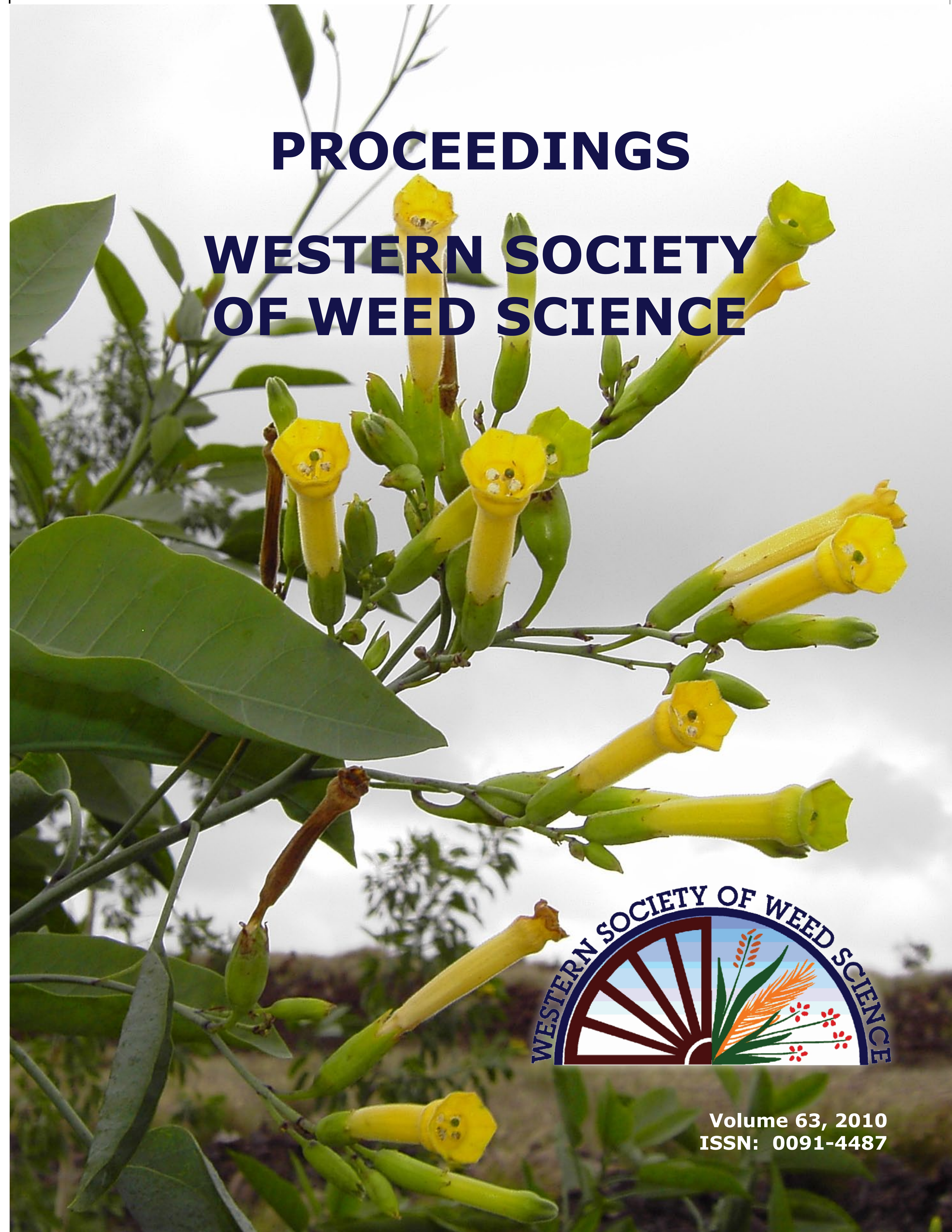
WSWS 2010 PROCEEDINGS VOLUME 63



PROCEEDINGS

WESTERN SOCIETY OF WEED SCIENCE

Volume 63, 2010
ISSN: 0091-4487

OFFICERS AND EXECUTIVE COMMITTEE (2010-11)

President	Joe DiTomaso
President-Elect	Vanelle Peterson
Immediate Past President	Jesse Richardson
Secretary	Rick Boydston
WSSA Representative	Tim Miller
Research Section Chair	Brad Hanson
Education Section Chair	Marvin Butler
Members-at-Large	Kassim Al-Khatib (Public Sector) Peter Forster (Private Sector)
Treasurer-business Manager	Phil Banks
Research Section Chair-Elect	Joe Yenish
Education Section Chair-Elect	Tim Prather
Cast Representative	Phil Stahlman
Constitution and Operating Procedures Representative	Corey Ransom
Webmaster, Web Editor	Tony White
Student Liaison	Tanya Skurski

Sustaining Members

AMVAC Chemical Corp.

Arysta LifeScience

BASF Corp.

Bayer CropScience

Dow AgroSciences

DuPont Crop Science

FMC

Gowan Co.

Helena Chemical Co.

Marathon Agricultural & Environmental Consulting

Monsanto Co.

Novozymes Biologicals, Inc.

PBI Gordon Corp.

Syngenta Crop Protection

Valent USA Corp.

Wilbur-Ellis Co.

Winfield Solutions LLC

2010
PROCEEDINGS
OF
THE WESTERN SOCIETY OF WEED SCIENCE

VOLUME 63

PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 8-11, 2010

WAIKOLOA BEACH MARRIOTT

WAIKOLOA, HAWAII

PREFACE

The Proceedings contain the written summary of the papers presented at the 2010 Western Society of Weed Science Annual Meeting plus summaries of the research discussion groups. The paper number located in brackets at the end of each abstract corresponds to the paper number in the WSWS Program. Authors and keywords are indexed separately. Index entries are published as received from the authors.

Copies of this volume are available from WSWS Business Manager, 205 W. Boutz, Bldg. 4, Suite 5, Las Cruces, NM 88005.

Cover photograph, Tree tobacco (*Nicotiana glauca*) by Phil Motooka.

Proceedings Co-Editors: Joan Campbell and Traci Rauch

TABLE OF CONTENTS

Title **Page**

POSTERS
Change in Broom Snakeweed Populations Over a 30-year period in New Mexico 1
Soil microsite variation of salt desert shrublands invaded by downy brome in Utah......................1
Strategy for Restoring Central Oregon Rangeland from Medusahead and Cheatgrass to a Sustainable Bunchgrass Environment..2
A neural network approach to predicting the occurrence of rush skeletonweed and yellow starthistle in the intermountain northwest. 2
Physiological Behavior of Aminocyclopyrachlor in Rush Skeletonweed (*Chondrilla juncea*).....3
Yellow Toadflax Control in Rangeland with DPX-MAT28..4
Postsenescence Herbicide Timing Gives Most Effective Control of Dalmatian Toadflax 4
Control of Dalmation and Yellow Toadflax over Five Years in Northern Colorado and Southern Wyoming..5
Prickly Pear Cactus Control with Fluroxypyr..5
Horseweed and Fleabane Control Studies in Non Crop Areas in the San Joaquin Valley..............6
Leafy Spurge Control with Tankmixes of Imazapic and Saflufencil applied in Spring..................7
Leafy Spurge Control with Tankmixes of Imazapic and Saflufencil applied in Fall. 7
Feral Rye Control on Colorado Rangeland..8
Tebuthiuron Use in Firebreak Installation and Maintenance..8
Herbicide Tolerance in Grasses and Native Forb Species. 9
Integrated Strategies for Controlling Scotch Broom (*Cytisus scoparius*) 10
Ecophysiology of the Rangeland Weed *Berteroa incana* (Hoary Alyssum)...............................10
Comparison of qualitative turf evaluations to quantitative methods for measuring weed pressure and turf quality..11
Increased Weed Seed (*Panicum miliaceum* and *Amaranthus retroflexus*) Predation in Response to Increased Populations of Pterostichus melanarius in a Controlled Field Experiment.........11
Effects of cover crops and cultivation in a young organic vineyard...12
Field Testing of Organic Herbicides..13
Dose response of weed seed and soil-borne pathogens to the fumigant dimethyl disulfide..........13
Flumioxazin Use Patterns in the Western US..14
Weed control using a stale seedbed method for processing cucumber and green pea. 14
Pigweed Control in Double Cut Peppermint and Spearmint with Sulfentrazone 15
Indaziflam for Residual Weed Control in Perennial Crops. 15
Indaziflam – A New Herbicide for Grass and Broadleaf Weed Control in Tree, Nut, And Vine Crops...15
Soil Interaction and Biological Activity of Pyroxasulfone..16
Efficacy of Postemergence Herbicides with a Light Activated, Sensor Control (LASC) Sprayer in Chemical Fallow in the Pacific Northwest. 16
Efficacy of novel triallate formulations affected by soil properties. 17
Effect of a Novel Adjuvant on Postemergence Herbicides. 17
Grass weed control in native species used for biofuel production...18
Horsetail *(Equisetum* spp.) Response to Herbicides and Mowing...18
Purple Nutsedge Management in Desert Alfalfa. 19

Tolerance of Ten Potato Varieties to Three Herbicides: Trial Set-up, Data Collection, and Results. 20
Wild Buckwheat Control in Dicamba Tolerant Soybeans. 20
Winter Wheat Response to Soil Residues of Aminocyclopyrachlor. 21
Winter Wheat Response to Aminocyclopyrachlor Methyl Ester as a Summer Fallow Burndown Treatment. 22
Spray additive effect on winter annual grass response to imazamox. 22
Winter Wheat Varieties Response to Mesosulfuron Applied Under Adverse Environmental Conditions in Idaho, Oregon and Washington. 23
Preemergence Applications of Saflufenacil and Flucarbazone in Spring Wheat. 24
Soybean Double Crop Rotation Response to Spring Applied Pyroxsulam in Winter Wheat. 24
Downy Brome Response to Soil Applied Herbicides. 24
Preharvest Herbicide Applications in Spring Wheat: Effects of Application Timing on Wheat Yield and Germination. 25
Downy Brome Control in Winter Wheat with Fall or Spring Herbicide Treatments 25
Impact of Application Timing of Pyroxsulam and Standards on the Control of Downy Brome in Montana. 26
The Critical Period of Weed Control in Chickpeas. 27
Response of Dry Beans to Plant Population and Row Spacing in Wyoming. 27
Weed Control and Chickpea Yield with Preplant and Preemergence Herbicide Application Timings 28
Dry bean response to flumioxazin 28
Weed Control and Pulse Tolerance to Soil-Applied Herbicides 29
Guayle Tolerance to Topical Herbicide Applications. 30
Small Burnet Tolerance to Several Herbicides. 31
Regional Summary of Millet Tolerance to Preemergence Saflufenacil. 31
Glyphosate-Resistant Kochia in Kansas: Fact or Fiction? 32
Control of Group 2 (ALS) Resistant Kochia (*Kochia scoparia*)in Spring Wheat (*Triticum aestivum*). 33
Fungicide and Insecticide Tank Mixtures With Glyphosate on Roundup Ready Sugar Beet. 33
Glyphosate tank mixtures for resistance management in Roundup Ready sugar beet. 34
Benchmark Study: Perspectives on Glyphosate-Resistant Crops and the Sustainability of Chemical Weed Management. 35
Weed Seedbank Response to Seven Continuous Years of Roundup Ready Corn. 36
Spatial Distribution of Enhanced Atrazine Degradation across North-Eastern Colorado: A Survey 36
Using a Sub-meter GPS to Facilitate Trial Data Collection. 37
Establishing Weed Prevention Areas and Evaluating Their Impact. 37
A Comparative Analysis of Water-Use by Greenhouse-Grown Weeds Commonly Found on the Leasburg Canal System in Southern New Mexico. 38
Relationship Between Flowering Time and Glyphosate Susceptibility in Common Lambsquarters. 38
Effect of soil moisture on bioavailability of acetanilide herbicides. 39
Inheritance and Metabolism of 2,4-D Resistance in Prickly Lettuce. 39

GENERAL SESSION 40

PROJECT 1: WEEDS OF RANGE AND NATURAL AREAS

Aminocyclopyrachlor A New Herbicide for Vegetation Management, Development, and Registration Update. 41
Aminocyclopyrachlor and Aminocyclopyrachlor Blend Products for Weed and Brush Control in Non-Crop Sites....................41
Control of invasive and troublesome weeds with aminocyclopyrachlor in North Dakota. 41
Aminopyralid and Aminocyclopyrachlor Impacts on Grass Establishment. 42
Salt Cedar and Russian Olive Control With Aminopyralid Containing Herbicide Treatments . ..43
Control of Russian Olive with DPX-MAT 28 and Other Herbicides in Northeastern Arizona. ...43
Russian Olive Control in Big Horn County, Wyoming. 44
Aminopyralid herbicide effects on Canada thistle and native vegetation in a seasonally wet meadow. 44
Aminopyralid for Preemergence Weed Control on Rights-of-Way and Rangeland. 45
Native Forb and Shrub Tolerance to Aminopyralid. 45
Management of meadow hawkweed in perennial grasslands.. 46
Effects of Vegetation Control with herbicides on Early Forest Community Development in the Pacific Northwest. 47
Susceptibility of yellow archangel (*Lamiastrum galeobdolon*) to herbicides. 48
Pernicious Weed Management with New Products in Texas Pasturelands.. 48
Endothall Concentration Profiles Following Applications in Irrigation Canals for Sago Pondweed Control. 49
Field Bindweed Control in Winterfat Seed Production Fields. 50
Efficacy of mechanical and herbicide control methods for tree tobacco (Nicotiana glauca). 50
Controlling Downy Brome on Montana Rangeland. 51
Potential of Tebuthiuron for Downy Brome Control on Western Rangeland. 51
Managing Downy Brome Seed Production and Litter to Exhaust its Soil Seed Reserve. 52
Post-fire cheatgrass dynamics in the southern Wind River Range of Wyoming. 53
Soil seedbank changes following leafy spurge (*Euphorbia esula* L.) control with Aphthona spp. Biocontrol agents. 53
Influence of prescribed fire on Canada thistle (*Cirsium arvense*) control and native grass and forbs production. 54
Soil Moisture Stress Tolerance of a Leading Perennial Biofuel Grass is Similar to the Invasive Plant Giant Reed. 54
The Role of Disturbance in Terrestrial Plant Invasions. 54

PROJECT 2: WEEDS OF HORTICULTURAL CROPS

Southwestern Cupgrass Control in Turfgrass 55
New Products for Weed Management in Texas Turf. 55
Performance of Indaziflam For Broadspectrum Residual Weed Control. 56
Indaziflam - A New Herbicide For Preemergent Control of Grass and Broadleaf Weeds in Perennial Crops. 56
Indaziflam - A New Pre-emergent Herbicide for Weed Control in Turf, Ornamentals, and Industrial Areas. 57
Pre-emergence herbicide screening for transplanted *Sporobolus virginicus* (L.) Kunth plugs, a native Hawaiian grass with roadside re-vegetation potential. 58
Penoxsulam - New Residual Herbicide for Use in Tree Nut Crops. 58

The Response of Weeds and Cut Stems of *Sporobolus virginicus* (L.) Kunth (a Native Hawaiian Ground Cover) to Two Forms of Oxadiazon Applied as a Component of a Hydromulch Cap in a Simulated Planting for Roadside Establishment. 59
Flumioxazin and V-10206 for Weed Control in Potato. 59
Hairy nightshade control with fomesafen in cucurbits. 60
Using Activated Carbon as a Safener for Pre-emergence Applied s-Metolachlor and Dimethenamid-p on Direct Seeded Dry Bulb Onions. 60

PROJECT 3: WEEDS OF AGRONOMIC CROPS
Optimum® GAT® Corn – Herbicide Programs for the Western States. 61
Optimum® GAT® Soybeans – Herbicide Programs for the Western States. 61
PulsarTM: New Herbicide for Broadleaf Weed Control in Wheat and Barley.. 62
Crop Susceptibility to Aminopyralid Soil Residue. 62
Group 2 Herbicide Resistance in a Direct Seed Wheat Cropping System. 62
The First Report of Glufosinate-resistance in Weed Species 63
Sulfonylurea and Quizalofop Tolerance Traits in Sorghum - New Weed Management Tools for Sorghum Production. 64
Vernalization Effects on Imazamox Translocation and ALS Activity in Feral Rye. 64
Herbicide Resistant Sorghum: New Opportunities for Weed Management. 65
Dry Pea, Chickpea, and Lentil Cultivar Tolerance to PPO-Inhibitors 65
Weed Management in GAT Corn and ALS-tolerant Sorghum in Central Texas. 66
Benchmark Study: Variation in Weed Management Tactics Implemented in Glyphosate-Resistant Cropping Systems. 67
Benchmark Study: Impact of Glyphosate-Resistant Crops on Seedbank and Weed Population Density. 68
Glyphosate Resistant Corn Control in Glyphosate Resistant Sugarbeet. 69
The Importance of Crop Fertilization Programs on Weed Management. 69
Broadleaf Weed Management in Seedling Grasses Grown for Seed. 70
The Requirements to Have Success With Skip-Row Corn. 71
Chateau SW Herbicide in CA Alfalfa - Findings From 2009 Grower Demo Trials. 72
Volunteer corn competition and control in dry edible beans. 72
The Critical Period of Weed Control in Lentils. 72
Saflufenacil and sufentrazone combinations for broadleaf weed control in chickpea 73
Saflufenacil Efficacy in Lentil and Field Pea on the Canadian Prairies. 74
Utilization of Fall applied Flumioxazin in Spring Seeded Pulse Crops. 74
High Speed Photography and Video for Comparison of Nozzles and Adjuvants for Spray Coverage and Reducing Spray Drift. 75
Adjuvant Enhancement of Optimum GAT Herbicides. 75
DRT Implications for Weed Control. 76
Comparisons of New Nozzle Types for Improved Weed Control. 76
Influence of Water Volume/Spray Pressure on Weed Control in Cotton, Trees, and Ditchbanks in California. 77
Development of a Residual Use Pattern for Flucarbazone-Sodium. 78
Thiencarbazone-methyl Combinations for PRE and Postemergence Weed Control in Western Corn. 79

Broadleaf Weed Control in Field Corn with Preemergence Followed by Sequential Postemergence Herbicides. 79
Corn Response to Nitrogen and Timing of Weed Control. 80
Performance of Pyrasulfotole Combinations for Grass and Broadleaf Weed Control in Northern Plains Cereals. 80
Amaranthus Control with Pyrasulfotole in Grain Sorghum. 81
Progress of the Okanola Project for managing weeds in wheat. 82
Tumble Mustard Control in Jagaline Winter Wheat 82
Fumitory Control in Winter Wheat. 83
Evaluation of Flumioxazin Applied Pre-plant for Weed Control in Winter Wheat 83
Management of Difficult to Control Grass Species with Mesosulfuron-methyl plus Propoxycarbazone in Wheat Grown in the Northern Plains. 84
Pyroxsulam Efficacy on Tough-to-Control Bromes in Central Plains Winter Wheat. 84

PROJECT 4: TEACHING AND TECHNOLOGY TRANSFER
Winter Wheat Meetings and Plot Tours. 85
WSSA Subject Matter Expert for the Office of Pesticide Programs at the USEPA: Goals, Activities, Vision. 86
25 Years of Pesticide Use Surveys - What Have We Learned?. 86
Grower, Crop Advisor, and Extension Agent Perceptions about Glyphosate Resistant Weeds in Kansas. 87
The Value of Systematic Survey for Invasive Plants in an Early Detection/Rapid Response Program. 88
Establishing Priority Weeds for Early Detection and Rapid Response (EDRR) Education in Nevada. 88
Audience Response Systems as a Pesticide Education Tool. 89

PROJECT 5: BASIC BIOLOGY AND ECOLOGY
MCPA-ester Improves Feral Rye Control with Imazamox. 89
Amimocylcopyrachlor Methyl Ester Volatility. 90
Resistance to Glyphosate in a Palmer Amaranth (*Amaranthus palmeri*) Population from New Mexico. 90
Characterization of Rubber Production in Eastern Washington Prickly Lettuce Biotypes. 91
Detection and Persistence of Imazethapyr in a Palouse Silt Loam 91
Weed Seeds and Ground Beetles: how agronomic management influences community dynamics and seed predation. 92
The Effect of Insect Herbivory on Performance of Common Mullein (*Verbascum thapsus*). 93
The Current Status of Kochia Research in the Central Great Plains. 93
Efficacy of Preemergence Herbicides in California Bell Peppers. 94
Evaluation of an In-Row Robotic Cultivator in Vegetable Crops. 94
Kochia Origin, Biology, and Distribution. 95
Genetic Diversity of Kochia. 96
Kochia prostrata: Weed or Drought Tolerant Forage. 96
Kochia and the Triazines - Past and Present. 97
Development and Spread of ALS-Herbicide Resistant Kochia. 97
History and Current Status of Dicamba Resistant Kochia in the Central Great Plains. 98

Suspected Glyphosate Resistance in Kansas. 99
Confirming Glyphosate Resistance in Kochia. 99
Kochia's Ability to Rapidly Adapt to Different Selection Pressures Makes the Plant a Long-term Survivor..100
Kochia growth according to ALS (AHAS) Mutation 101
Kochia with ALS (AHAS) Mutations: an Allometric Analysis of Manitoba accessions............101

PRESIDENTIAL ADDRESS 103

EDUCATION AND REGULATORY SECTION...106

DISCUSSION SECTIONS
Project 1: Weeds of Range and Natural Areas..107
Project 2: Weeds of Horticultural Crops..108
Project 3: Weeds of Agronomic Crops 109
Project 4: Teaching and Technology Transfer..111
Project 5: Basic Biology and Ecology 111

FINANCIAL REPORT..113

FELLOWS, HONORARY MEMBER, AWARDS...115

STUDENT AWARDS 123

NECROLOGY 126

MEETING REGISTRATION 127

AUTHOR INDEX 137

KEYWORD INDEX 141

COMMITTEE LIST 146

SUSTAINING MEMBERS .... INSIDE BACK COVER

POSTER SESSION

CHANGE IN BROOM SNAKEWEED POPULATIONS OVER A 30-YEAR PERIOD IN NEW MEXICO . Kirk C. McDaniel* and L. A. Torell, New Mexico State Univ., Las Cruces, NM.

In New Mexico, research investigating changes in broom snakeweed populations at 9 locations was initiated in 1979 and was continuously monitored through 2009. Three study locations were distributed in each of the states important rangeland ecological provinces including the Chihuahuan desert, and the NE, NW and central Plains and Prairie regions. When the study began sites supported moderate to dense broom snakeweed populations. Data for this study was gathered annually at the end of the growing season to determine changes in broom snakeweed canopy cover, yield, and density, and to estimate associated grass standing crop. Ten permanent sample quadrats (30 by 60 cm) were sampled in two study plots at each location. This information was further used to define equations that related grass biomass data to the amount of broom snakeweed occupying study areas over time. Depending on location, an exponential or a five parameter sigmoidal growth equation best expressed the relationship between understory grass biomass and overstory broom snakeweed yield. The overstory - understory relationship for broom snakeweed and blue grama grasslands we studied had the same negative curvilinear shape that has been observed for many other woody and herbaceous plants. As indicated by the predictive equations, when broom snakeweed canopy cover exceeds 5 to 8%, then herbage growth becomes highly suppressed. Precipitation data from nearby NOAA weather sites was also examined to determine how seasonal rainfall patterns influenced broom snakeweed propagation and mortality at specific sites. Above average 2nd-quarter precipitation was most important for recruitment success whereas 3rd quarter rainfall was vital for plant longevity. Our data indicates that broom snakeweed populations are primarily influenced by localized rather than region environmental events. The literature often describes broom snakeweed populations as cyclic but this may be simplistic or a misnomer as local snakeweed populations are driven by key soil moisture and temperature variables that are different across broad regional areas. (Published with approval of the New Mexico Agricultural Experiment Station). [1]

SOIL MICROSITE VARIATION OF SALT DESERT SHRUBLANDS INVADED BY DOWNY BROME IN UTAH. Thomas A. Monaco*, USDA-ARS, Logan, UT; and Merilynn Hirsch, Utah State University, Logan.

