenters (2) that isn't represented in both sections. We will present awards for first and second in Tues. section and first, second, and third in the Wed. contest. The total payout for posters and papers will be $750 (four 1st @$100, four 2nd @$75 and one 3rd @$50).

Judging: I have commitments for judging from 12 people plus myself. Which is enough for three judges per poster/paper section and four judges for the larger Agronomic papers section. The judges represent seven academic and five industry institutions.

Committee: I have spoken with the other committee members, Tim Miller (past Chair) and Peter Dotray (Chair 2002) regarding the contest. We didn't come up with any suggestions regarding changes to the bylaws, but after speaking with past judges and organizing the poster contest, I would recommend that the Paper Judging Chair have some discretion when organizing the poster section. The bylaws indicate that the section shouldn't be divided until the number of posters is greater than 14. I feel that it would be too difficult to judge that many posters in the allotted time. That works out to be less than 7 minutes per poster to read, ask questions, record comments, and find next poster. We have to keep in mind that other people are interested in the posters and the judges may not have immediate access to the presenter.

Mack also said that he would like the student paper abstracts ahead of time so that they can be given to the judges before the contest. Joan Campbell said she would send these to the chair of the student paper contest committee. ***It was moved (Mark Ferrell) and seconded that the report be accepted. Approved.***

Public Relations: Kia Umeda [Rich Zollinger]

A press release dated February 2, 2001 announced the 54th Annual Meeting of the WSWS) and was distributed as follows: mailed to: Agribusiness/California Farmer; AgAlert; Agribusiness Fieldman; Capital Press. faxed to: Ag Consultant; Farm chemicals; The Grower; CAPCA. e-mailed to: Western Farm Press; Meister Publishing; Yuma Daily Sun; WSSA Newsletter; American Society for Horticultural Science; Columbia Publishing; Carrot Country; Potato Country; Onion World; UC Vegetable Research and Information web site; Gemplers.com IPM web site. Continuing education hour's requests for various state licensing requirements for attendees were submitted to: Wyoming, Montana, Colorado, Utah, California, Arizona, New Mexico, Washington, Oregon, and Idaho.

Jack Schlesselman has consented to photograph traditional officers and awards recipients following luncheon. ***It was moved (Bob Parker) and seconded that the report be accepted. Approved.***

Education: Carol Mallory-Smith [Rich Zollinger]

Noxious Weed Short Course. Government agencies would like the training, however, some are not willing to pay for it or cannot pay for it. The education committee will pursue other training options. In order to meet expenses more may have to be charged for the course.

The Noxious Weed Short Course sponsored by the WSWS was held in Ft. Collins, CO during April 2000. Both sessions were filled (35 each) with employees of USFS, BLM, Fish and Wildlife Service, Dept. of Transportation, and County Weed District superintendents. Instructors included: Dr. Rod Lym, Dr. Steve Dewey, Barbra Mullin, Dr. Scott Nissen, Dr. George Beck, Dr. Phil Westra, Rita Beard, Jim Sebastian, Cindy Owsley, and

Celestine Duncan representing the Western Society of Weed Science. The committee greatly appreciates the support and assistance from all instructors. Participant evaluations ranked the course as excellent to good in terms of content and delivery. Comments regarding the course were very favorable, and there is a high level of interest in continuing the training in the present format. Two sessions of the short course will be held in Bozeman, April from the 17 th through 25 th 2001. Both sessions have been filled since mid December. There continues to be strong interest in the course from federal and state agencies. The current budget is $22,825.24. ***It was moved (Mark Ferrell) and seconded that the report be accepted. Approved.***

Old Business
It was discussed to combine the Resolution Committee with the Necrology Committee. There is very little activity with the Resolution committee. This suggestion will be brought before the WSWS membership for consideration and voted on at the General Business Meeting on 15 March 2001.

New Business
George Hittle, project coordinator for the Intermountain Agriculture Foundation, requested that WSWS continue to fund "A Kid's Journey to Understanding Weeds". Discussion indicated that the program has not made significant progress. ***A motion to not continue funding was made. It was moved (Steve Miller) and seconded. The board approved the motion.***

Rich Zollinger proposed that WSWS create an award recognizing a WSWS Outstanding Young Scientist. Steve Miller suggested WSWS create awards for the following categories: Outstanding Education, Outstanding Researcher, Outstanding Young Scientist, and Outstanding Technical Support. It was decided by the WSWS board to table this until the summer 2001 business meeting. ***Rich Zollinger, Steve Miller, and Jeff Tichota will serve on an ad hoc committee to develop a proposal to consider the details of these awards.***

President Don Morishita said that the WSWS business office needs a photocopier. ***A motion was made to purchase a photocopier. It was moved (Phil Banks) and seconded. The board approved the motion.***

President Don Morishita suggested that the Knapweed Symposium have a separate registration not affiliated with the WSWS. Also the Knapweed Symposium needs to coordinate more closely with WSWS. The WSWS business manager receives compensation from the Knapweed Symposium to handle its affairs. The WSWS business manager will coordinate more closely with the Knapweed Symposium in the future.