Salt desert shrublands in the Great Basin of North America have been invaded by downy brome in the last 30 years. Restoring these ecosystems with desirable plant species often results in partial success, suggesting that considerable variability in soil properties may exist. We hypothesized that: 1) Soil properties could be used to quantitatively define soil microsites; and 2) These microsites would vary in the abundance of downy brome across a landscape. A total of 224 downy brome-dominated patches within a 10-km2 area in Park Valley, Utah were identified in 2009 and monitored for plant cover and 18 soil properties. Hierarchical clustering was performed on soil variables to produce a dendrogram to define four distinct clusters. Clusters were designated as soil microsites and used as the dependent variable to analyze differences between a select set of soil properties that met the assumptions of a statistical analysis. According to hypothesis one, microsites varied significantly ($P < 0.05$) for soil water content, pH, infiltration rate, and total nitrogen and carbon. Hypothesis two was similarly supported as soil microsites also varied significantly ($P < 0.05$) for percentage downy brome cover. Microsites with the highest downy brome cover had significantly ($P < 0.05$) lower soil water content and higher pH, sand content, soil nitrate, and total soil nitrogen. This microsite assessment suggests that downy brome abundance is indeed dependent on key indicators, which may serve as predictors of invasion across landscapes, and the forecasting of restoration success. [2]

STRATEGY FOR RESTORING CENTRAL OREGON RANGELAND FROM MEDUSA-HEAD AND CHEATGRASS TO A SUSTAINABLE BUNCHGRASS ENVIRONMENT. Marvin D. Butler* and Kandy J. Marling, Oregon State University, Madras.

Annual grassy weeds medusahead (*Taeniatherum caput-medusae*) and cheatgrass (*Bromus tectorum*) are capable of crowding out bunchgrasses, leaving rangelands with little feed for cattle and more prone to devastating fires and soil erosion. Two sets of plots were established at two locations north of Madras, Oregon, one where bunchgrasses remained despite significant populations of medusahead and a second where few bunchgrasses were present. Herbicide treatments only were applied to the first set of plots, with herbicide applications followed by planting of six bunchgrass species to the second set. Herbicide only applications controlled medusahead and cheatgrass, and without this competition bunchgrass size increased. Inadequate moisture following two late herbicide applications plus planting resulted in poor performance of Matrix and Landmark and poor stand establishment of 6 bunchgrass species during the spring of 2008. Moderate stands were established during the spring of 2009. The best performing bunchgrasses were Sandberg's bluegrass, crested wheatgrass and Sherman big bluegrass. Residual herbicide efficacy deminished during the second season, but continued to provide a significant reduction in competition from annual grasses in both the herbicide only plots and herbicide followed by planting of bunchgrasses. [3]

A NEURAL NETWORK APPROACH TO PREDICTING THE OCCURRENCE OF RUSH SKELETONWEED AND YELLOW STARTHISTLE IN THE INTERMOUNTAIN NORTHWEST. . Larry Lass*, Bahman Shafii, Tim Prather, William Price, Stephan Cook, University of Idaho, Moscow, Steve Radosevich, Oregon State University, and Woodham Chung and Tyron Venn, University of Montana.

Weed occurrence models are increasing our understanding of potential land management implications with prediction of current and future distributions. Methodology for integrating ecological and topographic information has provided an accurate estimate of occurrence, but addition of anthropogenic data describing human activities, i.e. transportation right-of-way, campgrounds, trail heads, and logging operations, presented problems. This research applies a method for multi-scale and multi-type spatial data integration in predicting the likelihood of occurrence of yellow starthistle and rush skeletonweed in central Idaho. The method uses a back propagation algorithm to train multi-layer data in a feed-forward artificial spatial network. The model operates without parametric assumptions allowing the characterization of data containing non-linear relationships and inherent dependence of the variables. It becomes a powerful tool for integrating secondary data related to human activities that influence the risk of weed invasion. The performance of spatial back-propagation neural network models are compared to logistic regression using ecological and topographic data and assessed with Relative Operating Characteristics (ROC) statistics. The addition of highway corridors showed increased estimated likelihood of occurrence for both yellow starthistle and rush skeletonweed. The addition of county roads and streets with a 100 m buffer produced a lower estimated occurrence as compared to the 20 m buffer. This suggests that estimating right-of-ways distance is critical to understanding how transportation routes may be added to an artificial spatial network model. [4]

PHYSIOLOGICAL BEHAVIOR OF AMINOCYCLOPYRACHLOR IN RUSH SKELETON-WEED (*CHONDRILLA JUNCEA*). Jared Bell*, Ian C. Burke, Washington State University, Pullman; Tim Prather, University of Idaho, Moscow, and C. William Kral, Dupont Crop Protection, Twin Falls, Idaho.

Aminocyclopyrachlor is a new growth regulator type herbicide being developed for broadleaf weed control in non-crop and rangeland systems. Two formulations were studied, the acid (DPX-MAT28), and its methyl ester derivative (DPX-KJM44). Field efficacy studies were also conducted to evaluate application timing effects in rush skeletonweed (*Chondrilla juncea*). An experiment was established near Cambridge, ID in sagebrush-steppe with DPX-MAT28 and DPX-KJM44 applied at the rosette stage on Nov. 17, 2008. DPX-MAT28 was applied at three rates 70, 140, and 210 g ai/ha while DPX-KJM44 was applied at a single rate, 202 g ai /ha. Rush skeletonweed rosette density was evaluated in the fall, November 16, 2009, to determine treatment effects on rosette recruitment. Rosette density in each treatment by application timing did not differ in comparison to the nontreated check. At similar rates, DPX-MAT28 had lower rosette density than DPX-KJM44. To better understand the physiological behavior of aminocyclopyrachlor acid in comparison to the ester and to determine cause of the discrepancy between the two formulations applied at similar rates, absorption, translocation, and metabolism of the two formulations was studied in rush skeletonweed. Rush skeletonweed plants were grown from rhizome fragments in 75/25 sand/potting soil mixture. At the 4 to 5 leaf stage, the adaxial side of the newest fully expanded leaf was covered. Plants were treated with a non-radiolabeled mixture containing 210 g ai/ha of either herbicide and a nonionic surfactant at 0.25% v/v using a carrier volume of 300 l/ha. Immediately after application, 5 0.5-µL droplets containing a total of 5.83 kBq radioactive herbicide were spotted on the formerly covered leaf. Plants were harvested at 2, 4, 8, 24, or 72 h after treatment (HAT), divided into five parts (above treated leaf, below treated leaf, crown, root, and treated leaf), frozen, and the individual plant parts extracted into methanol. Herbicide metabolites were separated on TLC plates and visualized using a TLC plate reader capable of detecting 14C. In absorption and translocation studies, absorption of DPX-MAT28 and DPX-KJM44 by rush skeletonweed was 54% and 68% of applied material at 72 HAT. Regression of total translocation of applied DPX-KJM44 was greater than DPX-MAT28 at 72 HAT, but more DPX-MAT28 had translocated at 24 HAT. Only the two parent compounds were observed in treated leaf extracts. The methyl ester was rapidly de-esterified to the acid with 68.6% ester remaining in treated leaves 2 HAT and 17.9% 72 HAT. No detectable ester was found in plants 72 HAT from extracts of above treated leaves. Aminocyclopyrachlor acid appears to be the major form of translocated herbicide throughout the plant. By applying the acid formulation, more parent compound is translocated in the first 24 HAT. The de-esterification step limits the available acid for translocation in the same time period. [5]

YELLOW TOADFLAX CONTROL IN RANGELAND WITH DPX-MAT28. Brian M. Jenks, North Dakota State University, Minot.

Yellow toadflax (*Linaria vulgaris* P. Mill.) has spread over hundreds of acres of rangeland in western North Dakota that were previously infested with leafy spurge. Leafy spurge was controlled 10-20 years ago through biological and chemical means. Given less competition, yellow toadflax has now replaced one yellow flowered noxious weed with another. The objective of this study was to evaluate DPX-MAT28 (aminocyclopyrachlor) for yellow toadflax control in rangeland compared to picloram. DPX-MAT28 is an experimental herbicide being developed by DuPont for weed control in rangeland, pasture, and non-cropland areas. Treatments were applied at the vegetative stage (Jul 25), flowering stage (Sep 11), and in late fall (Oct 16) of 2008. Treatments were applied to 10 by 30 ft plots with a hand boom using standard small plot procedures. The treatments were evaluated for percent visual control in July 2009. Weed density was recorded prior to application in 2008 and again in July 2009. Picloram provided 23-60% visual control of yellow toadflax and reduced toadflax density 6-55%. DPX-MAT28 at 1.5 oz provided 90-95% visual control and reduced density 84-98%. DPX-MAT28 at 3 oz provided 100% visual control and reduced density 100%. DPX-MAT28 at 2 oz tank mixed with chlorsulfuron provided 99-100% visual control and reduced density 99-100%. Grass injury from all treatments was 6% or less. [6]

POSTSENESCENCE HERBICIDE TIMING GIVES MOST EFFECTIVE CONTROL OF DALMATIAN TOADFLAX . Guy B. Kyser* and Joseph M. DiTomaso, University of California, Davis.

Dalmatian toadflax is an herbaceous perennial listed as a noxious weed in most western states. It grows best on coarse, dry soils in cool, semi-arid climates. This study was conducted in high desert scrub near Gorman, CA. We applied broadcast treatments with selective soil residual/foliar herbicides at three stages: early rosette (16 Jan 2008), bolting (22 Apr 2008), and postsenescence (18 Nov 2008). Plots were 3 m x 6 m in a randomized complete block design with four replications. All treatments were applied in 25 gpa with a CO2 backpack sprayer and 3-m boom with six 8002 nozzles. Plots were rated the following spring at bolting (22 Apr 2009) and peak flower (4 Jun 2009). We evaluated percent cover of Dalmatian toadflax and presence/absence of other common species, e.g., native subshrubs and perennial grasses. Two-factor ANOVA of Dalmatian toadflax cover (timings x treatments) showed that dormant applications gave the greatest control of Dalmatian toadflax (13% cover overall, compared to 19%, 22%, and 30% cover for rosette and bolting stages, and untreated control, respectively). Over all treatment times, aminocyclopyrachlor (4 oz a.i./ac) gave the best results (7.5% cover), followed by imazapyr at 12 oz a.i./ac (9.1%) and picloram at 8 oz a.i./ac (12.1%). However, imazapyr caused excessive injury to desirable species, and aminocyclopyrachlor and picloram are not registered in California. Chlorsulfuron (1.5 oz a.i./ac), aminopyralid (3.5 oz a.i./ac), and aminocyclopyrachlor (2 oz a.i./ac) reduced Dalmatian toadflax cover by about 50% over all treatment times. In postsenescence applications, the most effective treatments – imazapyr (12 oz a.i./ac), aminocyclopyrachlor (4 oz a.i./ac), and aminopyralid (3.5 oz a.i./ac) – reduced Dalmatian toadflax cover to 0.4%, 0.8%, and 3.0%, respectively, compared to 30% in untreated controls. [8]

CONTROL OF DALMATION AND YELLOW TOADFLAX OVER FIVE YEARS IN NORTHERN COLORADO AND SOUTHERN WYOMING. Jim T. Daniel, Consultant Keenesburg,CO; John D. Cantlon* and Ronnie Turner, DuPont Crop Protection, Lakewood, CO; and George Beck, Colorado State University, Fort Collins, CO.

Control of Dalmation and Yellow Toadflax over Five years in Northern Colorado and Southern Wyoming. Jim T. Daniel, Consultant for DuPont Land Management, Keenesburg, CO; John D. Cantlon and Ronnie Turner, DuPont Land Management, Lakewood, CO; and George Beck, Colorado State University, Fort Collins, CO. Six demonstration trials on dalmation toadflax and five research trials on yellow toadflax were conducted across southern Wyoming and northern Colorado over the past five years (2004 – 2009). Chlorsulfuron at 0.375 to 1.5 ozai/A and chlorsulfuron at 0.75 ozai/A plus picloram at 0.31 lbae/A were evaluated on dalmation toadflax. All applications were applied in the fall to rosettes. Chlorsulfuron at 1.125 ozai/A and higher rates gave excellent control of dalmation toadflax at all locations. Several herbicides and herbicide combinations were applied to yellow toadflax. The majority of yellow toadflax treatments were centered on chlorsulfuron and chlorsulfuron plus picloram programs. Results on yellow toadflax were somewhat dependent upon location. Generally, chlorsulfuron plus picloram programs and higher rates of chlorsulfuron alone (1.9 to 2.25 ozai/A) were effective. DPX-KJM 44 was also evaluated on yellow toadflax. Three ozai/A of DPX-KJM 44 provided good yellow toadflax control in one trial. [9]

PRICKLY PEAR CACTUS CONTROL WITH FLUROXYPYR. Darrell L. Deneke*, Michael J. Moechnig, David A. Vos, and Jill K. Alms, South Dakota State University, Brookings.

Bigroot pricklypear (*Opuntia macrorhiza*) is often a troublesome weed in heavily grazed pastures, but can also be a problem in environmentally sensitive areas such as turf grass or near trees. Picloram is commonly used to control pricklypear in pastures, but few herbicide options are available for environmentally sensitive areas. Fluroxypyr is registered for use in pastures, cool season turf, and non-crop areas and some products are registered for pricklypear control. Studies were established in central and western South Dakota to evaluate pricklypear control resulting from fluroxypyr applications. The treatments in central SD were applied in June, 2007 and control was evaluated in July of 2008 and 2009. Two years after application, pricklypear control was 74 and 88% when fluroxypyr was applied at 0.42 and 0.63 kg a.e./ha, respectively. In comparison, pricklypear control was 93% when picloram was applied at 0.28 kg a.e./ha. Other growth regulator herbicides, such as aminopyralid (0.12 kg a.e./ha), aminocyclopyrachlor (0.09 kg a.e./ha), triclopyr (1.12 kg a.e./ha), dicamba (1.12 kg a.e./ha), or 2,4-D ester (3.19 kg a.e./ha) resulted in less than 18% control two years after application. The treatments in western SD were applied in July, 2008 and control was evaluated in June, 2009. One year after application, fluroxypyr applied at 0.42 and 0.63 kg a.e./ha resulted in 96 and 99% control, respectively. However, heavy spring precipitation at this site in 2009 stressed the pricklypear plants which may have enhanced the appearance of control. In conclusion, results from this study demonstrated that fluroxypyr applied at high rates may effectively control pricklypear. [10]

HORSEWEED AND FLEABANE CONTROL STUDIES IN NON CROP AREAS IN THE SAN JOAQUIN VALLEY. Steven D. Wright, Gerardo Banuelos, Kurt J. Hembree,University of California, Tulare and Fresno Anil Shreshta, Fresno State University, Bradley D. Hanson, UC Davis, Hugo Ramirez, Visalia, Vanelle Peterson, Portland.

Glyphosate resistant Conyza species (horseweed or marestail and flaxleaf fleabane) are rapidly infesting orchards, vineyards, roadsides and canal banks throughout the San Joaquin Valley. Several studies were conducted in Tulare County to evaluate herbicides and combinations for control of horseweed. Aminopyralid, clopyralid, at 10.6 oz., Krovar + glyphosate, diuron + glyphosate, and sulfometuron methyl + glyphosate gave up to 100 percent control of horseweed. The higher rates of aminopyralid at 7 oz. /A was needed to give the most consistent control. Treatment combinations of glyphosate at 2 lbs. ai. + Indicate, Citric Acid, ET, carfentrazone, or flumioxazin gave improved control compared to glyphosate + AMS. In all treatments glyphosate was an important addition for control of grasses that were present. Another study was conducted in Traver on April 4, 2008. A quad sprayer was used at 3 mph. The nozzle used was a 8002 flat fan with a spray pressure of 30 psi and a volume of 20 gpa. The weeds present at the application were horseweed (*Conyza canadensis)* and panicle willowweed (*Epilobium paniculatum*). Most treatments gave good control of horseweed after 21 days. DPX-KJM44 at 2 oz /A, DPX-KJM44 at 4 oz /A, DPX-KJM44 + Oust + Telar + glyphosate at 3 oz + 3.3 oz + 1.6 oz + 32 oz /A, DPX-KJM44 + Oust + Telar + glyphosate 4 oz + 2.25 oz + 1.13 oz + 32 oz /A, DPX-KJM44 + diuron + glyphosate, DPX-KJM44 + Krovar + glyphosate, rimsulfuron + glyphosate, rimsulfuron + DPX-KJM44 + glyphosate had 90 percent or greater control over horseweed. Most treatments gave fair control of panicle willow weed and good to excellent control of horseweed after 21 days. In 2009 the objective of this study was to evaluate the effectiveness of various herbicides at different rates at controlling horseweed (*Conyza canadensis*). Most treatments gave fair to good control but not excellent. DPX-KJM44 at a rate of .50 oz/A, DPX-KJM44 + Telar at a rate of 1 oz + .375 oz/A, DPX-KJM44 + Telar at a rate of 1.5 oz + .375 oz/A, DPX-MAT28 at a rate of 1 oz/A, DPX-MAT28 at a rate of 1.5 oz/A had 78 percent control or greater over horseweed after 21 days. Another study was conducted in Dinuba on February 25, 2009. A CO2 backpack sprayer was used at 3 mph. The nozzle used was an 8002 flat fan with a spray pressure of 40 psi and a volume of 20 GPA. The weeds present at the application were horseweed (*Conyza canadensis)*, redstem filaree (*Erodium cicutarium*), pinnacle willow weed (*Epilobium paniculatum*), fiddleneck (*Amsinckia menziesii*), malva (*Malva parviflora*), and henbit (*Lamium amplexicaule*). Most treatments gave excellent control of horseweed. Most treatments gave excellent control of redstem filaree. Treatments that gave excellent control of malva were MAT 7.5 oz + Oust 3 oz + Telar 1.5 oz, MAT 9.2 oz + Oust 3.7 oz + Telar 1.8 oz, MAT 6 oz + Oust 3 oz, MAT 8 oz + Oust 4 oz, MAT 6 oz + Oust 3 oz + diuron 128 oz, MAT 8 oz + Oust 4 oz + diuron 128 oz, Krovar 160 oz, MAT 5.8 oz), MAT 7.5 oz), MAT 9.2 oz, and MAT 9.2 oz + glyphosate 1 qt + AMS 5 lbs) . All treatments gave excellent control of henbit and fiddleneck. [11]

LEAFY SPURGE CONTROL WITH TANKMIXES OF IMAZAPIC AND SAFLUFENCIL APPLIED IN SPRING. Stevan Z. Knezevic, Avishek Datta, Ryan E. Rapp, Jon Scott, Haskell Agricultural Laboratory, University of Nebraska, Concord, NE; Leo D. Charvat, BASF Corporation, Lincoln, NE; Joseph Zawierucha, BASF Corporation, RTP, NC.

Leafy spurge is a serious weed problem in North America infesting over five million ha of rangeland and pasture. Imazapic is commonly used for leafy spurge control as a fall treatment only, because spring applications do not provide satisfactory control. Saflufenacil is a new herbicide being primarily developed for pre-plant and PRE broadleaf weed control in field crops and non-crop areas. Our hypothesis was that there might be synergism between imazapic and saflufenacil if applied in spring. Field experiments were conducted during spring of 2007 and 2008 with the objective to describe dose-response curves of imazapic and saflufenacil applied alone and tank-mixed. Saflufenacil rates were 0, 12.5, 25, 50, and 100 g/ha, imazapic rates were 0, 52.6, 105, and 158 g/ha. Dose-response curves based on log-logistic model were used to determine the ED90 values of saflufenacil for each imazapic level. In general, none of the imazapic rates applied alone provided satisfactory leafy spurge control. Saflufenacil applied alone provided excellent leafy spurge control for only 30-90 DAT depending on the rates used, then the leafy spurge started re-growing. In contrast, the longest control of leafy spurge (400 DAT) was achieved with saflufenacil ED90 rate of about 25 g/ha tank-mixed with 105 g/ha of imazapic. There was also cool season grass injury (10-30%) with 158 g/ha of imazapic, which lasted for six weeks only. Results from this study indicated that indeed there is a synergism between the two herbicides; additional studies are needed to determine the mechanism of such synergy. sknezevic2@unl.edu [12]

LEAFY SPURGE CONTROL WITH TANKMIXES OF IMAZAPIC AND SAFLUFENCIL APPLIED IN FALL. . Stevan Z. Knezevic, Avishek Datta, Ryan E. Rapp, Jon Scott, Haskell Agricultural Laboratory, University of Nebraska, Concord, NE; Leo D. Charvat*, BASF Corporation, Lincoln, NE; Joseph Zawierucha, BASF Corporation, RTP, NC.

Saflufenacil is a new herbicide being primarily developed for pre-plant burndown and PRE broadleaf weed control in field crops and non-cropland areas. Leafy spurge is a serious weed problem in North American range and pastureland. Imazapic is commonly used for leafy spurge control as a fall treatment. Our hypothesis was that there might be synergism between imazapic and saflufenacil if applied in fall. Field trials were initiated during fall of 2007 and 2008 with the objective to describe dose-response curves of saflufenacil tank-mixed with imazapic in order to determine the best ratios of the two for leafy spurge control. Saflufenacil rates were 0, 12.5, 25, 50, and 100 g/ha, imazapic rates were 0, 35, 70, and 105 g/ha. Dose-response curves based on log-logistic model were used to determine the ED90 values of saflufenacil for each imazapic level. Imazapic rate of 105 g/ha applied alone provided about 90% control at 240 DAT and about 80% control at 300 DAT. Saflufenacil applied alone provided excellent control but only for 30 DAT depending on the rates used, then the leafy spurge started re-growing. Imazapic rate of 35 and 70 g/ha applied alone provided about 65% control for 240 DAT. The ED90 values (90% control) of saflufenacil in the tank-mix with imazapic rates of either 35 or 70 g/ha were around 20-25 g/ha for control up to 275 DAT suggesting synergism between the two herbicides at those rates. There were also some grass injuries of about 10-20% with 105 g/ha of imazapic. sknezevic2@unl.edu [13]

FERAL RYE CONTROL ON COLORADO RANGELAND. Bobby Goeman*, Larimer County Weed District, Ft. Collins, CO, James R. Sebastian and George K. Beck, Colorado State University, Ft. Collins, CO.

Feral rye (*Secale cereale*) is a winter annual grass weed that reproduces by seed. SECCA was once an important crop and is a fairly common problem in Colorado winter cereals. It also readily invades roadsides, abandoned areas, and rangeland in Colorado. SECCA competes with desirable rangeland perennial grasses for moisture because of its winter and early spring growth habit. An experiment was established near Loveland, CO in January 2009 to evaluate chemical control of SECCE on Colorado rangeland. SECCE emerged in October 2008 following fall precipitation. Winter (January 2009) or spring (March 2009) application timings were compared in this experiment. Perennial grass species were 70 to 100% dormant at both of these timings, which were selected to minimize perennial grass injury from glyphosate treatments. Herbicides were applied when SECCE had developed 2 to 5 tillers and was 1 ½ to 5" tall (both application timings). Visual evaluations for SECCE control were conducted on July 23, 2009 approximately 4 or 6 months after treatments were applied. Glyphosate (32 oz/A; 16 oz ai/A) or glyphosate plus imazapic (32 oz/A; 6 + 3 oz ai/A) controlled 89 to 99% SECCE regardless of timing. Biomass was harvested in August 2009. Dormant perennial native grass species were not injured and increased in biomass where SECCE was controlled. There was a 66- to 118-fold increase in native grass biomass (330 to 588 lb/A) and 7 to 502-fold decrease in SECCE biomass (0 to 68 lb/A) in glyphosate (>8 oz/A; 4 oz ai/A) treated plots. There was 5 lb/A of perennial grass and 502 lb/A of feral rye in untreated plots. Imazapic and imazamox treatments controlled 18 to 32% SECCE and rimsulfuron controlled 65 to 77% of SECCE. Previous CSU research has demonstrated that downy brome (BROTE) control was improved when imazapic was applied preemergence or early postemergence compared to when BROTE had more than three leaves or was tillering. Weather conditions may also affect application timing, herbicide selection, herbicide rates, and SECCE control. Extremely dry conditions existed during the winter when treatments were applied. This may have also affected SECCE control from imazapic, imazamox, and rimsulfuron. Our study demonstrates that SECCE can be effectively controlled and stimulate perennial native grass biomass with appropriately timed applications of glyphosate. Caution should be exercised to avoid spraying glyphosate or glyphosate tank mixes if perennial grass species are not dormant such as often occurs during mild winters or when they are emerging in early spring. Additional research is needed to refine application rates and timings to balance best SECCE control with minimal perennial grass injury. [14]

TEBUTHIURON USE IN FIREBREAK INSTALLATION AND MAINTENANCE. D. Chad Cummings, Vernon B. Langston, and Robert A. Masters, Dow AgroSciences LLC, Indianapolis, IN.