Bob Parker suggested that the WSWS use profits the society makes to benefit the society members. Suggestions made included setting up a scholarship fund and subsidizing students within WSWS boundaries to travel to WSWS meetings. ***An ad hoc committee was set up to look into a good way to use WSWS profits. Those on the committee are: Don Morishita, Tom Lanini, and Jeff Tichota.***

There being no new business a motion was made to adjourn the meeting. It was moved (Bob Parker) and seconded. ***The board approved the motion.*** President Don Morishita adjourned the meeting at 4:50 pm.

Respectfully Submitted,
Mark A. Ferrell
WSWS Secretary 2000-2001

MINUTES OF THE 54RD ANNUAL BUSINESS MEETING
WESTERN SOCIETY OF WEED SCIENCE
COEUR D'ALENE RESORT—COEUR D'ALENE, IDAHO
THURSDAY, MARCH 15, 2001

Call to Order: President Don Morishita called the meeting to order at 7:00 am.

Minutes: Mark Ferrell
It was moved (Bob Parker) and seconded to approve the minutes of the March 16, 2000 business meeting as published in the proceedings. Motion passed.

Financial Report: Wanda Graves
There were 432 people in registered for the meeting. The WSWS is in good financial standing with a current balance of $334,689.57. Revolving account balances are $159,637.53 of the total capital. Revolving accounts hold funds to support Weed of the West ($70,232.19), Noxious Weed Short Course ($25,543.32), Biological Weed Control Handbook ($53,062.02), and Knapweed Symposium ($10,800.00). Capital is distributed as follows: Merrill Lynch Funds ($260,365.99), Money Market Savings ($42,199.01), and Checking Account ($32,124.57).

Immediate Past President's Report: Jeff Tichota
One member (Lamar Anderson) was recognized at the Retiree's Reception and New Member Recognition on Monday night.

The board has requested only one change in the WSWS Operating Guide. The proposed change alerts the WSWS secretary not to announce award winners of nominees when the WSWS summer board minutes are posted on the WSWS website.

Member-at-Large: Bob Stougaard
Due to inactivity of the Resolutions Committee it was recommended that it be combined with the Necrology Committee. This would require a change in the WSWS constitution.

Program Committee: Bob Parker
There were 132 presentations, including the General Session. There were 50 posters, 14 of which were in the student competition. There were 78 oral presentations, 16 in the student competition. Due to lack of funds to attend the meeting one paper was dropped. One paper was added by request of The National Park Service. There were about 15 less presentations this year compared to the 2000 meeting in Tucson.

Research Section: Phil Stahlman
It was recommended: 1) that the directions to authors be revised and updated. 2) Consider using electronic submission for research reports, and 3) Monitor and reemphasize the importance of discussion at the end of discussion sessions. A straw poll for the preferred manner in which Research Project Reports should be distributed was taken. About 50 were in favor of cd-rom distribution and 50 favored a hardcopy distribution. A straw poll was also taken to see if the membership would prefer using Trade Names instead of Common Names in the research reports. 30 were in favor and 60 were not in favor. Don Morishita asked if the membership would be in favor of using computer projection equipment for presentations. 150 indicated that they would be in favor.

Education and Regulatory: Rich Zollinger

The topics for the2001 meeting were as follows: What does industry expect from university/what does university expect from industry? The speakers were as follows: Arnold Appleby – The genealogy of chemical company mergers/acquisitions and buy-outs and the implications of merger-mania. Vince Ulstad, BASF, represented the chemical industry to poll other chemical companies and develop a core set of standards/expectation for university and training of graduate students. Steve Miller, University of Wyoming, represented the university system and poll other university faculty to develop a list of expectations for industry. Carol Mallory Smith summarized the university's role in training graduate students for employment in academia. Phil Banks is the Chair Elect of the Education and Regulatory Committee.

Rich emphasized the importance of leaving enough time at the end of discussion sessions for discussion on the topics covered.

Local Arrangements: Gil Cook
All went well with the meeting. The Coeur d'Alene Resort staff remarked that the WSWS membership was one of the best groups that they have had the pleasure of hosting. Gil thanked his committee for all their help. Steve Dewey is the local arrangements chair for 2001-2002.

WSSA Representative: Craig Alford presented the report for Steve Miller
The 41st meeting of the WSSA was held in Greensboro, NC. Steve Miller took over WSSA Representative duties from Donn Thill at the WSSA Board meeting February 15, 2001. Highlights of the meeting included: Charlotte Eberlein taking over the Presidency from Dick Oliver. Scheduling the Summer Board Meeting for Reno, June 28 – 30, 2001, and an update on research priorities. The priorities are in the WSWS secretary's notebook. The society lost $25,000 on the annual meeting and $85,000 for the year. Anne Legere is stepping down as publication director. A mission statement will be developed for Weed Science and Weed Technology. The strategic plan will be revised based upon member participation in a survey. The meeting schedule will be modified beginning in 2002 to more closely fit member preferences. Existing contracts through 2004 may hamper these efforts. An Invasive species workshop is planned for Reno. Several Old Business items were discussed but no action was taken. The 2002 meeting will be in Reno, NV February 10-13. The 2003 meeting will be in Jacksonville, Florida.