The most cost-intensive components of prescribed fire or wildfire prevention are the installation and maintenance of firebreaks. Historically, firebreaks have been installed by mechanical means such as bulldozers, fire plows and disks, or by using existing natural barriers (waterways, roads, and topography). Before these mechanical techniques can be used on public lands extensive archaeological site surveys and environmental assessments are often required. Herbicides are an alternative means to create semi-permanent firebreaks that minimize soil disturbance, and are less costly than the use of mechanical methods. The herbicide, tebuthiuron (Spike® 80 DF; 800 g ai/kg) can be used to provide the broad spectrum vegetation control required for firebreak installation and maintenance on non-crop areas and rangelands. Tebuthiuron offers residual control of many grass, forb, and woody species. Tebuthiuron use rates can range from 1.1 to 4.4 kg ai/ha (1.25 to 5 lb Spike 80DF/acre) depending on land management objectives and plant species to control. This dry flowable formulation can be applied with most types of herbicide spray equipment. Banded applications of the herbicide may be made with ground equipment in many states or with a helicopter in AL, KS, LA, MO, MS, NM, OK, and TX. Tebuthiuron can be used to create high quality, lasting firebreaks that facilitate prescribed fire activities, wildfire prevention and containment, fireline monitoring, and improved escape routes during wildfire control activities. [15]

HERBICIDE TOLERANCE IN GRASSES AND NATIVE FORB SPECIES. Kimberly A. Edvarchuk* and Corey V. Ransom, Utah State University, Logan.

Native forb seed is needed to restore the rangelands of the Intermountain West. Studies were conducted to identify herbicides that can be used to control weeds in forb seed production with limited injury to the forbs. The forbs evaluated in this project include: basalt milkvetch (*Astragalus filipes*), Western prairie clover (*Dalea ornata*), and Searls' prairie clover (*Dalea searlsiae*). Field trials were conducted in 2009 in Logan, UT on established fields transplanted in 2005 from cone-tainers and treatments were applied with a shielded bicycle sprayer delivering 20 gpa at 30 psi. Basalt milkvetch was treated with bromoxynil (0.25 lb ai/A), 2,4-DB (0.25 ae/A), clopyralid (0.124 ae/A), quinclorac (0.248 ai/A), and imazamox (0.078 ai/A). Treatments were applied on May 15 on milkvetch and May 21 on both Dalea species and injury was evaluated on May 26 and June 25. For milkvetch, clopyralid was most injurious at both evaluation dates showing 59 and 64% injury. Injury with bromoxynil and imazamox was initially high (41% and 39% respectively) but declined by the last evaluation date to 28% and 20% injury. Injury from 2,4-DB was minimal. Western prairie clover treatments included pendimethalin (0.71 ai/A), dimethenamid-P (0.84 ai/A), oxyfluorfen (0.25 ai/A), flumioxazin (0.064 ai/A), metribuzin (0.5 ai/A), bromoxynil and 2,4-DB (0.25 ai/A), clopyralid (0.124 ai/A), quinclorac (0.248 ai/A), imazamox (0.078 ai/A), and aminopyralid (0.047 ae/A). Results at 5 DAT and 35 DAT show that clopyralid injury was high initially (41%) and remained high (44%), while injury from aminopyralid was moderately high 5 DAT (35%) and increased significantly by 35 DAT (63%). Bromoxynil, clopyralid, and aminopyralid caused significant declines in seed head biomass. Plant heights and volume were also negatively impacted by oxyfluorfen, flumioxazin, clopyralid, imazamox, and aminopyralid. Plant height, width, and volume were similar to the control plots for plants treated with pendimethalin, dimethenamid-P, metribuzin, bromoxynil, and 2,4-DB. Searls' prairie clover plots were treated with the same treatments as the Western prairie clover except for dimethenamid-P and aminopyralid. Injury to Searls' prairie clover was similar to that observed for Western praire clover. Injury with oxyfluorfen and flumioxazin was severe at 5 DAT (65% and 58%, respectively) but declined at 35 DAT (16% and 21%, respectively). Pendimethalin, bromoxynil, and 2,4-DB caused little injury at 35 DAT (8%, 6%, and 5%, respectively). Oxyfluorfen, flumioxazin, and imazamox all reduced the average plant height, diameter, and volume when compared to the untreated. Plots treated with 2,4-DB had among the highest plant growth and were significantly greater than those treated with metribuzin, clopyralid, oxyfluorfen, flumioxazin, and imazamox. At this time, 2,4-DB appears to hold promise for use in controlling weeds in all three native forb species while several herbicides appear to have potential use in weed control in Searls' and Western prairie clover seed production. Further testing will be required to determine herbicide effects on seed production and viability. An additional trial evaluated native grass tolerance to preplant and preemergence herbicide treatments. Grasses evaluated included bluebunch wheatgrass, indian ricegrass, basin wildrye, bottlebrush squirreltail, and big bluegrass. Imazapic (0.94 and 0.125 lb ai/A) and sulfosulfuron were applied November 8, 2008. Aminopyralid was applied at 0.078, 0.109, and 0.219 lb ae/A on December 1, 2008. Grasses were broadcast planted on November 24, 2008. Grass injury was evaluated October 22, 2009. Injury from aminopyralid ranged from 0 to 14% across all varieties and aminopyralid rates. Imazapic caused 0 to 13% injury across rates and grass varieties. Injury from sulfosulfuron was severe on all varieties and ranged from 41 to 87, 83 to 97, and 93 to 99% at rates of 0.035, 0.062, and 0.094 lb ai/A, respectively. [16]

INTEGRATED STRATEGIES FOR CONTROLLING SCOTCH BROOM (*CYTISUS SCOPARIUS*) . Timothy B. Harrington*, USDA Forest Service, Olympia, WA.

Scotch broom is a large, non-native shrub that has invaded extensive areas throughout 16 eastern and six western U.S. states. Three research projects were undertaken to determine potential strategies for preventing or controlling this common invasive species in the Pacific Northwest. (1) In a forest productivity study near Matlock WA, third-year cover of Scotch broom was reduced by 71% when logging debris was retained, rather than removed, after timber harvest. Subsequent survival of planted Douglas-fir (*Pseudotsuga menziesii*) seedlings was 28% greater where debris was retained versus removed because of reduced competition from Scotch broom. (2) In laboratory studies, sulfometuron reduced root biomass of Scotch broom seedings by 58 to 95%, but seedling mortality was only 5 to 9%. Imposing soil drought conditions to the herbicide-treated soils caused seedling mortality to increase abruptly to 20%. Results suggested that increased control of Scotch broom with sulfometuron is likely if pre-emergent application is timed to expose recently emerged seedlings to developing conditions of soil drought, such as those that occur during late April to early May in the Pacific Northwest. (3) Greenhouse studies were conducted to compare the competitive abilities of three native grass species to inhibit development of Scotch broom seedlings. Aboveground biomass of Scotch broom seedlings was reduced up to 76% when grown with spike bentgrass (*Agrostis exarata*) or blue wildrye (*Elymus glaucus*), but only 19% when grown with western fescue (*Festuca occidentalis*). The grasses were able to inhibit Scotch broom development because of more rapid growth in cover and height of bentgrass and wildrye, respectively. [18]

ECOPHYSIOLOGY OF THE RANGELAND WEED BERTEROA INCANA (HOARY ALYSSUM). H. Madani*, G. Stopps, and Mahesh K. Upadhyaya, University of British Columbia, Vancouver.

Berteroa incana (hoary alyssum), a rangeland weed of BC, has no significant primary seed dormancy and maintains a large soil seed bank (132.4 m seeds/ha). Little information on loss of these seeds from seed banks and on interaction of this weed with associated grasses is available. Midday soil surface temperatures at B. incana-infested sites in BC can reach 83 C. Objectives of this study were to investigate the effect of high temperature on survival of B. incana seeds and the possible role of allelopathy in its interaction with associated grasses. Dry or imbibed B.

incana seeds were exposed to 60, 70, 80, or 90 C and the effect on subsequent germination at 25 C was studied in Petri dish assays. Exposure of dry seeds to 80 or 90 C reduced seed germination by 5 to 20% upon subsequent incubation at 25 C. However, imbibed seeds lost viability completely at lower (60 C) temperatures and shorter exposure durations. Since 93% of B. incana seeds are confined to the top 4 cm of soil profile, this could be significant in determining their fate. B. incana rosette leaves were ground and allelochemicals extracted by stirring the powder (0.5 to 4% w/v) in water on a rotary shaker (4 hr, 80 rpm). The leachate strongly inhibited seed germination and seedling growth (particularly of roots) of prairie junegrass (*Koeleria macrantha*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), and cheatgrass (*Bromus tectorum*) in Petri dish assays; the species differed in this regard. Higher concentrations (2 and 4%) also inhibited B. incana germination and seedling growth, which could be important in preventing seed germination near the mother plant. [18A]

COMPARISON OF QUALITATIVE TURF EVALUATIONS TO QUANTITATIVE METHODS FOR MEASURING WEED PRESSURE AND TURF QUALITY. Cheryl A. Wilen*, University of California Statewide IPM Program, San Diego, CA; and J. Michael Henry, University of California Cooperative Extension, Riverside, CA.

Long term weed control in turf depends on the competitive ability of the turf species and reducing vegetation gaps. Methods to improve the competitive ability of the turf and decrease the size and number of gaps would make the site less susceptible to weed invasion. From an integrated pest management standpoint, which stresses prevention of the pest, cultural practices such as proper fertilization to encourage a vigorously growing turf as well as overseeding to reduce gaps are better approaches than use of herbicides to restore the turf once invaded. We evaluated the effectiveness of overseeding and fertilizing on reducing the weed population in tall fescue turf plots and compared these treatments to commercial weed and feed products in 2006 and 2008. The goal was to fill in gaps (micro or macro) thereby reducing spaces where weeds could invade or establish. The qualitative evaluation of the plots was done by a visual rating generally based on the rating guidelines of the National Turfgrass Evaluation Program. The scale of 1 to 9 takes into account turf color, weediness, density, and ground cover with 1 being very poor and 9 being outstanding. A rating of 6 or above is generally considered acceptable. Weed cover was also rated qualitatively on a scale of 1-5 where 1=no weeds, 2=1-10% cover, 3=11-30% cover, 4=31-60% cover, 5= >60% weed cover. Quantitative measurements were done using a line transect to count weeds by species every 6” along 16’ of the 24’ plot, measuring turf color using a Turf Color Meter (TCM 500 from Spectrum Technologies), and measuring gaps(turf density) using high resolution digital photos of the turf and processing the images using SigmaScan software. Our results indicate that there is a correlation between turf density and weed ratings but that measurement of turf color did not reflect overall turf quality. [19]

INCREASED WEED SEED (*PANICUM MILIACEUM* AND *AMARANTHUS RETROFLEXUS*) PREDATION IN RESPONSE TO INCREASED POPULATIONS OF PTEROSTICHUS MELANARIUS IN A CONTROLLED FIELD EXPERIMENT. Alysia Greco * and Ed Peachey, Oregon State University, Corvallis .

Carabid beetles such as Pterostichus melanarius may be important consumers of weed seeds in annual cropping systems, including wild proso millet and pigweed. In greenhouse and laboratory studies, we observed that P. melanarius either consumed seeds immediately after locating them, or that the seeds were carried a short distance and cached for later consumption. Herbivory of wild proso millet seed by P. melanarius has not been reported, and the effect of P. melanarius caching behavior on wild proso millet seed survival has not been determined. The objective of this study was to measure weed seed predation and caching rates in response to increasing densities of P. melanarius in field conditions and to determine the fate of seeds after removal. Eighteen 1 m2 plots were constructed by installing 45 cm high 24GA galvanized metal fences 15 cm deep in the soil in a field at the OSU Vegetable Research Farm. Butternut squash were transplanted in each plot. P. melanarius were added at 0, 10 (5 male; 5 female) or 20 (10 males; 10 females) to plots. Each beetle had a unique identification mark applied with a Dremel tool to track movement in the event of migration to or from plots. Wild-proso millet, pigweed, and hairy nightshade seeds were placed together on seed trays in all plots at 50, 100, and 25 seeds, respectively. Seeds were counted and replenished weekly to maintain a consistent density. Seven days after P. melanarius were added to the plots, regression analysis indicated that wild-proso millet and pigweed seed remaining in the seed trays had declined by 0.74 ($R2=0.575$, $P<0.001$) and 0.23 ($R2=0.291$, $P=0.002$) seeds, respectively, for each additional P. melanarius added to the plots. There was no relationship between nightshade loss and beetle number. Thereafter, wild-proso millet and pigweed seed removal remained greater in plots with 20 P. melanarius than in the plots without beetles. After two weeks, an average of 23.8 (±4.4) wild-proso millet seeds had been removed from the seed trays in plots that had 20 beetles, resulting in an average of 6.5 (±4.7) wild-proso millet seedlings per plot. Examination of the digestive tract of P. melanarius collected after the study found starch granules similar to that of wild-proso millet endosperm. Both weed seed herbivory and caching behaviors of P. melanarius were observed in this study. Herbivory resulted in direct seed mortality, but seedlings emerged from some of the wild-proso millet seeds that were cached. [20]

EFFECTS OF COVER CROPS AND CULTIVATION IN A YOUNG ORGANIC VINEYARD.
Callie Bolton*, Carol Miles, Gary Moulton, Jonathan Roozen, and Timothy Miller, Washington State University, Mount Vernon.

An organic vineyard was established at Mount Vernon, WA in 2009 to analyze the efficiency of cover crops compared to tillage for weed control. Five treatments were applied to 'Pinot Noir Precose' and 'Madeleine Angevine' grapes: 1) rototilling between rows, hand-weeding in rows (standard), 2) rototilling plus Wonder Weeder between rows, hand-weeding in rows, 3) winter wheat cover crop, 4) winter pea cover crop, and 5) 2:1 winter wheat and winter pea respectively. The growth of five randomly-selected vines per cultivar, per treatment was measured July 30, August 13, and September 26; weed biomass within 0.13 m2-quadrats was collected August 3 and September 27. Vine growth for the two cultivars was similar in July, but 'Madeleine Angevine' shoots were 56.0 cm compared to 33.8 cm for 'Pinot Noir Precoce' by August and 90.0 and 55.2 cm, respectively, in September. August, in-row weed biomass was similar between cover crops and the standard treatment. By September, winter wheat plots had only 2.9 g weeds/0.13 m2 compared to 12.3 g weeds/0.13 m2 in winter pea plots. Standard and Wonder Weeder treatments resulted in similar weed biomass. Winter pea plots contained the most between-row weed biomass in September, followed by Wonder Weeder plots. Total in-row biomass (cover crop plus weed) was the same across treatments in August, although winter pea and wheat:pea treatments exceeded total biomass of the standard treatment in September. In-row biomass in winter wheat plots was also less than in winter pea plots by September. [21]

FIELD TESTING OF ORGANIC HERBICIDES. W. Thomas Lanini, Shosha Capps, Univeristy of California, Davis; and John A. Roncoroni, Univeristy of California Cooperative Extension, Napa, CA.

There has been an increase in the number of new organic herbicides available on the market in the past few years. The objective of the research was to evaluate weed control efficacy with five organic herbicides. The herbicides were acetic acid, GreenMatch (55% d-limonene), GreenMatch EX (50% lemongrass oil), Matran EC (50% clove oil), and WeedZap (45% clove oil and 45% cinnamon oil). Greenhouse experiments examined mustard (*Brassica nigra*), pigweed (*Amaranthus retroflexus*), and junglerice (*Echinochloa colona*) control with a range of organic herbicide concentrations and either 327 or 655 l/ha spray volume. Field experiments examined weed control with organic herbicides with weeds of different species and size. High spray volume (655 l/ha) consistently provided better control in all experiments. Acetic acid at 20% v/v, GreenMatch at 15% v/v (d-limonene 8.25% v/v), GreenMatch EX at 15% v/v (lemongrass oil 7.5% v/v), Matran EC at 15% v/v (clove oil 6.75% v/v), and WeedZap at 10% v/v (clove oil and cinnamon oil each at 4.5% v/v) were considered the minimum concentration for good weed control on mustard and pigweed. Junglerice was not controlled by any treatment in the greenhouse experiments. In field tests, time after emerge influenced weed control, with newly emerged weeds being more easily controlled than those which emerged 10 or more days ahead of treatment. All treatments provided better weed control when applied during warmer weather conditions and in the light versus shade. Grasses were most difficult to control, requiring repeat treatments applied 15 days apart for fair (50 to 75%) control. [22]

DOSE RESPONSE OF WEED SEED AND SOIL-BORNE PATHOGENS TO THE FUMIGANT DIMETHYL DISULFIDE. Bradley D. Hanson*, University of California, Davis; James S. Gerik, and Alfonso Cabrera, USDA-ARS, Parlier, CA.

Preplant soil fumigation is used in many high value annual and perennial crops for broad spectrum control of soil borne pests. One of the preferred fumigants, methyl bromide, is being phased out due to its contributions to the depletion of stratospheric ozone. A potential alternative to methyl bromide, dimethyl disulfide (DMDS), is being considered for registration in California under the trade name of Paladin. Relatively little data for DMDS is available regarding its broad-spectrum pest control; therefore a laboratory dose-response conducted to determine the impacts of DMDS on several representative soil borne pests. DMDS was applied to soil in 40 mL vials at rates of 4 to 250 mg L-1 soil air (approximately 12.5 to 800 lb A-1) for 6, 24, 96, or 192 hours before venting. No DMDS treatment provided acceptable control of Fusarium and Pythium in these experiments although there was a slight reduction in fungal populations at high rates and longer exposure times. Weed control also was poor with DMDS treatments; however experimental artifacts likely contributed to these results and weed bioassays are being repeated for verification. The control of citrus nematode was very good at rates of 31 mg L-1 and higher with at least 96 hours of exposure. DMDS at sufficient rates may provide acceptable control of nematodes but is likely will not be sufficient as a stand-alone product for control of weeds and soil fungal pests. [23]

FLUMIOXAZIN USE PATTERNS IN THE WESTERN US. Len Welch*, Valent USA Corp., Hood River, OR and John Pawlak, Valent USA Corp., Lansing, MI.

Flumioxazin is in the class N-phenylphthalimide, Herbicide Resistance Action Committee group 14. Flumioxazin controls weeds by inhibiting protoporphyrinogen oxidase, an essential enzyme required for chlorophyll biosynthesis. Flumioxazin is a preemergence herbicide at labeled use rates of 0.047 to 0.375 lb active ingredient per acre and aids in rapid burn-down when tank mixed with post emergence herbicides and a surfactant. Preemergence residual control varies from weeks to months based on rate of application, temperature, soil moisture, soil organic matter and crop competition. Flumioxazin is labeled for use in agricultural crops, nursery and field grown trees (conifers and deciduous) and shrubs and ground covers; established ornamentals in landscapes; and for bare ground weed control in non-crop areas, industrial areas and right-of-ways. Major western US agricutlural crop uses include alfalfa, asparagus, blueberry, nut trees, pome and stone fruit, garlic, mint, potato, garbanzo bean (pree weed control and as a harvest aid), no-till corn, fallow, and fall burn-down in field to be planted to barley, pea, flax, lentil, safflower, sunflower, and spring wheat. Flumioxazin is active on small seeded broadleaf weeds as well as a number of annual grasses. Some of the key weeds controlled include: annual bluegrass, common chickweed, common groundsel, downy brome, field pennycress, flixweed, hairy fleabane, hairy nightshade, henbit, horseweed, kochia, lambsquarters, London rocket, mayweed chamomile, panicle willow weed, prickly lettuce, redroot pigweed, Russian thistle and shepherd's purse. [24]

WEED CONTROL USING A STALE SEEDBED METHOD FOR PROCESSING CUCUMBER AND GREEN PEA. Carl Libbey* and Timothy Miller, Washington State University, Mount Vernon.

Weed control trials using stale seedbeds in green pea and processing cucumber were conducted at Mount Vernon, Washington in 2007 through 2009. Seedbed or soil preparation timings for both crops were 14 d prior to seeding, 7 d prior to seeding, 3 d prior to seeding, and 0 d (same day) of seeding. Preemergence herbicides applied prior to crop emergence, but postemergence to seedling weeds, were glyphosate, paraquat, glufosinate, pyraflufen, and flame. For the green pea trial in 2007, weed control ranged from 71 to 95% at 21 days after treatment (DAT) for all seedbed timings. By harvest, weed control was 67% in 14 d seedbeds and 85% in 3 d seedbeds. Pea vine and pod fresh weight was not affected by seedbed timings or herbicides in 2008. Weed control at harvest that year was 79% in 14 d seedbeds, 83% in 3 d seedbeds, and 86% in 7 d and 0 d seedbeds. Weed control in 2009 was excellent in 0 d, 3 d, and 7 d seedbeds (97, 97, and 94% respectively), although was only 54% in the 14 d seedbed. Glufosinate, glyphosate, and paraquat resulted in >90% weed control, while flame and pyraflufen had 79 and 78% control, respectively. For the cucumber trial in 2007, weed control at 21 DAT exceeded 70% for all timings. However, at harvest weed control was < 31% for all timings. Weed control in 2008 ranged from 93 to 99% for all seedbed timings throughout the season. Cucumber weed control for 2009 exceeded 90% for all seedbeds except for 14 d (85%). Weed control in cucumber was more closely related to yr rather than seedbed timing. Earlier-seeded beds in 2007 had poor weed control by harvest, while later-seeded beds in 2008 and 2009 had excellent weed control throughout the growing season. There was little or no difference in weed control between herbicides and flame in cucumber any yr. [25]

PIGWEED CONTROL IN DOUBLE CUT PEPPERMINT AND SPEARMINT WITH SULFENTRAZONE . Rick A. Boydston, USDA-ARS, Prosser, WA.

Broadleaf weed control in double cut mint production is often difficult as herbicides applied to dormant mint February have often dissipated by mid summer when mint is harvested. Herbicides that are currently registered for postemergence weed control in mint fail to consistently control pigweed species. Sulfentrazone was tested at 0.07 and 0.14 kg ai/ha in double cut peppermint and spearmint from 2007 through 2009. Sulfentrazone treatments were applied after the first mint harvest and prior to mint regrowth and irrigation. Sulfentrazone at 0.14 kg/ha consistently controlled (87 to 100%) redroot pigweed, whereas pigweed control was inconsistent with sulfentrazone at 0.07 kg/ha. Saflufenacil, pendimethalin, and carfentrazone applied after the first harvest failed to control redroot pigweed and/or delayed and stunted mint regrowth. At the rates tested, sulfentrazone did not substantially injure or delay the new growth of peppermint or spearmint following the first harvest and had no detrimental effect on peppermint or spearmint hay or oil yield. [26]

INDAZIFLAM FOR RESIDUAL WEED CONTROL IN PERENNIAL CROPS. Monte Anderson and Darren Unland, Bayer CropScience, Research Triangle Park, NC .