CAST Representative: Rod Lym
The most significant news is that Richard Stuckey is resigning as Executive Director of CAST. Candidates are being interviewed and an announcement is anticipated at the March 15 board meeting. Kay Niyo retired as scientific editor and was replaced by Linda Chimentia in January.
The CAST spring, board meeting was held at the same time as the 2001WSWS meeting. Thus, WSWS was not represented. Rod spoke to Dr. Harold Coble, current CAST president, and was assured it wouldn't happen again. However, the 2002 CAST meeting is scheduled for March 14-16.
CAST has over 2000 individual members and 38 society members. CAST has operated in the black for the past four years.
CAST's reputation as a leading source for reliable information concerning the Agricultural Sciences continues to grow. Representatives of CAST are often called to testify at agricultural hearings in Washington D.C. and reports written and edited by CAST are often sought out as sources of up-to-date, unbiased data.

Committee Reports:

Awards: Harry Agamalian
There were 5 nominations for the Outstanding Weed Scientist Award. The winners were Public Sector: Dr. Phillip Stahlman, Kansas State University. Private Sector: John E. Orr, Syngenta Corporation. The WSWS society members need to make every effort to encourage more nominations to be submitted for consideration. Rich Zollinger would like the membership to consider a new award, The Outstanding Young Weed Scientist Award. Five awards will be discussed at the 2001 summer business meeting: 1. Outstanding Young Weed Scientist Award, 2. Outstanding Weed Scientist Award, 3. Outstanding Educational Award, 4. Outstanding Research Award, and 5. Outstanding Technical Support Award.

Nominations: Don Morishita for Bob Wilson
129 members cast ballots at this year's election. Some voters did not vote for all candidates. The following individuals were elected: Jill Schroeder - President-elect, Richard Zollinger – Secretary, George Beck – Research Section Chair-elect, and Bill McCloskey - Education and Regulator Section Chair-elect.

Site Selection: Don Morishita for Mick Canevari
The association with Helms-Briscoe continues to work nicely and that relationship should continue. Future locations will be: March 12-14, 2002 the Little America Hotel, Salt Lake City; March 11-13, 2003 the Sheraton Kauai, Poipu Beach, Koloa, Hawaii.

Fellows and Honorary Members: Doug Ryerson
The recipients for the Fellows awards were Dr. Jill Schroeder and Ms. Barbra Mullin. The Honorary Member award recipient was Mr. Darrell Hanavan, Administrative Director of the Colorado Wheat Administrative Committee. There is one carry-over nomination for next year. Members are encouraged to submit nominations to the committee by May 15.

Sustaining Membership: Vince Ulstad
As of February 21, 2001, the WSWS has 19 paid sustaining members for the year 2001. A total of $6,200 has been received by the society from sustaining member dues. The WSWS had a net loss of five sustaining members from 2000, including American Cyanamid (acquisition by BASF), Ball Research, Inc., Patchen, Inc., and mergers of AgrEvo and Aventis to form Aventis CropScience, and Novartis and Zeneca to form Syngenta. Letters were sent to all sustaining members and 39 prospective members, inviting them to renew or become sustaining members of the WSWS. Six organizations responded to become sustaining members who were not so in 2000, including Agriliance, LLC; AGSCO, Inc.; Electronic Data Solutions; Helena Chemical Company; ID State Dept. of Ag; and, Wendy Lopez & Associates Consulting.

Finance: Drew Lyon for Nelroy Jackson
The committee reported that the WSWS finances had been audited and accepted by the committee and that Wanda Graves continues to do excellent work in managing the society. Drew also mentioned that Nelroy has retired and needs to be recognized.

Necrology: Steve Fennimore
The committee received notification of six deaths of people that were associated with the WSWS. Dan Hess, Louis A. Jensen, Larry Mitich, Clarence I. Seeley, Scott Stenquist, and Dean Swan. See Necrology Report.

Herbicide Resistant Plants: Ian Heap
Since the last meeting in Tucson, Arizona this committee has conducted an update survey of herbicide resistant weeds in the west. With the exception of increasing herbicide resistant weeds of rice in California there have been few new cases of herbicide resistant weeds reported in the west. The results of this survey are located at http://www.weedscience.com. Due to a decline in research activities by WSWS members on herbicide resistant weeds over the last 5 years the interest in this committee has died down. The committee is now placing greater emphasis on the potential rise of herbicide resistant crops in the Northwest Region, specifically Clearfield wheat and Roundup Ready wheat, and how they interact with the management of herbicide resistant weeds.

Resolutions: Don Morishita for George Beck
There were no resolutions submitted during 2000-2001.

Student Educational Enhancement: Jill Schroeder
There are five students signed up for the 2001-2002 year.

Legislative: Jim Oliveras
The second National Invasive Weed Awareness Week took place in February 2001. Senator Craig is sponsoring a bill titled harmful Nonnative Weed Control Act, to provide funds to State governments for management of Noxious Weeds. The bill is to provide money for cost share programs for groups wanting to initiate or strengthen activities of local weed management areas. There is a concern that this bill may take money away from existing federal land management agencies' noxious weed programs. The National Invasive Species Plan has been finalized and is on the web. Also, federal departments like USDA have been active in developing what has been titled, The USDA Crosscut Invasive species budget. The various department budgets are to display what department/agency initiatives and resources will be needed to implement the plan. They cover management, research and education needs. The next chairperson will be Roy Reichenbauch.