Indaziflam is a new preemergent herbicide active ingredient for broadspectrum weed control in perennial crops that is pending EPA approval. University, private, and internal trials in 2009 demonstrated that indaziflam provided excellent long lasting residual control of annual grass and broadleaf weeds. The low soil mobility and extended soil activity of indaziflam will make it ideal for use in conjunction with burndown herbicides. Field rates of 73-95 g ai/ha have consistently provided 80% or greater control of key weeds 90 days or longer after treatment. Length of control has been equal to or longer than all other registered products at the manufacturer's recommended use rates. Tank mixes with other residual herbicides and indaziflam have been beneficial to broaden the weed control spectrum and promote good weed management by including multiple modes of action to delay development of resistant weed populations. No antagonism or adverse effects from non-selective tank mixes have been observed. Upon registration, indaziflam will be marketed in perennial crops under the trade name of Alion® by Bayer CropScience. [27]

INDAZIFLAM – A NEW HERBICIDE FOR GRASS AND BROADLEAF WEED CONTROL IN TREE, NUT, AND VINE CROPS. Seth A. Gersdorf* and Darren Unland, Bayer CropScience, Research Triangle Park, NC.

Indaziflam is a new cellulose biosynthesis inhibitor under development as a preemergence broadspectrum herbicide. This new active ingredient from Bayer CropScience will be formulated as a suspension concentrate and branded as Alion® for use in perennial fruit, nut, and grape crops. Pending approval by EPA, Alion® will provide residual preemergence control of monocot and dicot weeds with excellent crop safety when applied alone or in a tankmix with other herbicides such as glufosinate. Alion® will be an effective tool to manage weed populations that are resistant to other modes of action including EPSP synthase inhibitors, ALS inhibitors, and PSII inhibitors. Alion® has very favorable toxicological properties with no evidence of effects on immunotoxicity, developmental toxicity, reproductive toxicity, genotoxicity or carcinogenicity. Based on residue tests results, Bayer CropScience anticipates a 14 day or less preharvest interval for all crops and no commodity trade restrictions. The application timing of Alion® is flexible and may be applied anytime of the year that the soil is not frozen to provide extended weed control and best control has been obtained when irrigation is applied or precipitation occurs soon after Alion® has been applied. [28]

SOIL INTERACTION AND BIOLOGICAL ACTIVITY OF PYROXASULFONE. Eric P. Westra*, Colorado State Unniversity, Dale Shaner, USDA-ARS, Fort Collins, CO, Philip Westra, Colorado State Unniversity, Fort Collins, CO.

A field study was conducted at 2 field locations in Colorado in 2009.Plots were conducted in sunflowers to compare the dissipation rates between pyroxasulfone and s-metolachlor over the growing season. Field 1 had a clay loam soil with overhead sprinkler irrigation, and Field 2 had a sandy loam soil with surface drip irrigation. Pyroxasulfone was applied at 0.28 kg ai/ha, and S-metolachlor at 1.68 kg ai/ha with three replications. Soil samples were taken periodically over the season and the samples were divided into four different depths. The herbicides were extracted from the soil with toluene and analyzed on GC/MS. Pyroxasulfone dissipated at a slower rate than s-metolachlor at both field sites. At Field 1 the half life (DT50) of s-metolachlor was 18 days compared to 32 days for pyroxasulfone. At Field 2 the dissipation of both herbicides was slower with DT50 of 61 days and 118 days for metolachlor and pyroxasulfone, respectively. The slower half life in Field 2 was related to drier soil conditions and less uniform water application. Both s-metolachlor and pyroxasulfone remained in the top 7.5 cm of the soil profile. Pyroxasulfone applied at one sixth the rate of s-metolachlor showed comparable weed control when plots were visually rated. Less dissipation within the soil profile allowed pyroxasulfone to provide weed control at lower rates then s-metolachlor while providing longer residual weed control. [29]

EFFICACY OF POSTEMERGENCE HERBICIDES WITH A LIGHT ACTIVATED, SENSOR CONTROL (LASC) SPRAYER IN CHEMICAL FALLOW IN THE PACIFIC NORTHWEST. Larry H. Bennett*, Daniel A. Ball, Oregon State University, Pendleton, OR; and Dilpreet S. Riar, and Joseph P. Yenish, Washington State University, Pullman, WA.

A study was conducted in chemical, summer fallow fields near Davenport, WA and Pendleton, OR in 2007 and 2008 to evaluate the postemergence weed control efficacy of herbicide treatments applied with a light activated, sensor-controlled (LASC - WeedSeeker™) sprayer compared to the broadcast application of glyphosate at 1680 g ae/ha. The LASC application of glyphosate alone (at 840, 1680 and 3360 g/ha) and in mixture with pyrasulfotole plus bromoxynil, or 2,4-D had weed control (≥ 95%) and biomass (≤14 g/m2) similar to the broadcast application of glyphosate across locations and years. The LASC application of carfentrazone plus dicamba without glyphosate, or 2,4-D without glyphosate had 33 and 35 percent less control of tumble pigweed and 14 and 13 percent less control of prickly lettuce control, respectively, compared to broadcast application of glyphosate. Bromoxynil treatment had minimum weed control (≤40%, averaged across species) and maximum total weed biomass (68 g/m2) compared with other treatments across years and locations. Carfentrazone + dicamba, 2,4-D, and pyrasulfotole without glyphosate, and bromoxynil + glyphosate all had significantly greater biomass, (38, 44, 27, and 25 gms/m2 respectively) than the broadcast application of glyphosate (7 gms/m2). Use of certain herbicides with a LASC sprayer for weed control in chemical fallow can provide comparable weed control to broadcast spraying with a significant per hectare savings in herbicide material. [30]

EFFICACY OF NOVEL TRIALLATE FORMULATIONS AFFECTED BY SOIL PROPERTIES. R. Bradley Lindenmayer*, Philip Westra, Galen Brunk, Colorado State University, Ft. Collins, CO; George Newberry, and Tim Kunkel, Gowan Company, L.L.C., Yuma, AZ.

Triallate [S-(2,3,3 trichloroallyl) diisopropylthiocarbamate] was a very popular herbicide across much of the wheat-producing Great Plains and Pacific Northwest of the United States for pre-emergence grass weed control in wheat, especially wild oats (L.), and provided an alternative chemistry to control such weeds with Group I and II resistance. Triallate requires soil incorporation, allowing weed seedlings' coleoptiles to grow through the herbicide layer and absorb the herbicide affecting leaf emergence through lipid synthesis inhibition. With the advent of no-till and conservation tillage practices, triallate use has declined as the herbicide is difficult to incorporate through the residue layer. Gowan Company has recently begun researching the ability of different triallate formulations to be washed off wheat-straw residue to be incorporated into the soil by irrigation or rain. The following study: 1) evaluated the herbicidal activity of 13 new formulations on wild oats in seven different soils in comparison to the currently marketed formulation, Far-Go EC, and 2) related wild oat control of the different formulations to different soil properties such as organic matter (OM), pH, clay content, and cation exchange capacity (CEC). Several of the formulations' efficacies were positively correlated with clay content and CEC, including Far-Go EC. [31]

EFFECT OF A NOVEL ADJUVANT ON POSTEMERGENCE HERBICIDES. Jerry Ries*, Richard Zollinger, and Angela Kazmierczak, North Dakota State Univeristy, Fargo.

Glyphosate is a highly hydrophilic herbicide and require surfactant type adjuvants to enhance phytotoxicity. Many postemergence herbicides applied with glyphosate to increase weed control are lipophilic (clethodim, tembotrione, others) and require oil type adjuvants for optimum weed control. Adjuvant selection when tank-mixing glyphosate and lipophilic herbicides may enhance or antagonize either herbicide. Surfactants are less effective in enhancing lipophilic herbicides and oil adjuvants, including crop oil concentrates (COC) and methylated seed oil (MSO), may antagonize glyphosate. High surfactant oil concentrates (HSOC) were developed to enhance lipophilic herbicides without antagonizing glyphosate. HSOC adjuvants by ASTM definition contain at least 50% w/w oil plus 20 to 50% w/w surfactant. Field trials were conducted in 2009 to compare commercial HSOC adjuvants. Flax, quinoa, tame buckwheat, and conventional corn were planted as assay species. Glyphosate and clethodim were applied alone, with nonionic surfactant, COC, MSO, an oil based surfactant: Trophy Gold, and the following HSOC adjuvants: Between, Diplomat, Exchange, High Load, Superb HC, and Destiny HC. All treatments were applied with and without ammonium sulfate (AMS), and applied perpendicular to assay species. All HSOC adjuvants are not created equal. HSOC adjuvants ranked in order of highest to lowest in activating glyphosate plus clethodim is: Destiny HC>Suberb HC=Trophy Gold>Diplomat=Exchange=High Load. Addition of AMS at 8.5 lb/100 gal water enhanced all treatments but the relative level of control generally remained similar to treatments applied without AMS. Trophy Gold plus AMS showed a higher increase in control than other treatments with AMS and was similar to Destiny HC for most assay species. Some HSOC adjuvants enhanced weed control from the lipophilic herbicide clethodim and also enhanced broadleaf weed control from glyphosate. Addition of AMS enhances phytotoxicity from all adjuvants applied with glyphosate plus clethodim but does not completely overcome antagonism from oil adjuvants applied with glyphosate. [32]

GRASS WEED CONTROL IN NATIVE SPECIES USED FOR BIOFUEL PRODUCTION. Mikki R. Ekken, Cassandra Setter, and Rodney G. Lym, North Dakota State University, Fargo.

Switchgrass (*Panicum virgatum* L.), a perennial native grass, has considerable potential as an alternative to corn for efficient biofuel production. However, control of grassy weeds has been a problem in switchgrass production. The objective of this research was to determine the efficacy of various herbicides for weed control in switchgrass. A total of 23 post-emergent herbicides from 15 families were evaluated in a series of greenhouse trials. The herbicides that did not injure switchgrass, but reduced smooth brome (*Bromus inermis* Leyss.) and quackgrass [*Elymus repens* L. (Gould)], were selected for field evaluation. Field trials were conducted in an established switchgrass field at the Central Grassland Research Extension Station near Streeter, ND and in a quackgrass- and smooth brome-infested field near Fargo, ND. Herbicides were applied at the common and maximum use rates either on May 21 or June 25 in 2009. At the Fargo location, sulfometuron, sulfosulfuron, and topramezone reduced quackgrass over 90% when applied in May. At the Streeter site, quackgrass was reduced over 90% by propoxycarbazone, sulfometuron, and sulfosulfuron. Smooth brome was reduced 100% after the application of aminocyclopyrachlor, sulfosulfuron, and pyroxsulam. However, switchgrass yields were similar regardless of treatment. Smooth brome and quackgrass were not injured when herbicides were applied in June. In summary, a variety of herbicides successfully controlled quackgrass and smooth brome and did not affect switchgrass yield when applied in spring, but were much less effective when applied in early summer. [33]

HORSETAIL (EQUISETUM SPP.) RESPONSE TO HERBICIDES AND MOWING. Glenn R. W. Nice*, Bill Johnson and Tom Bauman, Purdue University, West Lafayette, IN.

Horsetail (*Equisetum spp*.) can be a long-term problem in areas of Indiana that rely on surface drainage ditches to drain tile lines in row crop fields. It can also be an issue with some land managers and home owners. Colonies growing out of these ditches can encroach on agricultural fields and are not controlled with herbicides used in corn and soybean production. A study was conducted to evaluate horsetail response to herbicides and herbicide-mowing combinations. Flumetsulam [1 oz ai/A], flumetsulam [0.74 oz ai/A] + clopyralid [2.4 oz ai/A], aminopyralid, [1.6 oz ai/A], paraquat [16 oz ai/A], and paraquat [16 oz ai/A] + atrazine [16 oz ai/A] were applied with glyphosate [24 lb ae/A]. Glufosinate [6.4 oz ai/A] and saflufenacil [0.9 oz ai/A] were applied without glyphosate. Appropriate surfactants were used where needed. Herbicides treatments were applied to unmowed plots and mowed plots on April 8, 2009. The mowed plots received a second application of the treatments above on June 23, 2009. Paraquat + atrazine induced 56% of the reproductive stems to turn black 29 days after treatment. Other treatments also turned horsetail plots black; however, glyphosate had no effect. Regrowth in the mowed treatments 57 days after first herbicide treatment ranged from 4 to 32 stems/ft sq. The aminopyralid treatment had an average of 4 stems/ft sq, an 87% reduction. Percent biomass reduction 175 days after the first treatment and 99 days after the second treatment was at least 58% by treatments with paraquat or aminopyralid plus mowing. In the unmowed plots only paraquat + atrazine reduced biomass 31%. No other treatments reduced biomass. [34]

PURPLE NUTSEDGE MANAGEMENT IN DESERT ALFALFA. *William B. McCloskey, University of Arizona, Tucson; Eric Norton and Linda Masters, University of Arizona LaPaz County Cooperative Extension, Parker.

Purple nutsedge, a C4 perennial monocot, is very competitive with alfalfa, a C3 crop, in the Southwestern deserts of Arizona and Southern California where daily maximum temperatures usually exceed 100 F in June, July, August and September. The intense summer solar radiation and high temperatures are optimal for nutsedge growth but suppress the growth of alfalfa reducing the competitiveness of the crop. The efficacy glyphosate on purple nutsedge in glyphosate-resistant alfalfa was evaluated in experiments conducted near Parker, AZ using a randomized complete block experimental design with 4 replications and plot sizes of 20 feet by either 300 or 80 feet. The alfalfa (variety WL660) was planted October 18, 2006 and treatments were initiated on May 11, 2007 and continued through fall 2009. Three to five glyphosate applications at 0.91 (0.77 in 2007) to 1.54 lb ae/A were made annually depending on the year and rate of application. Glyphosate was applied with ammonium sulfate in a carrier volume of 12 gal/A using a tractor mounted boom sprayer travelling at 4 mph with flat fan nozzles (TT11003) operated at 25 psi. The glyphosate treatments were compared to an untreated control and a standard which was EPTC at 2 lb ai/A (Eptam 20G) applied 5 times just before irrigations during late spring and summer using a Valmar Airflo granule applicator. Percent purple nutsedge groundcover was assessed immediately after alfalfa harvest at various times during active growth. After the first summer of growth, the purple nutsedge ground cover on November 28, 2007 was 17 and 38% in the EPTC and control treatments, respectively. The purple nutsedge population surged in second summer of alfalfa growth and by August 27, 2008 purple nutsedge ground cover was 94 and 97% in the EPTC and control treatments, respectively. Not considering shoot die-back during the coolest part of the year, the percent purple nutsedge cover ranged between 60 and 80% in the EPTC and control treatments for the duration of the experiment (October 2009) even though other weed species became prevalent (e.g., red sprangletop and prostrate knotweed). During the first summer of growth, the percent purple nutsedge cover in the glyphosate treated plots gradually increased with fluctuations but remained below 15% during 2007. On November 28, 2007, plots treated 4 times with 0.77 lb ae/A had 7.5% purple nutsedge cover while plots treated 4 times with 1.125 lb ae/A or 3 times with 1.54 lb ae/A had 5.3 and 0.4% purple nutsedge ground cover, respectively. Percent purple nutsedge ground cover increased in all plots in 2008 to 25.8, 16.1, and 11.3% in the 0.91 (5X), 1.125 (4X) and 1.54 (3X) lb ae/A glyphosate treated plots, respectively, on September 5, 2008. Glyphosate applications were started earlier in 2008 (in March) than in 2007 (in May) resulting in a substantial warm period in the fall without glyphosate applications and on October 9, 2008 the purple nutsedge groundcover increased to 35.6, 39.3 and 23.6% in the 0.91 (5X), 1.125 (4X) and 1.54 (3X) lb ae/A glyphosate treated plots, respectively. Treatments were started on May 1 in 2009 when purple nutsedge shoot emergence rapidly increased and on September 9, 2009 percent nutsedge cover was 13.4, 6.7, and 10.6% in the 0.91 (3X), 1.125 (3X) and 1.54 (2X) lb ae/A glyphosate treated plots, respectively. The final alfalfa crown densities were 2.5c and 4.5bc crowns m-2 in the control and EPTC treatments, respectively, compared to 14.5bc, 15.8a and 16.6a crowns m-2 in the 0.91, 1.125 and 1.54 lb ae/A glyphosate treatments (letters following the means indicate significance at P=0.05 using the Student-Newman-Keuls test). The optimum time for starting gyphosate applications each year appeared to be early May and the best purple nutsedge suppression occurred when glyphosate applications were spread out over the warm season in May to September when the alfalfa was less competitive. [36]

TOLERANCE OF TEN POTATO VARIETIES TO THREE HERBICIDES: TRIAL SET-UP, DATA COLLECTION, AND RESULTS. JaNan Farr*, Brent Beutler, and Pamela J. S. Hutchinson, University of Idaho, Aberdeen.

Newly-released varieties- Alpine, Classic, Highland, Premier, and Western Russet, and Yukon Gem; and standard varieties- Russet Burbank, Shepody, Yukon Gold, and Dark Red Norland were planted into 3-row plots and hilled 2 wks later spring 2009. Flumioxazin, dimethenamid-p, or fomesafen at 1X and 2X rates was applied preemergence just after hilling and sprinkler-incorporated with 0.5 inch irrigation water. Nontreated variety-controls were included. Injury ratings and plant height measurements were recorded periodically. The trial area was kept weed-free. Pictures included a 4 ft stake marked at 1 ft increments placed in center-rows for use in presentations enabling a visual comparison by audiences. Potatoes were harvested from the center-rows and graded. Weather conditions were unusually cold and wet and injury such as stunting was visible early-season especially in plots treated with 2X rates. Slower growing varieties, such as Russet Burbank, were more affected than faster growing varieties, such as Shepody. Flumioxazin caused stem and lower-leaf necrosis as a result of intense rainfall events splashing treated soil. In spite of injury, 1X rates did not cause yield reductions, regardless of herbicide, while 2X rates resulted in some losses. Trial information was useful because growers were also experiencing injury on newly-released varieties which had never been tested. Past trials were conducted with six rows using the two center-rows for data. Although numerical yield differences between treated and nontreated varieties were seen, statistical difference did not occur possibly due to variability between reps. Four-row plots with two data-rows may be more appropriate in the future. [37]

WILD BUCKWHEAT CONTROL IN DICAMBA TOLERANT SOYBEANS. Michael J. Moechnig*, David A. Vos, and Jill K. Alms, South Dakota State University; Ron Christensen, Monsanto, St. Louis, MO.

A recent survey among 440 South Dakota farmers and herbicide applicators indicated that 78% believe that weeds are getting more difficult to control with glyphosate. Consequently, many farmers are seeking appropriate tank mix partners to achieve consistent weed control in Roundup Ready (RR) crops. However, appropriate glyphosate tank mix partners for soybeans are limited. Dicamba tolerant RR soybeans may provide a new option for farmers to control difficult weed species such as wild buckwheat (*Polygonum convolvulus*). Studies were established in eastern SD in 2008 and 2009 to evaluate wild buckwheat control in dicamba tolerant RR soybeans. Herbicide treatments included three-pass programs where glyphosate (0.84 kg a.e./ha) or glyphosate and dicamba (0.14 or 0.28 kg a.e./ha) were applied pre-emergence followed by two applications among three possible times (10, 30, or 40 cm tall soybeans). Four additional herbicide treatments included herbicides with soil residual activity, such as chlorimuron, flumioxazin, alachlor, or pendimethalin to represent alternative programs. In each year, the pre-emergence glyphosate applications resulted in approximately 70% wild buckwheat control but glyphosate mixed with dicamba resulted in 98% control in 2008 and 82% in 2009 without injuring the soybeans. All of the post-emergence programs with two passes of glyphosate alone or glyphosate and dicamba resulted in nearly complete weed control, including wild buckwheat. In summary, results from this study indicated that control of wild buckwheat and other grass and broadleaf weed species with programs that included glyphosate and dicamba was as good or better than alternative programs and the dicamba tolerant soybeans were not greatly injured by one or two dicamba applications. Consequently, dicamba tolerant RR soybeans may provide useful options to control difficult weed species. [38]

WINTER WHEAT RESPONSE TO SOIL RESIDUES OF AMINOCYCLOPYRACHLOR. Jared C. Unverzagt*, Andrew R. Kniss and David Claypool, University of Wyoming, Laramie.

Aminocyclopyrachlor is a synthetic auxin that is currently under development. Aminocyclopyrachlor may provide control of many weeds present in fallow areas in winter-wheat-fallow rotations. It is important to determine the potential response of winter wheat to aminocyclopyrachlor soil residual. A field study was initiated in 2008 to determine whether aminocyclopyrachlor applied to fallow would affect the yield of wheat the subsequent planting season. Herbicide treatments consisted of aminocyclopyrachlor (DPX-KJM44) at 0.013, 0.027, 0.054 and 0.107 lbs ai/A applied 6 months before planting (MBP), 4 MBP or 2 MBP. Plots were 10 ft wide by 30 ft long. Herbicide treatments were applied at 15 gallons per acre at 40 psi with TeeJet 110015 nozzles. Hard red winter wheat (cultivar 'Genou') was then planted at 60 lbs/A on September 18, 2008. Visual crop injury was evaluated on May 12, 2009, and a 5 foot swath was harvested from each plot on July 24, 2009. Aminocyclopyrachlor treatments resulted in 32 to 87% winter wheat yield reduction. Rate responses were observed in the 6 MBP and 2 MBP application timing, while the 4 MBP application timing resulted in similar yield loss regardless of aminocyclopyrachlor rate. Based on these results, aminocyclopyrachlor should not be used in fallow periods when winter wheat will be planted the ensuing season. [39]

WINTER WHEAT RESPONSE TO AMINOCYCLOPYRACHLOR METHYL ESTER AS A SUMMER FALLOW BURNDOWN TREATMENT. Robert Higgins*, Drew Lyon, University of Nebraska - Panhandle Research & Extension Center, Scottsbluff, NE.

Field studies were conducted at the University of Nebraska High Plains Agricultural Lab near Sidney, NE from 2007 to 2009 to evaluate winter wheat response to aminocyclopyrachlor methyl ester as a summer fallow burndown treatment. Studies were located on a Alliance silt loam (3.5% organic matter) in 2008 and a Duroc loam (3.4% organic matter) in 2009. Five rates (0, 15, 30, 60, and 120 g ai/ha) of aminocyclopyrachlor methyl ester were applied 6, 4 and 2 months prior to winter wheat seeding. The summer fallow was not tilled and the previous crop was corn in both years. Weeds observed included Russian thistle, kochia, tumble pigweed, redroot pigweed, puncturevine, and sandbur. Plots were evaluated for weed control approximately three weeks after treatments were applied. Following these evaluations, the entire study area was sprayed with glyphosate to control all emerged weeds and reduce soil water loss. Aminocyclopyrachlor methyl ester generally provided good to excellent control of kochia and Russian thistle at all rates when these weeds were present, typically 4 and 6 months prior to wheat planting. Redroot pigweed control was good to excellent except at the15 g/ha rate. Control of other weed species were variable and depended on rate and the time of application. Winter wheat injury was not observed in the fall of either year. Injury symptoms were generally first noticed at head emergence. Crop injury consisted of plant height reduction, delayed crop development, and sterile and trapped heads. In one replication in 2009, wheat stands were reduced over the winter. Visible injury was observed at the 120 g/ha rate at all application timings in both years. Injury was also observed at the 60 g/ha rate when applications were made 2 or 4 months before wheat planting. Wheat grain yield was negatively affected by lower rates of aminocyclopyrachlor methyl ester than those that caused visual crop injury. Yield responses were slightly different between the two years of the study, with yield reductions being slightly greater in 2009 than in 2008. Regression equations relating grain yield (y) in kg/ha to herbicide rates (x) in g/ha for 2008 were: $y = 3300 - 67.5x + 0.352x2$, $R2 = 0.953$; $y = 3230 - 66.4x + 0.345x2$, $R2 = 0.947$; and $y = 3150 - 21.4x$, $R2 = 0.908$ for 2, 4, and 6 months prior to winter wheat planting. In 2009, regression equations for these same application timings were: $y = 3000 - 86.1x + 0.521x2$, $R2 = 0.856$; $y = 3320 - 73.9x + 0.392x2$, $R2 = 0.899$; and $y = 3530 - 26.7x$, $R2 = 0.896$. All equations were significant at $p < 0.001$ and $n = 15$. Although aminocyclopyrachlor methyl ester provided good to excellent control of broadleaf weeds such as kochia, Russian thistle, and redroot pigweed during summer fallow, the risk of crop injury to the succeeding winter wheat crop is probably unacceptable. [40]

SPRAY ADDITIVE EFFECT ON WINTER ANNUAL GRASS RESPONSE TO IMAZAMOX. Holden J. Hergert, Andrew R. Kniss; and Drew Lyon, University of Wyoming, Laramie.

Field studies conducted at the University of Nebraska have shown a decrease in feral rye control when 10-34-0 fertilizer made up 25% or more of the imazamox spray solution. A greenhouse study was conducted in 2009 at the University of Wyoming to investigate the effect of nitrogen fertilizer rate in the imazamox spray solution on feral rye control. Two fertilizer sources (10-34-0 or 32-0-0) were added at 2.5, 25, or 50% by volume to imazamox rates of 4, 9, 17, 35, 53, and 70 g/ha. Herbicide treatments were applied in a spray chamber delivering 187 l/ha at 276 kPa. There were five replicates per study, and the study was conducted twice. Data were analyzed using analysis of variance and non-linear regression of above ground biomass dry weight. As the rate of 10-34-0 increased, control of feral rye decreased, whereas the opposite trend was observed with 32-0-0. When fertilizer was added at 50% of the spray solution by volume, dry weight reduction of feral rye biomass was 27% and 57% with 10-34-0 and 32-0-0, respectively, when averaged over imazamox rates of 35 g/ha and above. Current research is continuing to determine whether other sources of 10-34-0 have a similar antagonistic effect on feral rye control. [41]

WINTER WHEAT VARIETIES RESPONSE TO MESOSULFURON APPLIED UNDER ADVERSE ENVIRONMENTAL CONDITIONS IN IDAHO, OREGON AND WASHINGTON. Traci Rauch*, Donn Thill, University of Idaho, Moscow; Ian Burke, Dennis Pittman, Joe Yenish, Rod Rood, Washington State University, Pullman; Dan Ball and Larry Bennett, Oregon State University, Pendleton.

Mesosulfuron is a herbicide used in winter wheat to control many difficult annual grass weeds including wild oat and Italian ryegrass. Mesosulfuron can cause chlorosis and stunting in winter wheat especially under stressful environmental conditions, which include freezing temperatures or large temperature fluctuations. Studies were established near Moscow, ID, Pendleton, OR and Pullman, WA in 2008 and 2009 to evaluate visual injury, grain yield, and test weight of six winter wheat varieties treated with mesosulfuron and bromoxynil/MCPA applied alone or in tank mix combination during adverse environmental conditions. Only data from 2009 are presented. The experimental design was a randomized complete block, strip plot with four replications. Main plots were six winter wheat varieties (Boundary, Brundage96, Chukar, Eddy, Madsen, and 0RCF 102) and subplots were three herbicide treatments (mesosulfuron alone, mesosulfuron plus bromoxynil/MCPA, and bromoxynil/MCPA alone) and an untreated check. At Moscow, two weeks prior to or after the application date, 6 days had freezing temperatures and 15 days had at least a 15 C temperature fluctuation. At 7, 14 and 21 DAT, mesosulfuron plus bromoxynil/MCPA and mesosulfuron alone injured wheat 7, 10 and 9% and 4, 5, and 3%, respectively. Eddy wheat injury at 7 DAT (4%) was greater than all other varieties (3%). By 14 DAT, wheat injury did not differ among varieties. Wheat grain yield was lowest for Boundary compared to all other varieties. Wheat grain yield and test weight did not differ among herbicide treatments and the untreated check. At Pendleton, two weeks prior to or after the application date, 23 days had freezing temperatures and 6 days had at least a 15 C temperature fluctuation. At 21 and 35 DAT, mesosulfuron plus bromoxynil/MCPA and mesosulfuron alone injured wheat 3 and 4% and 1 and 2%, respectively. Boundary wheat injury at 35 DAT (3%) was greater than all other varieties (0 to 2%). Wheat grain yield and test weight was lowest for Chukar compared to all other varieties. Wheat grain yield did not differ among herbicide treatments and the untreated check. At Pullman, two weeks prior to or after the application date, 13 days had freezing temperatures and 5 days had at least a 15 C temperature fluctuation. At 14, 21 and 42 DAT, mesosulfuron plus bromoxynil/MCPA and mesosulfuron alone injured wheat 14, 18 and 2% and 5, 7, and 0%, respectively. Eddy wheat injury at 42 DAT (4%) was greater than all other varieties (0%). Wheat grain yield was lowest for Chukar but did not differ from Boundary. Wheat test weight was lowest for Chukar compared to all other varieties. All herbicide treated plots yielded less grain and had lower test weight compared to the untreated check but did not differ among herbicide treatments. [42]

PREEMERGENCE APPLICATIONS OF SAFLUFENACIL AND FLUCARBAZONE IN SPRING WHEAT. David A. Vos*, Michael J. Moechnig, Jill K. Alms, and Darrell L. Deneke, South Dakota State University, Brookings.

Recent registrations of saflufenacil and flucarbazone provide new options for residual weed control in wheat. Saflufenacil provides foliar and residual control of many broadleaf weed species whereas flucarbazone provides foliar and residual control of many annual grass weed species. Research was conducted from 2007 to 2009 in northeastern and central South Dakota to evaluate residual weed control after pre-emergence applications of saflufenacil and flucarbazone applied separately or in combination in spring wheat. Among three studies at two locations, flucarbazone applied at 15 g a.i./ha resulted in 67 - 91% wild oat (*Avena fatua*) control and 82 – 96% green foxtail (*Setaria viridis*) control. In one study, saflufenacil applied at 37 g a.i./ha resulted in 83% common lambsquarters (*Chenopodium album*) control, 73% common ragweed (*Ambrosia artemisiifolia*) control, and 50% wild buckwheat (*Polygonum convolvulus*) control. Mixing saflufenacil (18 – 25 g a.i./ha) with flucarbazone (15 g a.i./ha) did not antagonize weed control and resulted residual broadleaf weed suppression and good residual grass weed control without causing spring wheat injury. Therefore, results from this study suggested that saflufenacil and flucarbazone may effectively result in residual weed suppression or control when applied prior to spring wheat emergence. [43]

SOYBEAN DOUBLE CROP ROTATION RESPONSE TO SPRING APPLIED PYROXSULAM IN WINTER WHEAT. Roger E. Gast, Gary A. Finn, D. Chad Cummings, Monte R. Weimer and Jeffrey M. Ellis, Dow AgroSciences, Indianapolis, IN; Patrick W. Geier, Douglas E. Shoup, Kansas State University, Hays and Chanute; Thomas F. Peeper, Oklahoma State University, Stillwater; and Phil Westra, Colorado State University, Ft. Collins.

Field research was conducted over a two year period across the central and southern Plains to evaluate the crop response of soybeans following a spring application of pyroxsulam versus competitive standards in winter wheat. Four trials were conducted in 2008 and five trials conducted in 2009 in Colorado, Kansas, and Oklahoma. Pyroxsulam (1X use rate = 18.4 g ha-1) was compared against propoxycarbazone (1X use rate = 44 g ha-1), mesosulfuron (1X use rate = 15 g ha-1) and three premix products; 1) propoxycarbazone + mesosulfuron (Olympus Flex, 1X use rate = 25 g ha-1), 2) chlorsulfuron + metsulfuron (Finesse, 1X use rate = 26.3 g ha-1), and 3) chlorsulfuron + flucarbazone (Finesse Grass and Broadleaf, 1X use rate = 37.7 g ha-1). All herbicides were sprayed at 1X and 2X use rates and pyroxsulam, mesosulfuron, and Finesse were also included at 4X use rates. Applications were made in the spring to fully tillered winter wheat prior to stem elongation. Soybeans were planted as a double crop 32-120 days after the herbicide applications. Visual crop injury assessments were made after the soybeans emerged. Double crop soybeans were not affected when planted within the 32-120 day interval following a spring application of pyroxsulam at 1X, 2X, and 4X use rates, and mesosulfuron and propoxycarbazone at 1X and 2X use rates. The premix herbicides Olympus Flex, Finesse, and Finesse Grass and Broadleaf caused varying degrees of crop injury (5 – 53%) to soybeans dependent upon use rates. Soybean double crop results in the Plains states were supported by similar trial results for pyroxsulam from the Southern US. The labeled soybean double crop rotation interval was recently changed to 3 months following a spring application of pyroxsulam in winter wheat in selected geographies in the US. [44]

DOWNY BROME RESPONSE TO SOIL APPLIED HERBICIDES. Roberto Luciano* and Kirk A. Howatt, North Dakota State University, Fargo.

Downy brome (*Bromus tectorum* L.), a winter annual grass, is a serious weed in cultivated crops, forages, and rangelands. Few selective herbicides provide adequate control of established downy brome plants and germinating seeds over the season. Greenhouse experiments were conducted to evaluate the response of downy brome plants and seedlings to herbicides applied to soil without foliar contact. Atrazine, flucarbazone, flumioxazin, pendimethalin, propoxycarbazone, pyroxasulfone, and sulfentrazone at rates from 0.5 to 2x were applied to soil when downy brome was at germination and the one- to two-leaf stage. Control of downy brome varied considerably with plant stage, herbicide, and herbicide rate. Downy brome control with propoxycarbazone, flumioxazin, and pyroxasulfone increased as rate increased. Soil residue of propoxycarbazone at 1x rate provided 60 and 81% control of plants and seedlings, respectively. Flucarbazone at the 1x rate gave less than 55% control of either plants or seedlings. Seedling control was 60 and 91% with flumioxazin and pyroxasulfone, respectively, at the 1x rate. Downy brome plant growth was reduced 66 and 48% with flumioxazin and pyroxasulfone, respectively. Atrazine gave excellent control of downy brome plants (81%) and seedlings (99%) regardless of rate. Propoxycarbazone, flumioxazin, and pyroxasulfone have been selected for additional field research based on greenhouse results. Herbicides at 1, 1.5, and 2x rates will be evaluated for downy brome control. Also, crop safety to propoxycarbazone and flumioxazin at different application dates before seeding wheat will be evaluated. [45]

PREHARVEST HERBICIDE APPLICATIONS IN SPRING WHEAT: EFFECTS OF APPLICATION TIMING ON WHEAT YIELD AND GERMINATION. Jill K. Alms*, Michael J. Moechnig, David A. Vos, and Darrell L. Deneke, South Dakota State University, Brookings.

Preharvest herbicides have occasionally been applied to wheat fields to desiccate weed infestations that may inhibit harvest or prevent seed production by noxious weeds that may contaminate certified wheat seed. Recent increases in cover crop use may also provide an incentive to hasten small grain harvest to enable timely cover crop planting. It is generally recommended to apply preharvest herbicides when wheat seed moisture is 35% or less to prevent yield loss and loss of seed viability. Field research was conducted in 2007 and 2008 to quantify the effect of preharvest applications on spring wheat yield and seed germination to generate data for extension publications regarding preharvest application guidelines. Herbicide treatments included 2,4-D ester, dicamba, metsulfuron, glyphosate, and carfentrazone. Treatments were applied at 50% and 35% wheat seed moisture in 2007 and at 50% and 16% wheat seed moisture in 2008. Saflufenacil was applied at 16% seed moisture in the 2008. Wheat yields were measured and wheat seeds were tested for viability. Average wheat yields were similar in 2007 but glyphosate applied at 50% seed moisture reduced wheat yield by 8% in 2008. Only glyphosate applied at 50% seed moisture affected seed viability. Glyphosate applied at 50% seed moisture resulted in 70 to 92% abnormal seedlings while glyphosate applied at 35% or less moisture resulted in 2% abnormal seedlings. Abnormal seedlings where characterized as those having deformed or stunted coleoptiles and radicles. It is not known if seedling abnormalities induced by glyphosate would have affected wheat growth and yield. Results from this study reiterate the need to apply Roundup at 35% or less seed moisture to diminish the risk of yield loss and reduction of seed viability or seedling vigor. [46]

DOWNY BROME CONTROL IN WINTER WHEAT WITH FALL OR SPRING HERBICIDE TREATMENTS . Andrew R. Kniss and David A. Claypool, University of Wyoming, Laramie, WY, Jerry J. Nachtman*, Sustainable Ag Research and Extension Center, Lingle, WY,.

Downy brome is a serious weed problem in winter wheat in Wyoming, especially in no-till or reduced tillage systems. The need for herbicide control of downy brome has become very important. A field study was conducted at the Sustainable Agriculture Research and Extension Center near Lingle, Wyoming, in 2009 to evaluate fall and spring herbicide treatments for downy brome control in winter wheat. 'Genou' hard red winter wheat was planted in 7.5-inch rows at a rate of 60 lbs per acre on September 18, 2008. Soil at the site was Mitchell silt loam. Herbicide treatments were applied on October 4, 2008 and April 13, 2009. Visual crop injury evaluations were made periodically throughout the growing season. Downy brome control was evaluated visually on October 23, 2008, and July 14, 2009. A 5-ft swath from each plot was harvested on July 24, 2009, and yield was determined in the field. No herbicide treatment caused significant visual crop injury. Winter wheat yield was low, ranging from 8 to 15 bu/A, and did not differ between herbicide treatments. At the fall downy brome control evaluation, propoxycarbazone-sodium plus mesosulfuron-methyl provided less control than pyroxsulam, propoxycarbazone-sodium, or sulfosulfuron. However, by the summer evaluation, fall treatments of propoxycarbazone-sodium, propoxycarbazone-sodium plus mesosulfuron-methyl, and sulfosulfuron provided greater than 90% downy brome control compared to only 65% control from pyroxsulam. Pyroxsulam provided similar control regardless of whether it was applied in the fall or spring (63 to 65%). Splitting the application of pyroxsulam into fall and spring applications reduced downy brome control to 47%. Fall applications of propoxycarbazone-sodium, propoxycarbazone-sodium plus mesosulfuron-methyl, or sulfosulfuron provided better brome control than spring applications. Split applications of propoxycarbazone-sodium were similar to fall treatments. However, a trend for better downy brome control was observed if the split application consisted of 0.0393 lbs ai/A in the fall followed by 0.0131 lbs ai/A in the spring compared to 0.0263 lbs ai/A applied at both timings. [47]

IMPACT OF APPLICATION TIMING OF PYROXSULAM AND STANDARDS ON THE CONTROL OF DOWNY BROME IN MONTANA. Brett Oemichen* and Roger Gast, Dow AgroSciences LLC; Steven King and Ed Davis, Montana State University.

Field research was conducted in south-central Montana between 2007 and 2009 to evaluate the effect of application timing on the control of downy brome with pyroxsulam and competitive standards. Two trials were conducted; one during the 2007-2008 growing season and the second during the 2008-2009 growing season at the Montana State University Southern Ag Research station near Huntley, MT. Pyroxsulam (18.4 g/ha), propoxycarbazone (44 g/ha), propoxycarbazone-sodium + mesosulfuron-methyl (25 g/ha) and sulfosulfuron (35 g/ha) were applied at four timings during fall (Timing A), late fall (Timing B), late winter (Timing C) and spring (Timing D). Each of the four herbicides was applied with its labeled surfactant or surfactant + ammonium sulfate dosage. Control of downy brome varied between the two trial seasons, particularly at the B and C timings. Efficacy variability at the B and C timings was influenced by whether or not brome was either actively growing (2008-2009 study) or dormant (2007-2008 study). Herbicidal efficacy was most consistent at the A and D timings. The best control of downy brome was achieved at the fall application (A) timing where control ranged form 82 to 92% across both growing seasons. Pyroxsulam provided control of downy brome that was equal to or better than the competitive standards at the fall (A), late fall (B) and late winter (C) application timings. Control of downy brome with pyroxsulam in the spring (D) timing was superior to the competitive standards. At the D timing, herbicidal efficacy was challenged by advanced brome growth stages which varied from plants as large as 5 tillers to boot stage across both trial years. Consistent with the product labels, all of the herbicides included in the trials claim control of downy brome with a fall application and suppression with a spring application. These studies indicate that downy brome control with pyroxsulam and the other herbicides is best achieved when applied to actively growing plants < 2 tillers in size. Control of downy brome was reduced when herbicides were applied to winter dormant or large, multiple-tillered downy brome plants. [48]

THE CRITICAL PERIOD OF WEED CONTROL IN CHICKPEAS. Jamin Smitchger*, Ian C. Burke, and Joseph P. Yenish, Washington State University, Pullman.

The critical period of weed control for 'Dylan' (fern leaf) and 'Sierra' (simple leaf) chickpeas were determined in field experiments near Pullman, Washington in 2008 and 2009. The chickpea crop was kept free of weeds for periods of 0, 14, 25, 35, 45, 60, 75, or 100 days after emergence (DAE), or weeds were allowed to grow before removal for 0, 14, 25, 35, 45, 60, 75, or 100 DAE. Nontreated weedy controls of 'Dylan' chickpeas had 85% and 9% yield reduction compared to weed-free controls in 2008 and 2009, respectively. A comparison of the same treatments with 'Sierra' chickpeas indicated yield reductions of 52% and 28% in the same respective years. Measurements of weed biomass at crop maturity indicated 1% reduction in chickpea seed yield for every 4.89 g increase in dry weed biomass / m2. Based on a 5% yield loss threshold, critical weed-free periods for 'Sierra' were 33 to 54 and 11 to 20 DAE during 2008 and 2009 respectively. The critical period for 'Dylan' was 22 to 62 in 2008, while no critical period was observed in 2009. When combined over years and varieties, the critical period of weed control was estimated to be 22 to 39 DAE. Different weed densities, species, and environmental conditions appear to affect the critical period of weed control. Future research should focus on agronomic factors such as planting date and density on the critical period of weed control in chickpea. [49]

RESPONSE OF DRY BEANS TO PLANT POPULATION AND ROW SPACING IN WYOMING. Robert Baumgartner*, Andrew R. Kniss, David Claypool, University of Wyoming.

In order to better understand the relationship between plant population and row spacing in dry beans, a field trial was established at the Sustainable Agriculture Research and Extension Center near Lingle, Wyoming, to evaluate 5 plant populations (30,000; 60,000; 90,000; 120,000; and 150,000 seeds/acre) within two row spacings, 15- and 30-inches. EPTC at a rate of 1.3 lbs ai/A plus ethalfluralin at a rate of .75 lbs ai/A was applied and mechanically incorporated prior to planting. 'Orion' Great Northern beans were planted into 15- and 30-inch rows at the targeted populations with a multiple row spacing variable seed rate planter utilizing John Deere max emerge vacuum planter units. Plots were 10 feet wide by 30 feet long arranged in a split–plot design with 4 replicates. Bean populations were counted on June 29, 2009. Light interception data was collected on September 1, 2009 utilizing a LI-COR LAI 2000 Plant Canopy Analyzer (LI-Cor BioSciences, Lincoln, NE). Yield was determined from 25ft² per plot harvested September 10, 2009. Actual stand counts were higher than the targeted populations in the 30-inch rows, though the 15-inch row stand counts were close to the targeted populations. Dry bean yields ranged from 2,000 to 2,700 lbs/acre and were not influenced by row spacing or population. Test weights were also not significantly different between the treatments. Weed counts did tend to be lower in the 15-inch rows as compared to the 30-inch rows, though not statistically significant. Leaf area index (LAI) ranged from 2.8 to 4.2, but were not significantly different between population or row spacing. Dry bean yield was not significantly correlated to LAI or light interception on September 1, 2009. These results indicate that the dry bean crop was able to produce acceptable yields in all of the row spacings and plant populations tested in this study. Therefore dry bean growers may not see a yield increase from reducing dry bean row spacing from 30- to 15-inches. However, growers contemplating a switch to narrower row spacing due to benefits in other rotational crops will likely not see a reduction in dry bean yields. [50]

WEED CONTROL AND CHICKPEA YIELD WITH PREPLANT AND PREEMERGENCE HERBICIDE APPLICATION TIMINGS . Joseph P. Yenish* and Rodney Rood, Washington State University, Pullman.

Currently, there are no postemergence broadleaf herbicides labeled for use in chickpeas. Thus, growers must apply preemergence herbicides in a manner that provides the greatest duration of weed control. Proper timing of preemergence herbicide applications are important for herbicide efficacy and for growers to effectively allocate equipment and labor resources during the busy spring season. Studies were conducted in which 8 herbicide or herbicide combination treatments were each applied at 3 applications timings during 2008 and 2009. Weed populations varied between years, but consisted of mayweed chamomile, prickly lettuce, and spiny sowthistle. Three timings were approximately 1 and 2 weeks prior to and 1 week following crop planting. Herbicide treatments were 0.047 lbs imazethapyr, 0.1875 lbs sulfentrazone, 0.0478 lbs flumioxazin, 0.1875 lbs metribuzin, 0.1875 lbs metribuzin plus 0.03125 lbs imazethapyr, 0.1875 lbs metribuzin plus 0.1875 lbs sulfentrazone, 0.1875 lbs metribuzin plus 0.0478 lbs flumioxazin, and 0.1406 lbs sulfentrazone plus 0.0319 lbs flumioxazin. Additional treatments included weedy and weed-free controls. In 2008, weed density and weed biomass were lowest while crop yield was greatest with the combination of sulfentrazone plus flumioxazin applied post planting. In 2009, weed density and weed biomass were lowest with sulfentrzone and flumioxazin containing treatments applied at the earliest timing. There was no obvious trend in crop yield with the various herbicide treatments or timings in 2009. Generally, in 2008, delaying application increased herbicide effectiveness for all treatments except for imazethapyr alone. However, in 2009, the earliest application timing tended to have greatest efficacy. [51]

DRY BEAN RESPONSE TO FLUMIOXAZIN . Dennis C. Odero*, Andrew R. Kniss and David Claypool, University of Wyoming, Laramie.

Weed control is of major concern in dry bean production in the Central High Plains. Dry bean yield and quality may be reduced if adequate weed control measures are not undertaken. A field experiment was conducted in 2009 at the James C. Hageman Sustainable Agriculture Research and Extension Center, near Lingle, WY to evaluate the response of dry beans to preemergence (PRE) application of flumioxazin. Preplant incorporated (PPI) herbicide treatments were applied and mechanically incorporated, followed by planting of 'Orion' Great Northern dry beans and application of PRE herbicide treatments on May 29. A postemergence (POST) herbicide treatment was subsequently applied on June 29. Treatments containing flumioxazin in combination with trifluralin, pendimethalin, and ethalfluralin reduced dry bean stand by an average of 43% compared to EPTC + ethalfluralin PPI, and imazamox + bentazon POST. On

June 16, visual injury of bean plants was 50, 31, and 30% for combinations of flumioxazin with trifluralin, pendimethalin, and ethalfluralin, respectively. However, on June 29, and July 14, visual injury was between 2 and 5% indicating that bean plants were able to survive the flumioxazin treatment and outgrew the injury from the herbicide. Treatments containing flumioxazin provided at least 98% control of hairy nightshade, whereas EPTC + ethalfluralin PPI provided 90%, and imazamox + bentazon POST provided 75% control. All treatments provided more than 94% control of redroot pigweed, common lambsquarters, and green foxtail with the exception of imazamox + bentazon POST which provided 75 and 89% control of common lambsquarters and green foxtail, respectively. However, the weed control differences were not statistically different. Bean yields were variable, and consequently not statistically different. However, treatments containing flumioxazin yielded on average 31% less than the hand-weeded check. Wet spring conditions probably contributed to the high level of injury observed in 2009. In the two weeks following planting, over 8.4 cm of rain was received at this site. During this time span, there was only one day where precipitation was not recorded. [52]

WEED CONTROL AND PULSE TOLERANCE TO SOIL-APPLIED HERBICIDES . Brian M. Jenks*, Gary P. Willoughby, and Jordan L. Hoefing, North Dakota State University, Minot.