Publications: Rich Zollinger
The "Weeds of the West" publication has been very successful; about 97,500 copies have been printed. The second edition of "Weed of the West" is ready and 12,500 copies have been printed. 4,000 copies have sold within the first four months. Tom Whitson will come up with a policy allowing use of the photos in "Weeds of the West". The photos are now digitized and may be available on cd-rom in the future.

Placement: Doug West
No report.

Editorial: Joan Campbell
There were 350 copies of the 2001 Research Progress Reports printed at a cost of $11.41 each. There were four Newsletters published and posted on the WSWS web site. Hits on the web site continue to increase.
The 2000 Proceedings (Volume 53) of the Western Society of Weed Science had 142 papers, six research section reports, the business report, awards, indices which totaled 174 pages, table of contents inclusive. Six long papers and four abstracts with one or two tables were printed (7% of total). 2. All abstracts for the 2001 Proceedings were submitted online this year with ease, except the knapweed symposium abstracts, which were not submitted. There will be 132 abstracts printed, excluding general session speakers. 3. Format for the 2001 Proceedings will follow the WSSA Abstracts format, which will indicate the abstract number from the program, print the abstracts in the order of the program and print all abstracts from a Project together. 4. We have received one full paper, one abstract that contained several tables, and two abstracts with one table (3% of total) for the 2001 Proceedings.
Award winners will be included on the WSWS web site. Only abstracts will be printed in future proceedings. No resubmissions will be allowed. A straw poll was taken of the membership to see what format they would like for the proceedings. About 50 voted for cd-rom format and 75 voted for a hardcopy format.

Poster: Jay Gehrett
Jay reported that 50 posters were displayed at the meeting. 14 were student posters.

Student Paper Judging: Mack Thompson
There were 14 entrants in the Student Poster Contest and 16 entrants in the Student Paper Contest. The poster and paper contests were divided into two sections. Winners from the 2001 WSWS student paper/poster contest are as follows:
Poster Section #1: 1st – David S. Belles, Colorado State University, 2nd – Lynn Fandrich, Colorado State University
Poster Section #2: 1st – Todd R. Wehking, North Dakota State University, 2nd – Federico Trucco, Colorado State University
Paper Section #1: 1st – Oleg Daugovish, University of Idaho, 2nd – Nicole Wagner, Montana State University
Paper Section #2: 1st – L.R. Van Wychen, Montana State University, 2nd – Johnathon D. Holman, Montana State University, 3rd – Branden L. Schiess, University of Idaho

Public Relations: Kia Umeda
A press release dated February 2, 2001 announced the 54th Annual Meeting of the WSWS) and was distributed to various agricultural and regional organizations.
Continuing education hour's requests for various state licensing requirements for attendees were submitted to: Wyoming, Montana, Colorado, Utah, California, Arizona, New Mexico, Washington, Oregon, and Idaho.
Jack Schlesselman consented to photograph traditional officers and awards recipients.

Education: Carol Mallory-Smith
Two sessions of The Noxious Weed Short Course sponsored by the WSWS were held in Ft. Collins, CO during April 2000. Both sessions were full with 35 attendees each.
Two sessions of the short course will be held in Bozeman, April from the 17th through 25th 2001. Both sessions have been filled since mid December. There continues to be strong interest in the course from federal and state agencies.

New Business:
A motion was made by Bob Parker to combine the Resolutions and Necrology Committee into one committee and seconded by Paul Ogg. In the discussion it was asked why this was necessary. It was deemed necessary because the Resolutions Committee has little or no activity. Gus Foster suggested that resolutions be submitted to the Immediate Past President who would bring them before the WSWS board. The motion was withdrawn. This matter will be discussed at the WSWS summer board meeting.
A motion was made to change the Editorial Committee from Ad Hoc to a Standing Committee. It was so moved by Donn Thill and seconded by Bob Parker. The motion was approved by the WSWS membership.
Phil Westra stated that a cd-rom version of the Research Progress Reports could cut publication costs in half. Phil said he was in favor of multi-media presentations at WSWS. Phil suggested the WSWS look into having a calendar made based on winning photos. Pre-orders would need to be taken.
President Don Morishita then passed the "new hoe" (the old one was broken) to incoming president Bob Parker. Bob Parker presented Don Morishita with a plaque commemorating his tenure as WSWS President and expressing the

society's appreciation for his time commitment and for a job well done. Bob also thanked the hotel staff for their help. He reminded the membership the need to volunteer for committees. He also thanked Gus Foster for his continued willingness to help WSWS.
Bob invited everyone to the 2001 meeting in Salt Lake City, UT.
The meeting was adjourned at 8:35 am.