Weed control options are limited in dry pea, lentil, and chickpea production. Several studies were conducted in 2009 to evaluate weed control and pulse crop tolerance to soil-applied herbicides. In study 1, sulfentrazone, tribenuron, saflufenacil, KIH-485, flumioxazin, and pendimethalin applied preemergence (PRE) were evaluated for weed control and crop tolerance in dry pea, lentil, and chickpea. In study 2, dry pea and chickpea tolerance to various rates of saflufenacil applied PRE were evaluated. In study 3, we compared fall- vs. spring (PRE) applications for weed control and crop tolerance in dry pea and lentil. In study 4, pulse crop sensitivity to flumioxazin applied in September, October, or November was evaluated. In study 1, none of the herbicides caused visible chickpea injury. In dry pea, saflufenacil at 100 g/ha and flumioxazin at 107 g caused 9 and 8% injury, respectively. Other herbicides caused less than 5% dry pea injury. More herbicide injury was observed in lentil. About 6 weeks after treatment (WAT), all treatments caused at least 10% lentil injury. Tribenuron (13 g), saflufenacil (25 g), and imazethapyr (35 g) (all tank mixed with pendimethalin) and sulfentrazone (105 g) caused 10-16% lentil injury 6 WAT. KIH-485 (168 and 336 g) caused 16-25% injury and flumioxazin (72 and 107 g) caused 21-39% lentil injury 6 WAT. However, by 10 WAT all treatments recovered to less than 10% injury, except for flumioxazin which still caused 17-37% injury. Treatments containing sulfentrazone provided 83-97% control of lambsquarters, wild buckwheat, and kochia at 10 WAT; but were weaker on redroot pigweed (63-87%). KIH-485 generally provided only poor to fair control (38-67%) of these weeds, but was more effective on redroot pigweed (79-94%). Flumioxazin provided 58-86% control of the previously mentioned weeds. In study 2, saflufenacil (50, 75, 100 g/ha) caused no visible dry pea injury and about 8% chickpea injury with 100 g/ha. However, there was a trend for lower dry pea yield as rate increased, while in the chickpea study, there was a trend for increasing yield as rate increased. While the studies were not handweeded, there was generally low early-season weed pressure, but low to moderate late-season weed pressure. In study 3, several herbicides were applied in fall 2008 or PRE including combinations of flumioxazin, sulfentrazone, KIH-485, and pendimethalin. Dry pea and lentil were seeded in May 2009. Essentially no dry pea injury was observed from any treatment. In lentil, flumioxazin alone or mixed with KIH-485 caused the most injury (18-28%) at 6 WAT.

Tank mixes containing sulfentrazone caused 13-20% lentil injury. KIH-485 alone caused about 15% injury. Treatments containing sulfentrazone applied PRE provided better control of wild buckwheat and lambsquarters (85-100%) than treatments containing flumioxazin (67-87%). However, fall-applied flumioxazin provided better pigweed control (78-81%) than did sulfentrazone (63%). Fall-applied KIH-485 provided excellent pigweed control (99%) compared to 86% applied PRE. Spring-applied sulfentrazone generally provided equal or slightly better weed control compared to fall-applied. In study 4, flumioxazin was applied at 72 and 107 g/ha in September, October, or November of 2008. Pendimethalin was also applied in September as a standard comparison. Dry pea, lentil, and chickpea were seeded into the treated area in May 2009. There was no visible injury to dry pea and only 6% or less injury to lentil or chickpea. There were no differences in yield or test weight between treatments with any crop. [53]

GUAYLE TOLERANCE TO TOPICAL HERBICIDE APPLICATIONS. Erin L. Taylor*, University of Arizona Cooperative Extension, Phoenix; and William B. McCloskey, University of Arizona Cooperative Extension, Tucson.

Guayule, *Parthenium argentatum* (Gray), is a xerophytic shrub native to the Chihuahuan desert that produces natural latex. Guayule rubber and Hevea rubber have the same physical and structural properties and can be used to make the same products (e.g., latex gloves). However, guayule rubber contains only 0.2 to 2% of the protein content of Hevea rubber and does not cause the allergic reactions that are experienced with hevea rubber. Due to the lack of information on guayule tolerance to herbicides and lack of registered herbicides, weed control is a significant production issue with labor costs for hand weeding often exceeding $200/acre. Research was conducted at the University of Arizona Maricopa Agricultural Center in Maricopa, Arizona to identify herbicides that can be used to control weeds in guayule without injuring the crop. A randomized complete block design with 6 replications and one application time (2006) or a randomized split-plot design (2007) with 4 replications and either 1 or 2 sequential applications (2007) were used to conduct the experiments; plot size was 4 rows (13.33 ft) by 45 feet. Tractor mounted research plot sprayers were used to apply herbicides over the top of transplanted guayule (PARAR) seedlings (4 to 6 inch tall in 2006 and 6 to 10 inch tall in 2007) at carrier volumes between 15 and 29 gal/A depending on the herbicide and year of the experiment. The amount of guayule injury caused by the herbicides was evaluated by measuring stunting and visually estimating the degree of chlorosis and necrosis at various times after treatment (DAT). Of the synthetic auxin herbicides 2,4-DB, clopyralid, dicamba and fluroxypyr; clopyralid (0.25 to 0.75 lb ae/A), fluroxypyr (0.125 to 0.375 lb ae/A) and dicamba (0.25 to 0.75 lb ae/A) caused severe injury and significant mortality. In contrast 2,4-DB (0.25 to 1.0 lb ae/A) applied March 29, 2007 or February 19, 2008 caused the least injury (less than 10% stunting at rates up to 0.5 lb ae/A) but a later sequential application during warmer weather on May 14, 2008 caused severe injury. Herbicides that inhibit protoporphyrinogen oxidase (PPO) or protox inhibitors, caused minimal stunting of guayule 30 DAT and guayule height differences between protox inhibitor herbicide treatments were not significant 78 DAT (carfentrazone at 0.031 and 0.063 lb ai/A; flumioxazin at 0.096 and 0.19 lb ai/A; pyraflufen ethyl 0.0032 and 0.0065 lb ai/A; and oxyfluorfen [GoalTender] at 0.5 and 0.125 lb ai/A). Herbicides that inhibit branched-chain (aliphatic) amino acid synthesis, the ALS and AHAS inhibitors (halosulfuron-methyl, trifloxysulfuron-sodium, imazamox and imazethapyr), resulted in the most variable guayule injury symptoms. All treatments caused some degree of stunting with halosulfuron (0.062 and

0.094 lb ai/A) treatments resulting in the most injury, up to 30% stunting at 30 DAT. Imazamox (0.047 and 0.062 lb ae/A) caused minor injury at 30 DAT but the guayule plants recovered and exhibited little or no stunting or injury at 78 DAT. In conclusion, of the synthetic auxins only 2,4-DB has potential; it caused minor injury early but guayule canopy height was similar to control plants 78 DAT. The protox inhibitors carfentrazone, flumioxazin, pyraflufen-ethyl and oxyfluorfen all have excellent crop safety and other members of this group of herbicides with preemergence activity such as sulfentrazone should be investigated. The imidazolinones and sulfonylureas also all have some potential for weed control in guayule, especially imazamox but need further investigation with respect to application methods (e.g., topical versus post-direct) and application rates. [54]

SMALL BURNET TOLERANCE TO SEVERAL HERBICIDES. Abdel O. Mesbah, Mike J. Killen, and Sandra M. Frost, University of Wyoming, Powell.

Small burnet (*Sanguisorba minor* Scop.) is an introduced herbaceous member of the Rose family (*Rosaceae*). Small burnet seed is in demand for reclamation seed mixes, and is currently produced in small quantities. There is no information available on weed control and small burnet tolerance to herbicides. A one-year study was conducted in 2008-2009 in northwestern Wyoming to evaluate weed control and small burnet response to several soil applied and postemergence herbicides. Postemergence treatments were applied during the establishment year on July 14, 2008. Soil applied treatments were applied when small burnet was still dormant on March 4, 2009. With the exception of 2,4-DB Amine, all postemergence treatments caused moderate to severe crop injury (from 18 to 56%) during establishment year. Imazethapyr and Imazamox applied alone or in combination with bentazon, resulted in early high crop injury that declined with time. Bromoxynil and Bromoxynil/MCPA advanced treatments caused moderate crop injury; 18% and 25%, respectively. By the second year, small burnet recovered from most of the injuries except in plot treated with bentazon + imazamox or imazethapyr, where light injuries (8 to 10%) were recorded. These injuries resulted in short stature plants and fewer seed head production. Small burnet injuries from soil applied treatments were minimal (1-2%) and not significant. Weed control varied from poor to excellent depending on the treatments and weed species. The combination bentazon + imazamox provided better broadleaf weed control than bentazon + imazethapyr. Imazamox applied alone or tank mixed provided better control of common lambsquarters (Chenopodium album L.) than treatments containing imazethapyr. Grass weed control was excellent with treatments containing clethodim. [55]

REGIONAL SUMMARY OF MILLET TOLERANCE TO PREEMERGENCE SAFLUFENACIL. Phillip W. Stahlman and Patrick W. Geier, Kansas State University, Hays; Leo D. Charvat, BASF Corporation, Lincoln, NE; Michael J. Moechnig, South Dakota State University, Brookings; Philip Westra, Colorado State University, Ft. Collins; and Robert G. Wilson, University of Nebraska, Scottsbluff .

In Kansas in 2006, pearl millet and proso millet recovered from severe leaf necrosis caused by postemergence application of saflufenacil and grew normally, whereas the stand of foxtail millet was severely reduced. These results suggested saflufenacil might have potential for use in millets if applied preplant or preemergence. Field experiments were conducted at four sites in Colorado (1) , Kansas (1), and Nebraska (2) in 2009 to compare the relative tolerance of pearl millet, proso millet, and foxtail millet to preemergence-applied saflufenacil at rates of 36, 50, and 100 g/ha. A fifth site in South Dakota included only proso millet. Soils ranged from sandy loam to silty clay loam with a pH range of 4.7 to 8.1 and organic matter content range from 1.0 to 3.2%. Crop response varied considerably among experiments. Greatest crop injury occurred at Scottsfluff, NE on a sandy loam soil with pH 8.1 and 1.0% organic matter. Crop injury was least severe at the Colorado site, though response trends were similar to the other sites. At three of four sites, pearl and proso millets exhibited about four-times greater tolerance than foxtail millet to 36 and 50 g/ha rates of saflufenacil. Foxtail millet was essentially killed (≥94% growth reduction) by saflufenacil at 100 g/ha; except Colorado at 46% injury. Pearl millet was slightly more tolerant to saflufenacil than proso millet at two of four sites and when averaged over the four sites. Crop injury increased with increasing saflufenacil rate, especially from 50 to 100 g/ha. Despite early season necrosis and stunting, mean yields (forage or grain) of pearl and proso millets treated with saflufenacil at 36 or 50 g/ha ranged from 97 to 106% of untreated control yields. Collectively, these results confirm that saflufenacil has potential for use in pearl millet and proso millet but additional studies are needed to refine use rates and application timings (preplant versus preemergence) and determine if tolerance is affected by edaphic factors and production practice (till versus no-till). [56]

GLYPHOSATE-RESISTANT KOCHIA IN KANSAS: FACT OR FICTION?. Amar S. Godar*, Kansas State University, Manhattan; Phillip W. Stahlman, Kansas State University Agricultural Research Center-Hays; and J. Anita Dille, Kansas State University, Manhattan.

Several populations of kochia in western Kansas are thought to be resistant to glyphosate. A study was conducted to evaluate the response of kochia from a single population in northwest Kansas to glyphosate. Seedlings from a suspected glyphosate-resistant kochia population were sprayed with increasing rates of glyphosate at two-week intervals and evaluated visually. Two hundred and twenty three (223) plants out of 265 survived multiple applications of glyphosate at 560 fb 840 fb 1120 g ae/ha. Surviving plants were allowed to cross pollinate and seed was collected from individual plants (accessions). Several of these accessions including a known glyphosate-susceptible accession were grown in a greenhouse and outside for further testing. Plants were sprayed with glyphosate at 1, 2, 4, and 8-times the use rate of 840 g ae/ha when 10 to 15 cm tall. Plants from most accessions recovered from slight injury by the 2x glyphosate use rate and produced seed. Several outside-grown accessions survived 4x glyphosate and a few survived 8x glyphosate, but greenhouse-grown plants survived only 2x glyphosate rate. Susceptibility of kochia to glyphosate within and between accessions varied widely, but many plants of several accessions survived 2- to 4-times the normal use rate of glyphosate. Accessions that survived at least 2x glyphosate use rate germinated 5-7 days later at lower frequency and had less robust growth compared to known glyphosate-susceptible population. Presence of glyphosate-resistant kochia in Kansas is a fact, not a fiction and glyphosate-resistant plants may have different fitness than glyphosate-susceptible plants. [57]

CONTROL OF GROUP 2 (ALS) RESISTANT KOCHIA (*KOCHIA SCOPARIA*)IN SPRING WHEAT (*TRITICUM AESTIVUM*). K.L. Sapsford* and F.A. Holm, Department of Plant Sciences, University of Saskatchewan, E.N.Johnson and H.J. Beckie Agriculture and Agri-Food Canada .

In the 20 years since Group 2 herbicide-resistant kochia was identified on the Prairies, the resistant biotype has spread dramatically from its original area of adaptation in the Brown and Dark Brown soil zones to the Black soil zone. A survey of over 100 fields across the Prairies conducted by AAFC in 2007, revealed that about 90 percent of the fields contained Group 2-resistant kochia biotypes. At least three different target-site mutations in kochia confer resistance to Group 2 herbicides. In addition, kochia is an out-crossing species, so the dominant resistance gene can spread throughout a population quickly. Prolific seed production, a low level of seed dormancy and kochia's tumbleweed seed dispersal mechanism also contribute to rapid spread of resistant biotypes. Trials were established at Scott and Elstow, SK in 2006, 2007 and 2008. Kochia at the Scott site was all Group 2 susceptible whereas at Elstow it was Group 2 resistant. At each location a four replicate RCBD trial was conducted in hard red spring wheat. The treatments were applied when the kochia was 5 to 10 cm. tall. Visual ratings were done at 7-14 and 21-28 days after application. Conclusions: Unless you know otherwise, assume kochia infestations on the prairies contain Group 2-resistant biotypes. Group 4 herbicides that control susceptible kochia will control Group 2-resistant biotypes equally well. Herbicide products that contain Group 2 and 4 modes of action may not contain enough of the Group 4 component to control kochia. Two Herbicides that contain Group 2 and 4 modes of action and control Group 2-resistant kochia are Triton K® (tribenuron methyl + dicamba) and Stellar® (fluroxypyr + florasulam). Infinity® (pyrasulfotole + bromoxynil), a Group 6 and 28 mode of action herbicide, controls group 2-resistant kochia. [58]

FUNGICIDE AND INSECTICIDE TANK MIXTURES WITH GLYPHOSATE ON ROUNDUP READY SUGAR BEET. Donald L. Shouse, Don W. Morishita, J. Daniel Henningsen and Oliver T. Neher, University of Idaho, Twin Falls.

A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho in 2008 and 2009 to compare glyphosate tank mixed with five insecticides and three fungicides for crop injury potential and weed control compared to glyphosate alone in glyphosate resistant sugar beet. All of the insecticides and fungicides are currently registered for use in sugar beet. Experimental design was a randomized complete block with four replications. Soil type was a Portneuf silt loam. 'CT02RR08' and 'Betaseed 26RR-14' sugar beet was planted April 16 and 24, 2008 and 2009, respectively in 22-inch rows at a rate of 57,024 seed/A. Kochia, common lambsquarters, redroot pigweed, and green foxtail, and barnyardgrass were the major weed species present both years. In 2009, annual sowthistle, Russian-thistle, and common mallow were also present. The two grass species were evaluated together as grasses. Herbicides were applied broadcast with a CO2-pressurized bicycle-wheel sprayer calibrated to deliver 15 gpa using 8001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 18 and 88 days after the last herbicide (DALA) application on July 1 and September 26, respectively. In 2009, crop injury and weed control were evaluated visually 17 and 107 days after the last herbicide (DALA) application on July 9 and October 9, respectively. The two center rows of each plot were harvested mechanically October 15 and 12, 2008 and 2009, respectively. All weed control data, where the weed species were evaluated both years, and yield data were combined over both years using SAS software program. In 2008, there was less than 6% crop injury 18 DALA from all treatments except glyphosate + trifloxystrobin, which injured the crop 10%. No herbicide treatment injured the crop more than 3% in 2009. No injury was observed in subsequent evaluations. All of the insecticides and fungicides tank-mixed with glyphosate controlled all weed species 94% or better 18 DALA in 2008, and were equal to glyphosate applied alone. On the 17 DALA evaluation in 2009, all herbicide treatments controlled all weeds 96% or better. In the late season evaluation taken 88 DALA 2008, common lambsquarters, kochia, redroot pigweed, and grass control with esfenvalerate, chlorpyrifos, zeta-cypermethrin, methomyl, and oxamyl tank mixed with glyphosate were equal to glyphosate alone. Common lambsquarters control with glyphosate plus azoxystrobin at 0.28 kg ai/ha or prothioconazole, was reduced to 84 and 83% control, respectively. A similar response was observed with these glyphosate and fungicide tank mixtures for redroot pigweed and grass control. In a 2007 preliminary study, a reduction in weed control was observed with the strobilurin fungicides at an early weed control evaluation. In 2008, the reduction in weed control was observed later in the season with these two fungicide tank mixtures and no effect on early season weed control was observed. At 107 DALA in 2009, all herbicide treatments averaged 90% for the control of all weeds. These results are similar to the 2008 observations indicating that there is little or no compatibility issues affecting crop safety or weed control when tank mixing these insecticides and fungicides with glyphosate. Root yields of the herbicide treatments ranged from 83 to 92 Mg/ha. The untreated check averaged 4 Mg/ha root yield. There was no significant difference in root yield among the herbicide treatments. Although a reduction in late season weed control was observed with the glyphosate plus fungicide tank mix treatments, sugar beet yield and quality was not affected. After two years of testing the compatibility of selected insecticides and fungicides with glyphosate, it does not appear that yield is affected by these tank mixtures. It is unclear however, if weed control is slightly reduced with strobilurin tank mixtures and if these tank mixtures have any negative effect on insect or disease control. [60]

GLYPHOSATE TANK MIXTURES FOR RESISTANCE MANAGEMENT IN ROUNDUP READY SUGAR BEET. J. Daniel Henningsen, Don W. Morishita, and Donald L. Shouse, University of Idaho, Twin Falls; and Joel Felix, Oregon State University, Ontario.

Grower adoption of glyphosate resistant sugar beet has grown rapidly since 2008, the first year they became available. Previous studies in Idaho evaluating registered soil-active herbicides tank mixed with glyphosate have shown promise for improving weed control over one or two glyphosate applications alone. We determined there was a need for information on the compatibility of glyphosate with soil-active herbicides for use in glyphosate resistant sugar beet. The objectives of this study were: 1) evaluate glyphosate tank mixtures with registered soil active and foliar applied herbicides for crop injury and weed control and 2) determine the economics of glyphosate tank mixtures compared to glyphosate alone for consideration of glyphosate resistant weed management. Field studies were conducted in 2009 at near Kimberly, Idaho and Ontario, OR. Soil-active herbicides evaluated with glyphosate included cycloate, dimethenamid-P, EPTC, ethofumesate, and s-metolachlor. Experimental design for both studies was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type at Kimberly was a Portneuf silt loam and an Owyhee silt loam at Ontario. 'BTS

26’RR14' sugar beet was planted April 9 and 14, 2009 at Ontario and Kimberly, respectively in 56-cm rows. At Kimberly, the crop was planted at 140,900 seed/ha as a ‘plant-to-stand’ density, while at Ontario, the crop was planted at a high seeding rate and thinned to a uniform stand of 88,066 plants/ha. Kochia (*Kochia scoparia*), common lambsquarters (*Chenopodium album*), redroot pigweed (*Amaranthus retroflexus*), green foxtail (*Setaria viridis*), and barnyardgrass (*Echinochloa crus-galli*) were the major weed species present at Kimberly and common lambsquarters, hairy nightshade (*Solanum physalifolim*), redroot pigweed and barnyardgrass were the primary species at Ontario. Sugar beet yield and net return were greater at Ontario compared to Kimberly. This is partially attributed to a longer growing season and more uniform plant stand from hand thinning at Ontario. Overall weed control with one-time glyphosate alone applications or in combination with a soil-active herbicide was fair to excellent at Kimberly, depending on the weed species early in the season while late season weed control with one-time applications was unacceptable. At Ontario, all single applications controlled all weeds greater than 90% in early season evaluations and continued to control all weeds later in the season. At Kimberly, all one-time applications had negative net returns due to continued weed emergence and interference. Among the highest net returns at Kimberly were glyphosate alone applied 3 times, ethofumesate applied preemergence followed by (fb) one glyphosate postemergence application, and glyphosate plus ethofumesate fb glyphosate alone. Single applications at Ontario had positive net returns, but were less than multiple applications. Glyphosate alone applied 2 times had the highest numerical net return, but was not different from glyphosate applied 3 times, glyphosate + dimethenamid-P fb glyphosate, or glyphosate + ethofumesate, and glyphosate + s-metolachlor applied one time. These studies confirm our previous work that showed that glyphosate can be safely tank mixed with several soil-active herbicides. Several of these tank mixtures can be economically acceptable depending on the sugar beet stand and weed pressure, while at the same time, be used as a glyphosate resistant weed management tool. [61]

BENCHMARK STUDY: PERSPECTIVES ON GLYPHOSATE-RESISTANT CROPS AND THE SUSTAINABILITY OF CHEMICAL WEED MANAGEMENT. Lori Howlett*, University of Nebraska, Scottsbluff, Micheal D. K. Owen, Iowa State University, Ames, Bryan G. Young, Southern Illinois University, Carbondale, David R. Shaw, Mississippi State University, Mississippi State, Robert G. Wilson, University of Nebraska, Scottsbluff, David L. Jordan, North Carolina State University, Raleigh, Stephen C. Weller, Purdue University, West Lafayette, IN and Philip Dixon, Iowa State University , Ames.

A six-state field project was initiated to study methods that may help glyphosate-resistant (GR) systems remain sustainable in terms of grower economics and the evolution of weed resistance. The four-year study was initiated following a farmer survey on weed management practices and their views on GR weeds and management. The findings included: 1) 30% of farmers thought GR weeds were or would become a serious problem; 2) few farmers thought tillage and/or using a non-GR crop in rotation would help prevent or manage GR weed evolution and 3) most farmers underestimated the role of herbicide selection pressure on the evolution of herbicide resistance. These results suggest major challenges facing agriculture and the weed science communities with regard to establishing sustainable systems within the GR-crop agroecosystems. Paramount is the need to develop and communicate clear science-based management recommendations that minimizes current rhetoric and convinces farmers to change long-held bias about weed control thus reducing the evolution of weed populations resistant to herbicides. Without a proactive and integrated approach to manage weeds in GR crops, the continued and wide-spread evolution of GR weeds is inevitable. This will be problematic in all crop systems and endanger the economics of GR technology which dominates current agriculture globally. Furthermore, lack of action on the part of weed science communities increases the likelihood of regulatory intervention. Given present systems where alternatives to chemical weed control are essentially impractical, anything that compromises GR technology will significantly damage global agricultural productivity if effective solutions are not identified. [62]

WEED SEEDBANK RESPONSE TO SEVEN CONTINUOUS YEARS OF ROUNDUP READY CORN. Robert E. Blackshaw* and Brendan Postman, Agriculture and Agri-Food Canada, Lethbridge, AB.