Respectively submitted,
Mark Ferrell
WSWS Secretary 2000-2001

2001-2002 WESTERN SOCIETY OF WEED SCIENCE OFFICERS AND EXECUTIVE COMMITTEE, Front Row (L to R): Rod Lym (CAST Representative), Wanda Graves (Treasurer/Business Manager), Don Morishita (Immediate Past President), Bob Parker (President). Top Row (L to R): Richard Zollinger (Secretary), Scott Nissen (Research Section Chair), Steve Miller (WSSA Representative), Phil Banks (Education and Regulatory Section Chair), Jill Schroeder (President-elect). Not pictured: Rick Boydston (Member-at-Large)

WESTERN SOCIETY OF WEED SCIENCE FINANCIAL STATEMENT
APRIL 1, 2000 THROUGH MARCH 31, 2001 (Year-End)

INCOME	2000	2001
Registration & Membership Dues	$ 4,395.00	$29,843.00
Proceedings	917.75	3,190.00
Research Progress Report	730.93	2,592.50
Weeds of the West Book	59,198.68	
Noxious Weed Control Short Course	34,395.00	
Bio Book	496.00	
Knapweed Symposium	17,850.00	
Promotional Hats	1,118.00	
Conference evening boat cruise		2,574.00
Bank Interest	5,515.06	
Sustaining Membership Dues		6,200.00
Conference Coffee Break Contribution		2,500.00
		$ 171,515.92

EXPENSES	2000	2001
Office Supplies & Equipment	$ 428.09	
Postage, Box Rental, Bulk Mailing	2,346.70	
Telephone	527.24	
Network Solutions (Website)	735.00	
Tax Accountant	210.00	
Franchise Tax Board & Secretary of State	30.00	
F. Dan Hess Endownment Fund	500.00	
WSWS Washington Liason Rep	7,300.00	558.60
CAST Membership Dues		529.00
Sheraton/Kaui 2003 Contract Deposit	1,000.00	
Business Manager	7,300.00	
Noxious Weed Control Short Course	21,522.45	
Knapweed Symposium	509.75	
Weeds of the West Book	74,719.12	
Bio Book	1,018.95	
Wyoming Weed & Pest Council	2,000.00	
Hosted Coffee Breaks		2,500.00
Printing		
Newsletter	1,151.69	
Research Progress Reports	2,678.31	4,158.56
Proceedings	3,701.45	
Envelopes, Forms, etc.	523.80	
Programs		1,497.85
Annual Awards Luncheon	4,325.08	8,345.19
Student Awards	405.78	810.00
Award Plaques		230.70
Executive Committee Meetings	1,549.15	1,461.06
Business Meeting Breakfast		4,497.02
AV Rental		1,300.34
Conference Spouse Breakfast		439.91
Boat Rental – Conference Recreation		2,159.01
Refund-Registration Fees & Boat Ride		717.00
		$163,686.80

WESTERN SOCIETY OF WEED SCIENCE
YEAR-END FINANCIAL STATEMENT
APRIL 1, 2000 THROUGH MARCH 31, 2001

CAPITAL

2000-01 Balance Forward		$315,362.86
Current Income	7,829.12	
	$323,191.98	

DISTRIBUTION OF CAPITAL

Merrill Lynch Funds	260,365.99
Money Market Savings	51,646.35
Checking Account	11,179.64
	$323,191.98

Revolving Account Balances Included in the $323,191.98

Weeds of the West	$70,232.19	Total Capital	$323,191.98
Noxious Weed Short Course	23,884.24	Revolving Accts	163,824.75
Bio Book	52,068.07		
Knapweed Symposium	17,640.25		159,367.23

BARBRA MULLIN
FELLOW WSWS

It is a great pleasure for me to be able to recognize this individual as a Fellow of the WSWS. Her enthusiasm and tireless efforts on behalf of the WSWS and weed science in general over the years has been truly outstanding. She has served the WSWS in numerous capacities since 1982 including: Secretary-1995; President 1997; and committee's to numerous to mention. She has been a driving force behind the development and delivery of the highly successful Noxious Weed Management Shortcourse; and was instrumental in obtaining funding and in the development of the publication "Biological Control of Weeds in the West. She has also served as editor of the WSWS Newsletter and the WSWS Research Progress Report.. She recently served as the Task Force Chair for the CAST Issue paper on Invasive Plant Species published in February of 2000.

She has received numerous awards from various Federal and State organizations that have recognized her efforts in protecting federal lands from invasive species including: A Distinguished Service Award from the ARS for "Biological Control of Weeds in the West"; a special merit award from Secretary of the Interior Bruce Babitt for her part in organizing the National Non-Native Plant Meeting held in Denver; and she was also recognized by the Western Weed Coordinating Committee for outstanding leadership and service.

To sum it up I'll read a quote from a letter of support received on her behalf: "She has dedicated her professional life and a fair amount of her personal time to noxious weed management and to the WSWS. She has always been supportive of her colleagues, and through her creative educational activities has made many valuable contributions to both the WSWS and weed science." It is a great pleasure to recognize Barbra Mullin as a Fellow of the WSWS.

DR. JILL SCHROEDER
FELLOW WSWS

200I am also very pleased to recognize this individual as a Fellow of the WSWS. She has been extremely active in the WSWS for the past 13 years. She has served on numerous committees over the years, selected as Member-at-Large and has been elected to the offices of Research Section Chair and Secretary of the WSWS. She has judged student posters, served on the Program Committee and has conducted membership surveys. In addition, she and her students have given 29 presentations at WSWS meeting in the past six years.

She has been the WSWS representative to the CAST Conversations on Change Team which has involved countless hours learning techniques for enhancing services, dealing with membership issues and providing leadership training. Both WSWS and WSSA have put her skills to good use. For her outstanding commitment and service to WSWS, she received the Presidential Award of Merit in 1997.

In addition to her service to WSWS, she is active in WSSA having served as a reviewer for both Weed Science and Weed Technology, and as an Associate Editor for Weed Technology. She has also served as Secretary to the WSSA.

She leads a very creative and innovative research program that is well balance and aimed at solving practical weed management problems in several crops. She has published 23 refereed journal articles and 7 experiment station publications. Her excellent research program earned her the NMSU Distinguished Research award in 1999. She is also recognized as an outstanding teacher, teaching introductory and advanced courses in weed science. She has high expectations of her students and teaches them to synthesize information and more importantly to think.

"In summary, she has an outstanding record of service to WSWS, her students and her fellow weed scientists. She willing shares her research ideas, time, and talents, and does not toot her own horn or try to upstage her colleagues. Rather she leads by example and works for the common good in a highly professional manner." It is a pleasure to recognize Jill Schroeder as a Fellow of the WSWS.

DARREL HANAVAN
HONORARY MEMBER WSWS

It is a pleasure to recognize Darrel Hanavan as an Honorary Member of the WSWS. Although not a weed scientist by training, he has impacted many people including those of us in the WSWS in many positive ways.

As the Administrative Director of the Colorado Wheat Administrative Committee he has helped raise the general awareness of weed issues in wheat at the local and national level. He has taken a leadership role in contacting legislative personnel in Washington D.C. to obtain support for the National Jointed Goatgrass Research Program which has been funded since 1994 to the tune of $330,000 annually. His efforts to gain support from state wheat organizations and the National Association of Wheat Growers has help fund 15-20 research and technology transfer projects in 10 western states. Annually these projects have involved about 35 weed scientists and has provided in excess of 2.3 million dollars over the last 7 years. He has served as the chair of the National Jointed Goatgrass Steering Committee since 1994.

Because of Darrell's efforts, there have been two national symposia on jointed goatgrass held at the National Association of Wheat growers meetings. In 1999 Darrell presented a paper on the future direction of the National Jointed Goatgrass Research Program during a symposium held at the WSWS Meeting in Colorado Springs, Co.

Darrell has played a leading role in the promotion of herbicide-resistant wheat as a management tool for the control of jointed goatgrass and other grassy weeds. He advice and counsel on the development of herbicide-resistant wheat has been sought out by companies currently involved in development of these technologies for wheat.

In summary and I quote "I can think of no other person outside of WSWS who in recent times has made a bigger impact on weed science than Darrell Hanavan." Please help me recognize Darrell Hanavan as an Honorary Member WSWS.

2001 PRESIDENTIAL AWARD OF MERIT
JACK SCHLESSELMAN

Jack Schlesselman, Field Research and Development Representative for Rohm and Haas Company is the 2001 recipient of the Presidential Award of Merit. Jack joined the Air Force after graduation from high school and served a tour of duty in Vietnam. After finishing his hitch, Jack enrolled at Fresno State University where he earned a B.S. degree in zoology in 1971. After graduation, Jack went to work for Dr. Art Lange at the University of California's Kearney Ag Center in Parlier for 8 years. During this time Jack also pursued a Master's degree in Weed Science, which he completed in 1979. In 1980 Jack accepted a position with Rohm and Haas Company.

During his career as a field biologist at Rohm and Haas, Jack has made many significant contributions. His knowledge, expertise and professionalism in the area of field research has led directly to business success for the company. Jack has been instrumental in the continued development of Goal herbicide as an important tool for western agriculture. He has also sought out and conducted work to develop many new and interesting opportunities for Goal in minor crops. His early work with Goal on onions for example has earned him the affectionate title of "Captain Onion" within Rohm and Haas. Jack's commitment to the development of Goal on both large and small acreage crops has been at the heart of his success.

More recently Jack has played a key leadership role in the development of the new herbicide Visor, for use in the California TNV market. He was also a part of the western research and development team that successfully brought Rally fungicide to California grape and tree fruit growers. He has also conducted a great deal of field research on three new development insecticides; Confirm, Intrepid and Aphistar.

In addition to his product development expertise Jack is recognized for his expert photography skills. Jack's talent in the area of field photography has made him a significant contributor to the communication resources at Rohm and Haas. His work is utilized extensively in the preparation of advertising, sales and marketing media within the company.

To those of us in the Society, Jack has been a longtime member of the WSWS and a mainstay for the Public Relations committee. For many years Jack held the responsibility of organizing and sending information relative to the Society meetings and activities to various news media, as well as spearheading the applications for continuing education credits for consultants, crop advisors, licensed pest control advisors, and certified crop advisors from all the states in the Westerns. In addition to these activities, Jack also has served as our official photographer for many years.

OUTSTANDING WEED SCIENTIST AWARD--PUBLIC SECTOR
PHILLIP W. STAHLMAN

Dr. Phillip Stahlman is a professor and Senior Research Scientist at Kansas State University Agricultural Research Center-Hays. He received his B.S. degree at Oklahoma Panhandle State College, M.S. degree at North Dakota State University and the Ph.D. in Agronomy (Weed Science) from the University of Wyoming.

Dr. Stahlman's contributions to the state of Kansas, dryland agriculture, specifically weed science, has been most significant during his 26 years of service with the University. Several colleagues emphasized the quality of his excellent research and its practicality to help grower needs. Phil's research efforts are directed towards the efficiency and sustainability of dryland agriculture. Using an integrated approach to weed management includes the use of cropping systems, seeding rate, row spacing and variety selection in crops such as wheat, sorghum, corn and soybeans.