A field study addressing agronomic and environmental questions surrounding genetically-engineered (GE) crops was conducted from 2000 to 2007 at Lethbridge, Alberta. A subset of treatments within this study was chosen to examine potential weed responses to various cropping frequencies of RR corn. Treatments included 1) continuous RR corn, 2) continuous conventional corn, 3) RR corn - RR canola - Bt corn - RR canola grown in rotation, and 4) corn - canola - corn - canola (all conventional crops) grown in rotation. All crop phases of rotations were present each year. Herbicides were glyphosate (890 g/ha) in RR corn, glyphosate (445 g/ha) in RR canola, ethalfluralin (1100 g/ha) + quizalofop-P (45 g/ha) + ethametsulfuron (22 g/ha) + clopyralid (200 g/ha) in conventional canola, EPTC (4350 g/ha) + bromoxynil/MCPA (560 g/ha) or atrazine (1180 g/ha) + nicosulfuron (25 g/ha) applied in alternate years in continuous conventional corn, and EPTC (4350 g/ha) + bromoxynil/MCPA (560 g/ha) applied in conventional and Bt corn when grown in the rotation treatments. Results indicated that the total weed seedbank was lower with continuous RR corn than with continuous conventional corn. However, the seedbank of some individual species such as common lambsquarters and round-leaved mallow was higher with continuous RR corn compared with continuous conventional corn. In contrast, dandelion, field pennycress, kochia, and redstem filaree seedbanks were lower with continuous RR corn than with continuous conventional corn. The seedbank of several species such as redroot pigweed, wild buckwheat, and wild mustard was similar with continuous RR and conventional corn. The total weed seedbank were often lower in rotation treatments compared with either of the continuous corn treatments. Diversified crop rotations can be expected to mitigate potential weed population responses to GE crops and should be strongly encouraged. [63]

SPATIAL DISTRIBUTION OF ENHANCED ATRAZINE DEGRADATION ACROSS NORTH-EASTERN COLORADO: A SURVEY. Raj Khosla,* Colorado State University; Dale Shaner, USDA-ARS Water Management Unit; Mary Stromberger, Colorado State University; Bruce Bosley, Cooperative Extension Colorado State University; and Alan Helm, Cooperative Extension Colorado State University.

When it comes to weed management, logically, farmers have a very low tolerance for weed infestations since it can cause significant damage to their crop yields. However, over application of pesticides for any infestation has a serious consequence. Recently, farmers in the north-eastern Colorado reported that Atrazine was not giving the residual control as expected. This could be a cause of concern for many reasons because Atrazine is widely used in Colorado for controlling many broadleaf and certain grass weeds in corn (*Zea mays* L.) and other crops. A survey was conducted in 2007-2008 to determine the extent of fields showing enhanced Atrazine degradation. Soils were collected from several fields in various counties, such as Kit Carson, Larimer, Logan, Morgan, Philips, Washington, Weld and Yuma counties. Soil samples were collected from the fields had been planted in maize, wheat or were fallow at the time of collection. Our soil analysis indicates that approximately 30% of the fields tested showed enhanced Atrazine degradation. All of the fields with enhanced Atrazine degradation had a history of Atrazine use. Our survey findings suggest that Atrazine degrades rapidly in fields in Colorado where the herbicide has been continuously used for 3 or more years. This rapid degradation leads to loss of residual weed control as reported by farmers. [63A]

USING A SUB-METER GPS TO FACILITATE TRIAL DATA COLLECTION. Jerry Schmierer, University of California Cooperative Extension, Colusa, CA.

Collecting data from herbicide trials in farmer cooperator alfalfa fields over the summer harvest season either requires that plot stakes be removed for harvest and then replaced for data collection, or use of a GPS that is accurate enough to locate plots without the need to re-stake. Several methods for collecting sequential plot data over the alfalfa harvest season were evaluated. A robust method using the software programs ArcMap, ArcPad and Excel was developed and successfully used to take weed control ratings in two alfalfa herbicide trials, and transfer the data to Excel where analysis was easily completed. The process is initially time consuming to set up the trial/plot maps in ArcMap and the data collection forms in ArcPad, but these maps and forms are re-used for ratings that take place later in the season. Data collection was very easy using the sub-meter GPS and the ArcPad data collection forms. There was also a time saving in transferring the field data to Excel without having to re-enter data. A substantial time saving was realized in not having to remove plot stakes in the alfalfa field for each harvest and then re-stake the trial for weed control evaluations between cuttings. [64]

ESTABLISHING WEED PREVENTION AREAS AND EVALUATING THEIR IMPACT. Stephanie D. Christensen*, Corey V. Ransom, and Kimberly A. Edvarchuk, Utah State University, Logan.

Despite the efforts of many land managers weed invasion continues at an alarming rate. The creation of Weed Prevention Areas (WPAs) is a relatively new tool being implemented to help stop the spread of weeds. Unified stakeholders work together at a local level to proactively protect healthy rangeland and critical habitat from advancing weed invasion by implementing integrated plans of prevention, early detection, and ecosystem management. The purpose of this study was to help establish WPAs in Paradise and Park Valley, Utah and collect baseline data for the evaluation of the effectiveness of these WPAs in 2011. Each WPA was paired with a non-WPA community and GPS vegetation inventories were conducted to determine the initial abundance and distribution of fifty invasive weed species. Four 600 acre plots were placed throughout each community to obtain a sampling of high, moderate, and low use areas. Targeted weeds infested a total of 993 acres in Paradise and 305 acres in Park Valley. Early invaders targeted for prevention and eradication included species with ten or less patches equaling one acre or less infested. A survey was also mailed to all land owners of 2 acres or larger within selected communities to evaluate current opinions and activities regarding aspects of weed prevention and control. Respondents believed weed prevention strategies were an important part of managing invasive plants, but less than half implemented prevention strategies on their property. Limited funding, resources, and knowledge concerning weed prevention were indicated as major factors in weed management decisions. [65]

A COMPARATIVE ANALYSIS OF WATER-USE BY GREENHOUSE-GROWN WEEDS COMMONLY FOUND ON THE LEASBURG CANAL SYSTEM IN SOUTHERN NEW MEXICO. Cheryl Fiore*, Jill Schroeder, Naomi Schmidt, New Mexico State University, Las Cruces; Leigh Murray, Kansas State University, Manhattan.

A survey was conducted to identify plant species growing on the Leasburg irrigation canals, Dona Ana County, NM. Statistical analysis of the survey data identified the most commonly occurring species; based on these analyses a series of 24-hour water-use trials were conducted to establish relative water use by 12 commonly occurring species compared to the most common species growing on the canal, Cynodon dactylon (CYNDA). Due to greenhouse space and time management constraints, the 12 species were grouped into 8 subsets that were run for a varying number of water-use trials. A total of 15 trials was conducted over two years. Each trial included CYNDA as the reference species. Data for CYNDA was modeled with a quadratic random-coefficients model where the response variable was water use (ml), the predictor variable was total above-ground biomass (g), and the random component was the trial. The mean predicted water use for CYNDA increased from an average of 33 ml to nearly 100 ml in 24 hr as above ground biomass increased from 0 to 9 g dry weight, and then leveled off. The fitted models for each trial of the three test species were compared to the 95% confidence region for CYNDA by evaluating graphed models in ranges of observed biomass for each species. Water use by three species of perennial grasses, Distichlis spicata (DISSP), Leersia oryzoides (LEEOR) and Sorghum halepense (SORHA) (tested in 7 trials each) was modeled with a regression model where the response and predictor variables were the same as CYNDA. Within each species, fitted models had different intercepts but common linear and quadratic coefficients. The mean fitted models for the three test species were compared to the 95% confidence region for CYNDA by evaluating graphed models. Water use by DISSP was greater than CYNDA in three out of seven trials and within the confidence region for CYNDA in the other trials. SORHA water use was greater than CYNDA in three trials, within the confidence region for CYNDA in three trials and used less water in one trial. The model for LEEOR was different than for CYNDA or the other species with respect to curvature. Water use by LEEOR was greater than CYNDA in four trials and comparable to CYNDA in the other trials. The models suggest that, while environmental conditions and plant vigor affected water use among trials by all species, none of these perennial grasses would improve irrigation efficiency of the canal system over CYNDA. [66]

RELATIONSHIP BETWEEN FLOWERING TIME AND GLYPHOSATE SUSCEPTIBILITY IN COMMON LAMBSQUARTERS. Nevin C. Lawrence* and Andrew R. Kniss, University of Wyoming, Laramie.

Common lambsquarters (*Chenopodium album*) is a widely distributed summer annual that can be difficult to control in glyphosate-resistant cropping systems. Anecdotal evidence suggested that common lambsquarters biotypes that are less susceptible to glyphosate may flower earlier than biotypes that are more susceptible to glyphosate. A greenhouse experiment was conducted to determine the relationship between flowering time and gylphosate susceptibility. Ten common lambsquarters biotypes were chosen based on their response to glyphosate in previously conducted field studies. When treated with 840 g ae/ha glyphosate, five tolerant biotypes ranged from 56 to 66% mortality, whereas the five susceptible biotypes ranged from 91 to 97% mortality. Plants were seeded into 4 inch pots, and grown under a 17 hour photoperiod for 12 weeks, after which the photoperiod was reduced by thirty minutes each week for the remainder of the study. Results indicate a significant difference in flowering times of susceptible and tolerant biotypes. Time to flowering averaged 129 days for susceptible biotypes compared to 90 days for tolerant biotypes. Tolerant biotypes also had significantly more true leaves per plant and were on average taller than susceptible biotypes. These results indicate a potential link between the genetics of glyphosate tolerance and flowering time, plant height, and the number of true leaves. [67]

EFFECT OF SOIL MOISTURE ON BIOAVAILABILITY OF ACETANILIDE HERBICIDES. Dale Shaner* USDA-ARS, Eric Westra and Philip Westra, Colorado State University, Fort Collins.

A study was done to determine the effect of soil moisture on the dissipation and bioavailability of three acetanilide herbicides, metolachlor, dimethenamid and pyroxasulfone. Three soils (loamy sand, sandy loam and silt loam) were used at three levels of moisture, -33, -100 and -500 kPa. The plant available water was extracted by centrifugation and the total amount of herbicide in the soils was extracted with toluene. The herbicides were measured via GC/MS. Soils were sampled at 1, 2, 4, 8, 16, and 32 d after treatment. The rate of dissipation of the herbicides from the soil was dimethenamid > metolachlor >pyroxasulfone. The average half life across all three soils at -33 kPa was 11, 25, and 79 d and at -500 kPa was 40, 109, and >>100 for dimethenamid, metolachlor and pyroxasulfone, respectively. The concentration of herbicide in the plant available water was dimethenamid > pyroxasulfone >metolachlor, which reflected the binding of these herbicides to the soils. As soil moisture decreased the concentration of the herbicides per unit volume of soil water remained relatively constant across all three soils, but the total amount of each herbicide extracted from the soil decreased more than 10 fold as the soil moisture decreased from -33 kPa to -500 kPa. [68]

INHERITANCE AND METABOLISM OF 2,4-D RESISTANCE IN PRICKLY LETTUCE. Dilpreet S. Riar, Ian C. Burke*, Jared Bell, Kulvinder Gill, and Joseph P. Yenish, Washington State University, Pullman.

Prickly lettuce has become a widespread and troublesome weed in the PNW. It occurs in all rainfall zones and is difficult to control largely due to ALS resistance but also due to increased tolerance to glyphosate and resistance to 2,4-D. The objectives of this study where to determine the mechanism and inheritance of the 2,4-D resistance in prickly lettuce. To determine the mechanism of resistance, absorption, translocation and metabolism studies using 14C-2,4-D were conducted on the 2,4-D resistant biotype and a known susceptible biotype. At 96 HAT, resistant and susceptible biotypes absorbed 33.8 and 42.7% of applied 14C-2,4-D respectively and out of the total herbicide absorbed, 74.5 and 70.1 % remained within the treated leaves of resistant and susceptible biotypes, respectively. At 96 HAT, the total amount of radioactivity translocated from the treated leaf to different plant parts was similar in both biotypes (25.5 and 29.9% for resistant and susceptible biotypes, respectively). However, 23% less 2,4-D was translocated to the crown of resistant biotype compared to susceptible biotype. Metabolism of the parent compound was similar between the two biotypes. The 2,4-D resistant biotype appears to sequester the 2,4-D, but the resistance could be an altered signal receptor. Re-growth of resistant prickly lettuce biotypes commonly occurs from apical or lateral meristems located in the crown. Reduced herbicide translocation to the crown in resistant biotypes could be, in part, a mechanism for 2,4-D resistance in prickly lettuce. The phenotypic screening of 15 F1s and RF1s each confirmed the homozygosity of the parental genotypes as all F1s and RF1s showed 2,4-D resistance equivalent to the resistant parent and also suggesting a dominant action of the putative resistant gene(s). Based on monogenic inheritance, two classes of resistant progeny were expected but not observed in F2 segregation for the 2,4-D resistance. Consequently, injury ratings were used to characterize 2,4-D resistance in the F2 population. The visual injury among F2 plants ranged from no response to complete mortality. Based on the rating system, the F2 plants were divided into three groups: resistant, intermediate, and susceptible. Out of the total 191 F2 plants, 51 (25%) plants were highly resistant, 100 (55%) plants expressed an intermediate resistance, and 40 (21%) plants were highly susceptible. The chi square analysis of these phenotypic classes suggested a monogenic inheritance (1:2:1) with co-dominant gene action. The phenotypic screening of F1s and RF1s suggested that 2,4-D resistant trait is a dominant but the segregation of F2 plants showed the decrease in magnitude of resistance of plants grouped in the intermediate class. [69]

GENERAL SESSION

WSWS PRESIDENTIAL ADDRESS Jesse Richardson, Dow AgroSciences, Hesperia, CA
(See page 103 for full text) [70]

NATIONAL AND REGIONAL WEED SCIENCE SOCIETIES: Director of Science Policy Update. Lee Van Wychen, Director of Science Policy, Washington, DC. [71]

INVASIVE ALGAE: A GROWING PROBLEM FOR CORAL REEFS IN A TIME OF CHANGE AND STIMULUS. Celia Smith, University of Hawaii, Honolulu, HI. [72]

DEVELOPMENT AND IMPACT OF TRNAGENIC PAPAYA: A DECADE AFTER ITS COMMERCIALIZTION. Dennis Gonslaves, USDA-ARS, Hilo, HI. [73]

PROJECT 1: WEEDS OF RANGE AND NATURAL AREAS

AMINOCYCLOPYRACHLOR A NEW HERBICIDE FOR VEGETATION MANAGEMENT, DEVELOPMENT AND REGISTRATION UPDATE. Jon S. Claus*, Mark J. Holliday, DuPont Crop Protection, Wilmington, DE; Ronnie G. Turner, Jeff H. Meredith and C. Stephen Williams, DuPont Land Management, Memphis, TN.

Aminocyclopyrachlor, an exciting new class of auxin herbicide from Dupont, is under development for non-crop uses such as bareground, brush, right-of-way and turf as well as for range, pasture and invasive weed control. Aminocyclopyrachlor has demonstrated activity on a number of important Western species such as leafy spurge, mesquite, huisache, field bindweed and brush such as box elder. It also controls a number of glyphosate and ALS resistant weeds such as marestail, Russian thistle, kochia, and prickly lettuce. Aminocyclopyrachlor has exhibited a number of positive stewardship attributes with very low impact to mammals and the environment. [74]

AMINOCYCLOPYRACHLOR AND AMINOCYCLOPYRACHLOR BLEND PRODUCTS FOR WEED AND BRUSH CONTROL IN NON-CROP SITES. Ronnie G. Turner*, Jerry R. Pitts, DuPont Land Management, Memphis, TN; Edison Hidalgo, Jon S. Claus, DuPont Stine-Haskell Research Center, Newark, DE.

Vegetation management is essential for the safe and efficient operation of railroad switch yards, railroad lines, fuel tank farms and electrical substation sites. In these types of bareground weed control situations, aminocyclopyrachlor and aminocylcopyrachlor plus DuPont sulfonylurea (SU) herbicides (developmental blend products) were evaluated in a number of sites across the United States in 2007, 2008 and 2009. Both preemergent and postemergent applications were made to small plot replicated trials using a CO2 back-pack sprayer. In these trials, aminocyclopyrachlor at 3.5 to 4.5 ounces active per acre tank mixed with DuPont SU (sulfonylurea)herbicides provided excellent control of several key broadleaf weeds such as, Russian thistle (*Salsola kali*), kochia (*Kochia scoparia*), marestail (*Conyza canadensis*) and field bindweed (*Convolvulus arvensis*), including weeds resistant to ALS inhibitors and glyphosate. In these studies installed across the U.S., the combination blend product of aminocyclopyrachlor, sulformeturon methyl and chlorsurlfuron provided 98 to 100% control of marestail and Russian thistle at 150 DAT (days after treatment). The average control of kochia across all studies was approximately 95% at 150 DAT and in four field trials, field bindweed control averaged 95% at 538 DAT. The results observed in these trials will help support registration and labeling efforts for aminocyclopyrachlor blended products in non-agricultural areas such as railroad and electric utility rights-of-way, tank farms and other industrial sites. [75]

CONTROL OF INVASIVE AND TROUBLESOME WEEDS WITH AMINOCYCLOPYRA-CHLOR IN NORTH DAKOTA. Rodney G. Lym, North Dakota State University, Fargo.

A series of studies were begun in 2007 to evaluate aminocyclopyrachlor for control of invasive and troublesome weeds in pasture and rangeland. The aminocyclopyrachlor methyl ester (DPX KJM44-062) was used in all studies except as noted. Aminocyclopyrachlor applied at 2 oz ai/A or higher provided better long-term leafy spurge (*Euphorbia esula* L.) control than the standard treatments of picloram at 8 oz ae/A or picloram plus imazapic plus 2,4-D at 4 + 1 + 16 oz/A. Aminocyclopyrachlor applied at 2 oz/A provided 90 and 85% leafy spurge control 12 and 24 MAT (months after treatment) respectively, compared to 58 and 41% control, respectively, with picloram at 8 oz/A. Less than 5% grass injury was observed with any treatment. Aminocyclopyrachlor applied during the bolting stage provided excellent long-term Canada thistle (*Cirsium arvense* L.) control which averaged 95% 12 MAT, compared to 58% or less with picloram and aminopyralid applied at the standard use rates. Canada thistle control averaged 95% 21 MAT with aminocyclopyrachlor applied at 2 to 3 oz/A compared to 0 and 23% with picloram and aminopyralid. Aminocyclopyrachlor provided excellent control of perennial sowthistle (*Sonchus arvensis* L.) in the year of treatment, but control averaged less than 50% by 12 MAT regardless of application rate. Aminocyclopyrachlor provided very good cattail (*Typha spp*.) control the year after treatment when applied at 2 to 8 oz/A during flowering, but did not control cattail when applied earlier in the growing season. Initial cattail control with aminocyclopyrachlor was < 20% during the season of application regardless of timing. However, aminocyclopyrachlor provided >95% control 11 and 13 MAT when applied at flowering and was similar to the standard glyphosate treatment. A study to evaluate aminocyclopyrachlor as a cut-stump treatment for control of Russian olive (*Elaeagnus angustifolia* L.) regrowth was established using the DPX MAT28-038 2 SL formulation. Aminocyclopyrachlor at 2 to 15% (v:v) in bark oil was applied to run-off 31 days after cutting. No regrowth was observed on any treated stump 13 MAT compared to an average of 68 stems per stump on the untreated controls. Although aminocyclopyrachlor provided excellent control, grass and brush species surrounding the cut-stumps died even though the herbicide was not directly applied to these plants. The area of total vegetation control around each stump increased as the aminocyclopyrachlor application rate increased. In summary, aminocyclopyrachlor provided similar or better control of leafy spurge, Canada thistle, and perennial sowthistle than commonly used herbicides. Aminocyclopyrachlor controlled cattail similarly to the standard treatment of glyphosate when applied at the catkin growth stage and provided excellent Russian olive control when applied as a cut-stump treatment. [76]

AMINOPYRALID AND AMINOCYCLOPYRACHLOR IMPACTS ON GRASS ESTABLISHMENT. Joseph D. Vassios*, Scott J. Nissen, James R. Sebastian, K. George Beck, Cameron H. Douglass, Colorado State University, Ft. Collins, CO.

Russian knapweed (*Acroptilon repens*) is a creeping perennial that spreads through seed and vegetative root buds. When present, it can form dense monoculture stands. Because of its extensive vegetative reproduction, long-term control and grass establishment following removal can be difficult. A study was initiated to examine the effects of tillage and herbicide applications on Russian knapweed control and establishment of two restoration species; slender wheatgrass (*Elymus trachycaulus*) and western wheatgrass (*Pascopyrum smithii*). Tillage treatments included no tillage, minimum tillage, and full seedbed preparation and these were established as main plot treatments. Herbicide applications were made in the fall as subplots and included: 35, 70, and 140 g ai/ha aminocyclopyrachlor, 864 g ai/ha picloram, 126 g ai/ha aminopyralid, a handweeded treatment, and a control. Tillage and herbicide treatments were established in fall of 2008 and grasses seeded in the winter of 2009. Aboveground biomass was collected for grass species and Russian knapweed in August, 2009. There was no significant difference between tillage treatments ($p=0.32$), so biomass from all tillage treatments was pooled. Biomass for slender wheatgrass was the greatest in the aminopyralid treatment, while for western wheatgrass 140 g ai/ha aminocyclopyrachlor resulted in the greatest biomass. Russian knapweed control, averaged across all herbicide treatments, was greater then 97%. Removing aboveground Russian knapweed biomass by hand resulted in grass biomass that was not significantly different from control plots. These results provide strong evidence that Russian knapweed allelopathy is a function of belowground interactions and are not function of leachates from surface residues. [77]

SALT CEDAR AND RUSSIAN OLIVE CONTROL WITH AMINOPYRALID CONTAINING HERBICIDE TREATMENTS. Byron Sleugh, Mary Halstvedt, Chad Cummings, Vanelle Peterson, Dow AgroSciences, Indianapolis, IN; and Robert G. Wilson, University of Nebraska Panhandle Research Center, Scottsbluff, NE.

Chemical control of salt cedar (*Tamarix spp*.) and Russian olive (*Elaeagnus angustifolia* L.) has had varying degrees of success. Some non-selective herbicides cause unacceptable injury to desirable species or do not control invasive species under the canopy. Aminopyralid (Milestone®) controls many invasive herbaceous broadleaf weeds, but control of salt cedar and Russian olive has not been fully explored. Experiments were established to assess the efficacy of various aminopyralid containing products and aminopyralid and triclopyr (Garlon 3A or Garlon 4 Ultra) mixtures on these plants. Treatments included triclopyr amine and triclopyr ester at various rates plus aminopyralid at 120 g ae/ha (0.11 lbs ae/acre) and Milestone® VM Plus at 9.6 L/ha (1 gal/acre) [triclopyr amine at 1.12 kg ae/ha (1 lb ae/acre) and aminopyralid 120 g ae/ha (0.11 lb ae/acre)]. At 326 days after application, 3.3 kg ae /ha (3 lbs ae/acre) triclopyr ester plus 120 g ae/ha aminopyralid provided excellent control (98%) of Russian olive and salt cedar (94%), similar to efficacy of imazapyr at 1.12 kg ae/ha (1 lb ae/acre). Triclopyr + aminopyralid treatments caused little to no grass injury (0 to 5%) compared to the imazapyr treatments (50 to 85%). Milestone® VM Plus at 9.6 L/ha provided 91% control of salt cedar and no grass injury. Adding aminopyralid to either the triclopyr amine or triclopyr ester was synergistic and provided increased control of Russian olive and salt cedar thus providing another option for controlling these species without significant injury to desirable understory vegetation. ®Trademark of Dow AgroSciences, LLC. Please read and follow all label instructions. [78]

CONTROL OF RUSSIAN OLIVE WITH DPX-MAT 28 AND OTHER HERBICIDES IN NORTHEASTERN ARIZONA. John H. Brock*, Brock Habitat Restoration and Invasive Plant Management LLC, Tempe, AZ.