Phillip is recognized for his extensive research on downy brome and its impact on dryland cereal production. His published research on the biology and ecology of downy brome has been cited many times. This has led to a better understanding of the competitive nature of this weed to western Kansas wheat growers.

Phil was instrumental in the development of a four state central great plains jointed goatgrass integrated management project. This project was so well conceived, it received a special U.S. Congressional grant to support the research and technology transfer. It will provide wheat growers practical solutions for managing jointed goatgrass. This project is an excellent example of the "cooperative spirit" and respect this scientist has with his weed science colleagues. One of his other major research projects is the control of field bindweed. Kansas research that dates to the 1930's is continued by Phil's efforts to work on novel approaches in its control.

His publication credits are extensive; with a significant balance between his excellent research and extension publications. Dr. Stahlman is a frequent speaker at regional and national industry conferences.

Phil has a history with WSWS that is quite unique. He was the petitioner for Kansas state membership into the Western Society Weed Science. Since 1986 he has been an active member of the Society, serving on numerous committees, project/research chair and session moderator. Phil's interest in students, along with Paul Ogg were instrumental in developing the Student Educational Enhancement Program, which has broadened student opportunities in Weed Science.

One significant aspect of Phil's career; emphasized by his colleagues, is his strong work ethic and devotion to getting the job done and doing it correctly. We all know that is the most significant attribute of a true professional.

2001 OUTSTANDING WEED SCIENTIST AWARD--PRIVATE SECTOR
JOHN E. ORR

John Orr received his B.S. degree in Agriculture/Biology from Murray State University and followed with a M.S. from the University of Arkansas. He has been a member of the WSWW for 30 years. His service to the Society includes the Office of Secretary and numerous committee's including awards, local arrangements, site selection and resolutions. His educational input included technical papers at WSWS meetings and being an active participant in the Whats New in Industry Section.

John has been involved with weed science in the Pacific Northwest, and most recently serving as the Principal Field Development Biologist for Sygenta Corporation. During his 30 year career, John has proven himself to be committed to his organization and weed science. His involvement in extensive pesticide field evaluation has lead to the timely development of new product registration, beneficial to western agriculture. He has been instrumental in maintaining older crop registration of herbicides, so vital to minor crops in the Pacific Northwest. With the diverse knowledge of weed management in dryland and irrigated crops including field, row and specialty crops.

Several of his academic colleagues have recognized the cooperative efforts of John, to assist them in the common goal of solving weed problems of economic importance to their states. John's student enhancement efforts have been to mentor many undergraduate students as working summer interns. In this capacity he has demonstrated the professional aspect of a commercial agriculturist, stimulating many of these students to pursue graduate degrees in Weed Science and related disciplines.

John's involvement in public policy issues has included leadership in the Idaho Weed Control Association, Leadership Idaho Agriculture Foundation, Idaho Crop Production Association, Idaho Citizens for Food and Shelter, Idaho Ag Summit and membership in other professional societies.

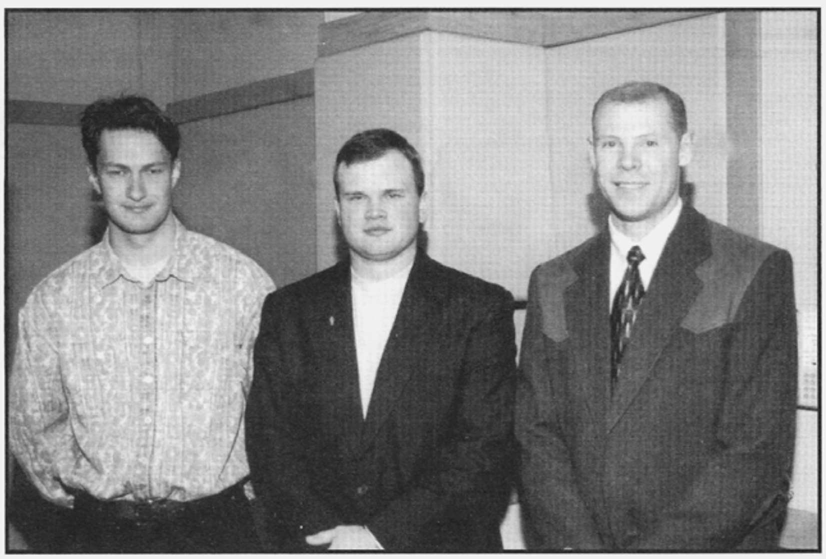
Throughout John's career he has been acknowledged for his accomplishments. The WSWS recognized his contributions with the Presidential Merit Award (1995) and he was named a Fellow in 1999. In addition, recognition has come form Idaho Crop Production Association and the Idaho Department of Agriculture Directors Cup Service Awards, 2000.

His involvement as a leader in many organizations truly demonstrates his professionalism and sincere commitment to serving the agricultural community above self.

Darrell Hanavan, Honorary Member (L), Barbra Mullin, Fellow (C), Jill Schroeder, Fellow (R)

John Orr, Outstanding Weed Scientist - Private Sector (L), Phil Stahlman, Outstanding Weed Scientist - Public Sector (C), Jack Schlesselman, Presidential Merit Award (R)

2001 WSWS STUDENT POSTER WINNERS (L to R): David Belles (1st), Todd Wehking (1st), Lynn Fandrich (2nd), Federico Trucco (2nd)



2001 WSWS STUDENT PAPER WINNERS (L to R): Oleg Daugovish (1st), Johnathon Holman (2nd), Branden Schiess (3rd). Not pictured: Lee Van Wychen (1st) and Nicole Wagner (2nd)

NECROLOGY REPORT

Dan Hess passed away August 4, 2000. Dan joined Colorado State as an assistant Professor in 1976, but his tenure was short there and he moved to Purdue in 1977. In 1985 Dan was selected as the WSSA outstanding research scientist by WSSA. Dan left Purdue in 1985 to work with Zoecon in Palo Alto, CA as the director of Plant Science Research. After the merger with Sandoz, he became the director of Biology and Biochemistry research. In 1998 he began a new agricultural research unit, AffinityAgro. He remained active as a teacher by continuing to teach at the Purdue Herbicide Action Course and the UC Davis Weed School. Dan was the President of the WSSA in 1998, and WSWS Honorary Member in 1997. He was the WSSA outstanding graduate student in 1975.Louis Jensen passed away July 11, 2000 in Logan, Utah. Mr. Jensen began his career with the Utah State Extension Service as a County Agent in rural Utah in 1946 and became an Extension Agronomist in 1953. He was heavily involved with the WSWS and served as President in 1967, and was elected a Fellow in 1979.

Larry Mitich died August 16, 2000 in Davis, CA. Larry was President of the WSSA in 1990-91 and President of the WSWS in 1987-88. Larry served 4 years as an Assistant Professor of Agronomy at the University of Kabul in Afghanistan in the mid –1950s, in a project sponsored by the University of Wyoming. He joined North Dakota State University as an Extension Agronomist in 1963 and served as the first extension weed scientist in North Dakota. In 1980 Larry joined the University of California, Davis as an Extension Specialist. He was editor of the *NCWSS Research Report* and *NCWSS Proceedings* for many years. For his years of service with the NCWSS Larry received the Distinguished Service Award in 1978 and was named an Honorary Member in 1981. In the Western Society of Weed Science, he served on several committees and on the Board of Directors. Larry was WSWS program chair, and society president during 1986-88. He was named a WSWS Fellow in 1991, and Outstanding Weed Scientist in 1995. Larry had been an active member of WSSA since 1963. He served as chairman of several committees, and as editor of the *WSSA Newsletter* and *Weeds Today*. He served as an associate editor for Weed Technology and until the time of his death he was a regular contributor to the feature article "Intriguing World of Weeds". Dr. Mitich received the WSSA Extension Worker Award in 1978 and was named a WSSA Fellow in 1983. He served as WSSA vice president, program chair and president between 1988 and 1991.

Clarence I. Seeley died Tuesday November 28, 2000, in Moscow, Idaho. Clarence started working for the USDA in 1936 and was one of the original four "weed investigators" employed by the USDA as a result of the historic Bindweed Investigations Appropriations Bill of 1936. In 1947, he joined the Agronomy Department at the University of Idaho as an agronomist and weed scientist and worked there until his retirement in 1976. Clarence was a charter member of the Weed Science Society of America and served on many committees, including four years on the executive committee. He had been a member of the Western Society of Weed Science almost since its inception and served as its president in 1954. He was elected a Fellow of the Society in 1975. He also was a member of the Idaho Weed Control Association and served on the Board of Directors for many years.

Scott Stenquist died Tuesday evening, January 23, 2001, in his Gresham home. Scott's professional career stretched across the National Wildlife Refuge System including Fish Springs, Great Swamp, Tinicum, Upper Mississippi, Umatilla, and Ankeny NWRs. Most recently, Scott worked as the Pacific Region's Integrated Pest Management Coordinator addressing a variety of critical projects and issues. Of special note was Scott's leadership role in development and implementation of a formal integrated pest management program for the Klamath Basin Refuges in southern Oregon and northern California, a technically complex and politically very controversial issue. Although Scott was regionally based, he regularly operated outside of those boundaries and at the national level made significant contributions, including projects on the control of purple loosestrife, salt cedar and mosquitoes.
Dean Swan, retired Extension Weed Specialist at Washington State University passed away suddenly on October 1, 2000. Dean taught high school in Chadron, Nebraska from 1952-1953. After earning his master's degree, Dean was employed by Oregon State University at the Pendleton Experiment Station from 1954 to 1965. He received his Ph.D. from the University of Illinois in 1965 and spent one year on the faculty at the University of Arizona in Tucson before returning to the Pacific Northwest in 1966 as the Extension Weed Specialist at Washington State University in Pullman. Dean stayed in this position until his retirement in 1989. In addition to his years of distinguished service to eastern Washington farmers, he is probably best known for his skill at preparing and photographing weed specimens. Many of his photographs were entered into the WSSA Photo Contest over the years and appear in Western Society of Weed Science and Weed Science Society of America publications. Together with Rowena, Dean spent an active retirement traveling extensively, working on various publications, and returning to WSU in 1996 to co-teach the introductory weed science course.

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