Russian olive (*Elaeagnus angustifolia*) has invaded many streams in northern Arizona. It is especially common on the Navajo Reservation. Russian olive is well adapted to semi-arid landscapes, and in riparian areas can form monotypic stands. It is competitive with native woody riparian species and when in dense stands, the understory of the plant community is very sparse. Russian olive is considered a phraetophyte and can cause avulsion of stream flows that results in channel change and enhanced stream bank erosion. Russian olive produces many seeds that remain viable in the seed bank about 3 years. The trees tolerate saline and/or alkaline conditions and Russian olive has teamed with a Frankia microorganism to allow it to fix nitrogen in its root system. Herbicide trials for this species at Holbrook and Ganado were initiated in 2008 for the purpose of testing DPX MAT 28 herbicide for comparison to imazapyr and imazapyr plus metsulfuron effectiveness for Russian olive control. Treatments have included foliage sprays in the fall of 2008 at Holbrook, and in the spring of 2009 at Holbrook and Ganado. Fall 2009 treatments were also applied. All of the herbicides have been effective in reducing the live canopy of Russian olive. Results show that DPX MAT 28 promotes defoliation of the canopy at a faster rate than does imazapyr and imazapyr plus metsulfuron. [79]

RUSSIAN OLIVE CONTROL IN BIG HORN COUNTY, WYOMING. Ruth Richards*, Big Horn County Weed and Pest Control District, Greybull, WY; Mary B. Halstvedt, Dow AgroSciences, Billings,MT and Tom D. Whitson, University of Wyoming, Professor Emeritus.

Big Horn County is located in north central Wyoming. Russian olive, *Elaeagnus angustifolia*, was listed as a state noxious weed in 2007. Russian olive removal projects were initiated across the state. A standard treatment program involves the mechanical removal of all above ground growth followed by a foliar treatment to regrowth. Standard herbicide recommendations for treating the regrowth proved to be inadequate. The objective of this project was to identify an effective herbicide, rate and timing. Russian olive trees were mechanically removed in February 2008 using a mulcher mounted on a skid steer. Plots were set up as a randomized complete block with three repetitions. Treatments included two timings: 5 months (July 2008) after removal when regrowth was 2-4 feet tall and 8 months (October 2008) after removal to regrowth from 3-8 feet. Early timing treatments were triclopyr ester alone at 2, 3, and 4 lb ae/A (2, 3, and 4 qts/A Remedy® Ultra/Garlon® 4 Ultra), triclopyr ester plus aminopyralid (Milestone®) at 2+ 0.11 lb ae/A (2 qt + 7 fl oz/A). Later timing treatments were triclopyr ester alone at 2 and 3 lb ae/A, triclopyr ester plus 2,4-D at 1 +1 lb ae/A, triclopyr ester plus aminopyralid at 2+0.11 lb ae/A , aminopyralid+metsulfuron at 0.11+.02 lb ae/A (Chaparral® at 3.3 oz/A), and triclopyr amine at 3 lb ae/A (Garlon® 3A at 4 qts/A) plus aminopyralid at 0.11 lb ae/A. All treatments included 1 qt of MSO/A. Plots were visually evaluated for percent control 1 YAT in October 2009. None of the early treatment plots yielded acceptable levels of control. In the later application timings, triclopyr ester at 2 lb ae/A plus aminopyralid at 0.11 lb ae/A yielded the highest control at 97%. Triclopyr ester at 3 and 4 lb ae/A both showed 93% control. Triclopyr ester at 2 lb ae/A provided only 66% control. The treatment that provided the lowest level of control at 47% was the triclopyr ester tank mixed with aminopyralid+metsulfuron at 1 lb+.11+.02 lb ae/A. Applications in July will not provide effective control of Russian olive regrowth. Treatments applied in October when there was more regrowth were significantly more effective. Adding 0.11 lb ae/A (7 fl oz/A) of aminopyralid to 2 lb ae/A (2 qt/A) triclopyr ester improved Russian olive control to 95% from 66% when triclopyr ester was applied at 2 lb ae/A alone. ® Trademark of Dow AgroSciences LLC. [80]

AMINOPYRALID HERBICIDE EFFECTS ON CANADA THISTLE AND NATIVE VEGETATION IN A SEASONALLY WET MEADOW. Timothy B. Harrington*, David H. Peter, and Warren D. Devine, PNW Research Station, USDA Forest Service, Olympia, WA.

In May 2009, four rates of aminopyralid (0.03, 0.06, 0.09, and 0.12 kg ae/ha) were compared at a meadow site near Trout Lake, WA infested with Canada thistle and other non-native, invasive species. The rates corresponded to 25, 50, 75, and 100% of the maximum labeled rate for aminopyralid, respectively. The experimental design was completely randomized with six replications of the four herbicide rates arranged in a split-plot design. Aminopyralid rate was randomly assigned to each main plot, and a treated versus non-treated designation was randomly assigned to each split plot. Plant control (%) 10 weeks after application of aminopyralid was calculated as 100 x [1 - (observed cover / predicted cover)], where predicted cover was calculated via linear regression. For all species combined, control increased from 24 to 43% as aminopyralid rate varied from 25 to 100% of maximum labeled rate. Aminopyralid provided over 94% control of Canada thistle and white clover when applied at 50% or more of the maximum labeled rate. Control of dandelion increased from 44 to 98% as aminopyralid rate varied from 25 to 75% of maximum labeled rate, whereas control of oxeye daisy did not exceed 65% regardless of herbicide rate. At the 75% aminopyralid rate, Kentucky bluegrass increased its abundance relative to the non-treated check. Occasional plants of the native iris, mountain blue-eyed grass (Sisyrinchium sarmentosum) – a Washington State threatened species – were not affected by aminopyralid at any of the tested rates. At rates less than the maximum labeled value, aminopyralid provided excellent control of Canada thistle and other broadleaf invasive species. The observed release response of Kentucky bluegrass suggests that aminopyralid will increase dominance of monocot species in meadow communities. [81]

AMINOPYRALID FOR PREEMERGENCE WEED CONTROL ON RIGHTS-OF-WAY AND RANGELAND. Vanelle F. Peterson*, Pat L. Burch, William N. Kline, D. Chad Cummings, Byron B. Sleugh, Marc L. Fisher, Monica M. Sorribas, and M.B. Halstvedt, Dow AgroSciences LLC, Indianapolis, IN; P. Lloyd Hipkins, Virginia Polytechnic Institute, and Reid J. Smeda, State University, Blackburg, VA , University of Missouri, Columbia, MO. .

Aminopyralid (registered as Milestone® and Milestone VM) is a systemic herbicide developed by Dow AgroSciences and registered by EPA in 2005 to control noxious and invasive weeds on rangeland, permanent pasture, natural areas, and non-cropland areas including industrial sites, rights-of-way, such as roadsides and railroads. Aminopyralid is used by vegetation managers to control over 70 herbaceous broadleaf plants including Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), horseweed (*Conyza canadensis*), flaxleaf fleabane (*Conyza bonariensis*), spotted knapweed (*Centaurea biebersteinii*), and yellow starthistle (*Centaurea solstitialis*). Research trials were initiated across the U.S. in 2000 through 2009 on rangeland, pasture and IVM sites to determine the preemergent activity (applied before weed emergence) of aminopyralid. Aminopyralid preemergent control of herbaceous weeds such as yellow starthistle, and knapweeds is a proven benefit in rangeland and pastures. In 2007 to 2009 trials were established to determine aminopyralid premergence control of of horseweed, flaxleaf fleabane, pigweeds (*Amaranthus spp.*), Russian thistle (*Salsola tragus*), and kochia (*Kochia scoparius*) on rights-of-way. Results from these studies indicate that aminopyralid at 120 g ae/ha (0.11 lb ae/acre) provided season-long preemergence control of horseweed, fleabane, Russian thistle, yellow starthistle, spotted knapweed and other weeds. Aminopyralid has an excellent fit in preemergent control of weeds on rangeland, pasture and rights-of-way. ® Trademark of Dow AgroSciences LLC [82]

NATIVE FORB AND SHRUB TOLERANCE TO AMINOPYRALID. Mary B. Halstvedt* and Daniel C. Cummings, Dow AgroSciences, Billings, MT and Perry, OK; Travis Almquist, Luke Samuel, Rodney G Lym, North Dakota State University, Fargo; K. George Beck, Colorado State University, Ft. Collins; Roger L. Becker, University of Minnesota, St. Paul; Celestine A.

Duncan, Weed Management Services, Helena, MT; Peter M. Rice, University of Montana, Missoula.

Aminopyralid is a broadleaf herbicide that has reduced risk to the environment compared with other commercially available herbicides, making it a desirable choice for invasive weed control on rangeland and wildland sites. Effect of aminopyralid on desirable native forbs and shrubs is a consideration for land managers when making decisions about controlling invasive plants. Experiments were established at ten locations in four states to determine long-term response of native forbs and shrubs to aminopyralid applied in early summer or fall, and to develop a tolerance/susceptibility ranking for native plants. Studies were established within diverse native plant communities in western Montana; Boulder, Colorado, Theodore Roosevelt National Park, North Dakota; Glacial Ridge Preserve and restored prairies in Minnesota. Field experiments were designed as randomized complete block with two to five replications and initiated from 2004 to 2007. Herbicide treatments were aminopyralid at 1.25 or 1.75 oz ae/A. Broadcast ground applications were made with either a CO2 backpack sprayer, or pickup boom sprayer. A broadcast application was made with a helicopter at one Montana location. Treatments were made in September or October at six locations, June at two locations, and either June or September at two Minnesota sites. Data collection across sites varied from either canopy cover or plant counts along a permanent transect, or plant density within each plot. First year post-application vegetation sampling was conducted in June and July the summer after treatment at all locations. Second year sampling was completed at eight study sites. There were a total of 118 native forbs across sites, with 20 species occurring at more than one location. There were 29 plant families represented, with the greatest number of species (35%) in the Asteraceae family. Individual rankings of tolerance to aminopyralid were established for 98 native forb species and 19 shrubs. Evaluations were based on individual species reduction in canopy cover or density compared to non-treated controls or baseline data. Four ranking categories were developed: susceptible (S - 75% or more reduction), moderately susceptible (MS - 75 to 50% reduction), moderately tolerant (MT- 49 to 16% reduction) and tolerant (T – 15% or less reduction). Of the 98 forb species categorized, 28, 16, 26, and 28 were ranked S, MS, MT, and T, respectively. Data were collected on 68 species approximately 2 years after treatment. Many forbs recovered by the second year following aminopyralid application with 55 of 68 native forbs ranked either MT or T (compared to 37 of 68 at 1 year after treatment). Sunflower, yarrow, and lobelia were very susceptible to aminopyralid while lupine, Golden Alexander, and wild bergamot were very tolerant. Shrubs were more tolerant than forbs to aminopyralid. There were 19 shrub species, and 74% were either MT or T. Shrubs in the Rosaceae family were generally the most susceptible to aminopyralid. Most native forb species and shrubs were moderately tolerant to tolerant, or quickly rebounded following treatment with aminopyralid. Thus, land managers can use aminopyralid to restore the plant community by controlling invasive plants while minimizing non-target plant injury. [83]

MANAGEMENT OF MEADOW HAWKWEED IN PERENNIAL GRASSLANDS. TImothy Prather and John Wallace, University of Idaho, Moscow.

Meadow hawkweed is an invasive perennial forb of upland forest openings, mountain meadows, permanent pastures and abandoned farmlands in the Pacific Northwest. In spite of its small size, meadow hawkweed has been able to dominate grasslands. Developing strategies for control of meadow hawkweed have involved herbicide selection, adjuvant selection, timing of herbicide application, fertilization and plant community composition. Clopyralid and aminopyralid reduce meadow hawkweed cover by at least 90% with consistently higher control from aminopyralid. Nonionic surfactants, ammonium sulfate, and methylated seed oil all were effective with no distinct advantage among them. Contrasting timing of control between spring rosettes, flowering plants or fall rosettes has determined spring rosette and flowering stages more effective than the fall rosette stage. Surprisingly, plant community response in Idaho fescue dominated communities resulted in dramatic increases to perennial grass cover even when <25% o initial plant community cover was perennial grasses. In one study, areas treated with clopyralid are still nearly free of meadow hawkweed even 5 years after herbicide application. Plant community response and meadow hawkweed invasion both appear linked to below ground interactions, at least involving mycorrhizal fungi. Controlled experiments manipulating mycorrhizal fungi resulted in larger plants of meadow hawkweed and smaller Idaho fescue plants, even when a root barrier was placed between the two species so that below ground interactions were limited to hyphal movement across the root barrier. Invasion by meadow hawkweed seems facilitated by mycorrhizal fungi yet the interactions preventing invasion after herbicide application are still not understood. [84]

EFFECTS OF VEGETATION CONTROL WITH HERBICIDES ON EARLY FOREST COMMUNITY DEVELOPMENT IN THE PACIFIC NORTHWEST. David H. Peter* and Timothy B. Harrington, USFS Pacific Northwest Research Station, Olympia, WA.

Many non-native species have invaded clearcuts in the Pacific Northwest (USA), however little is known about how they affect native plants in these communities. We explored the roles of non-native ruderal, native ruderal and native residual forest species in community assembly after clearcutting with and without logging debris and vegetation control treatments. We used a randomized complete block design at three sites in Washington and Oregon. At two sites (Matlock and Molalla) there were four replications of six treatments in a factorial combination of three debris treatments x two vegetation control treatments. The Fall River site had eight replications of three treatments. Logging debris was either piled (Matlock, Molalla), removed (all sites) or dispersed (all sites). Vegetation control included an initial treatment (Matlock and Molalla only) and repeated annual herbicide treatments for five years (all sites). Species richness decreased with site productivity, increased with site topographic complexity and was ranked among sites as Fall River > Molalla = Matlock. Molalla was the most topographically complex site and would likely otherwise have had less species richness than Matlock as predicted by its higher productivity. Vegetation control increased Douglas-fir growth, but decreased native and non-native species cover. Debris treatment effects were small, but appeared to increase non-native ruderal cover including *Cytisus scoparius* (Scotch broom) on the lowest productivity site. Without vegetation control, a competitive relationship between non-native and native ruderal species was evident in canopy cover data, but neither group clearly dominated and non-native plant richness increased with native plant richness. However, non-native species were more numerous and constituted a larger proportion of the flora at the lowest productivity site. [85]

SUSCEPTIBILITY OF YELLOW ARCHANGEL (*LAMIASTRUM GALEOBDOLON*) TO HERBICIDES. Timothy Miller*, Carl Libbey, Washington State University, Mount Vernon, WA; Sasha Shaw, and Frances Lucero, King County Noxious Weed Control Program, Seattle, WA.

Yellow archangel (*Lamiastrum galeobdolon*) is a densely-growing perennial ground cover that is beginning to become a problematic weed in the Pacific Northwest and elsewhere. It is a horticultural species that spreads by plant fragments via lawn clippings or yard waste and can quickly form adventitious roots and grow to form new infestations. Greenhouse and field trials were conducted to determine susceptibility of this species to various herbicides. Wild-type yellow archangel and cultivated 'Hermann's Pride' plants were used for the greenhouse trial in 2007 and 2008. In both iterations, wild-type yellow archangel was uniformly less sensitive to herbicides than was the named cultivar. Herbicides resulting in greater than 90% control of yellow archangel re-growth at 3.5 months after treatment (MAT) in both iterations were triclopyr, imazapyr, metsulfuron, isoxaben, and sulfometuron, while glyphosate, triclopyr + 2,4-D, imazapic, nicosulfuron, diclobenil, flumioxazin, and glufosinate also were effective in 2008. In field trials, triclopyr gave 93 and 90% defoliation at 1 MAT and 4 MAT, respectively, while two applications of 20% acetic acid and 20% clove oil gave at 89 and 88% defoliation at 4 MAT, respectively. By 10 MAT, however, control with triclopyr was only 80%, while the natural herbicides gave approximately 50% control. Four other herbicides resulted in 60 to 75% control by 10 MAT, including imazapyr, aminopyralid, glyphosate, and metsulfuron. Yellow archangel biomass at 12 MAT was minimized by imazapyr, triclopyr, and glyphosate (83, 78, and 71% of the non-treated check, respectively), while two applications of acetic acid resulted in 66% biomass reduction. [86]

PERNICIOUS WEED MANAGEMENT WITH NEW PRODUCTS IN TEXAS PASTURE-LANDS. Travis W Janak, Paul A Baumann and Mathew E Matocha, Texas AgriLIFE Extension, College Station, TX.

Field Sandbur (*Cenchrus incertus*) is a troublesome annual weed in Texas pastures, being a nuisance to people and causing reduced performance in grass fed livestock. By detracting from forage quality and production, this weed costs Texas forage producers millions of dollars annually. Field studies were conducted in 2008 and 2009 to evaluate Prowl H2O (pendimethalin) and Pastora (nicosulfuron + metsulfuron methyl) for field sandbur control and bermudagrass tolerance. Weed control studies were conducted in southern Brazos Co., TX, while tolerance studies were completed in central Lavaca Co., TX. Bermudagrass tolerance work was performed on Tifton 85, Coastal, Jiggs and Common bermudagrass varieties. To evaluate sandbur control, Prowl H2O was applied PRE singularly and sequentially at rates of 1, 2, 3, 4, 1+1, 2+1, and 2+2 lbs ai/acre. A postemergence application of Prowl H2O at 1 lb ai/acre + Accent (nicosulfuron) at 0.66 oz/acre was also applied. These treatments were also applied to Tifton 85 bermudagrass to assess tolerance. In a separate study, Pastora was applied to 1-3" sandbur at 1 and 1.5 ozs/acre alone and 1 oz + 1 lb ae 2,4-D ester. Three additional 1 oz treatments were applied using UAN as 50, 75, and 100% of the carrier. These Pastora treatments were applied to all four bermudagrass varieties at initial greenup in the spring and again following the first forage harvest to assess bermudagrass tolerance. In a third study, Pastora was applied at 1, 1.5 and 2 oz/acre to sandbur immediately after mowing. In 2009, Prowl H2O provided between 30% and 78% control of sandbur at 69 days after the initial application. It should be noted that the experimental site was a monoculture of field sandbur, containing 20-30 plants/ft2. Prowl H2O applied at 2 f.b. 2 lbs ai returned 78% control at 69 DAT, significantly greater than the 1, 2, 3, and 1+1 rates. The single postemergence treatment with Accent provided 58% control at 16 DAT. No phytotoxicity or yield reduction was observed from any of these treatments when applied to Tifton 85 bermudagrass. All Pastora treatments controlled 1-3" sandbur from 83% to 93% at 61 DAT, with the exception of Pastora at 1 oz + 100% v/v UAN, where control was significantly reduced. When Pastora was applied to sandbur immediately after mowing (tillered, 4-6" diam.), 1, 1.5, and 2 oz/acre rates gave 80% to 87% control at 30 DAT. The use of UAN as partial to complete spray carrier for Pastora resulted in a significant reduction in chlorosis and stunting to all bermudagrass varieties, with injury decreasing at higher UAN rates. No yield reduction was observed at either the first or second harvest with any treatment on all varieties examined. [87]

ENDOTHALL CONCENTRATION PROFILES FOLLOWING APPLICATIONS IN IRRIGATION CANALS FOR SAGO PONDWEED CONTROL. Cody J. Gray*, United Phosphorus, Inc., Michael D. Netherland, US Army Corps of Engineers, Jeremy G. Slade, University of Florida, Gerald Adrian, United Phosphorus, Inc. and Brian Olmstead, Twin Falls Canal Company.

The task of controlling aquatic vegetation in irrigation canals is an extremely important venture, especially in the western United States. The waters supplied by these canals are the primary, and in some locations the only, source of water for irrigating agronomic crops. In other locations, these waters supply industrial water users as well. Therefore, aquatic weed control in irrigation canals becomes extremely critical; however, the tools available to canal managers for weed control are limited. Sago pondweed [*Stuckenia pectinatus* (L.) Börner] is a native aquatic perennial that forms dense troublesome infestations in irrigation canals and drainage ditches; thereby, not allowing for proper water delivery or flow. On June 16, 2009, the Twin Falls Canal Company applied endothall to their main canal to control sago pondweed. An initial application was made for 2 ppm endothall for 12 hrs followed by a secondary application of 1 ppm endothall for 12 hrs approximately 40 km from the initial application, when the initial application had reached the location; thereby, providing a total treatment of 3 ppm endothall for 12 hrs. Endothall concentrations moved throughout the entire canal system (2.8 to 3.1 ppm at 107 km from the initial application site) at concentrations targeted to achieve sago pondweed control. Sago pondweed control 11 weeks after treatment is greater than 90% for the entire system. At 15 weeks after treatment sago pondweed control had decreased to approximately 75% throughout the system. Results from these trials indicate endothall will provide a safer, more effective tool for controlling aquatic weeds in irrigation canals compared to other alternative control methods. [119]

FIELD BINDWEED CONTROL IN WINTERFAT SEED PRODUCTION FIELDS. Roger Hybner* and Jim Jacobs, USDA-Natural Resource Conservation Service, Bridger and Bozeman, MT.

Winterfat, Krascheninnikovia lanata, is a native half-shrub highly valued as winter forage for livestock and wildlife ungulates in the western United States. Crude protein levels remain between 7 to 11 percent at that time and the plant is also high in calcium, phosphorous and potassium. Other uses for winterfat can be mineland reclamation, an addition to seed mixtures in range renovation, and wildlife habitat improvement. The USDA Natural Resource Conservation Service's Bridger Plant Materials Center, Bridger, MT, has a tested class germplasm release named Open Range. They are responsible for raising and keeping Foundation seedstock on hand for sale to interested certified seed growers in MT and WY. One large problem with many forb/shrub seed production fields is the invasion of broadleaf weeds, such as field bindweed (*Convolvulus arvensis L.*). Due to winterfat being a broadleaf, many common herbicides normally used for field bindweed control are not labeled for use on the plant. A second problem involves field bindweed seeds attaching to the fuzzy outer covering of winterfat seed, thus making their removal very difficult during the seed cleaning process. To address these problems, a study to determine the effects of aminopyralid, quinclorac and imazapic and a no herbicide check on field bindweed control and subsequent winterfat seed production was initiated on 1 July, 2008, when field bindweed was actively flowering. Aminopyralid was applied at 0.188, 0.313, and 0.375 lb ai/A, quinclorac was applied at 0.25 and 0.375 lb ai/A, and imazapic was applied at 0.25, 0.375, and 0.5 lb ai/A. Methylated seed oil was included in the spray solution at 1 qt/A and nitrogen fertilizer was added via UAN at 1 gal/A. The herbicides were applied using a backpack plot sprayer delivering 15 gal/A spray solution. The study was organized in a randomized complete block design w/ four replications and individual plots were 10 feet by 20 feet. Field bindweed control was visually rated on 16 July, 2008, and again on 22 June, 2009. A fall 2008 application of herbicides was planned, but not implemented due to inadequate regrowth of the field bindweed in the plots. The ANOVA model used to analyze the data included herbicide, rate, and their interaction. Visual observations indicated all herbicides at all rates negatively suppressed winterfat seed production to zero the autumn after herbicide application. Herbicidal control of field bindweed depended on the rate ($p<0.05$). Imazapic at 0.5 lb ai/A resulted in 70 percent control of field bindweed, significantly greater than 30 percent field bindweed control where quinclorac was applied at 0.375 lb ai/A. The difference may be attributed to application timing as quinclorac is normally sprayed just before the first frost in the fall for optimum field bindweed control. Although no winterfat plants died due to the any of the treatments, it should be noted application of these herbicides does have a deleterious effect on subsequent seed production. [121]

EFFICACY OF MECHANICAL AND HERBICIDE CONTROL METHODS FOR TREE TOBACCO (*NICOTIANA GLAUCA*). Scott R. Oneto*, Guy B. Kyser, and Joseph M. DiTomaso, University of California.

Tree tobacco (*Nicotiana glauca*) is an invasive plant native to South America. It was first introduced into North America in the early 1800s and has spread throughout much of the United States. The objective of this experiment was to evaluate mechanical methods (Weed Wrench, lopping), several herbicides, and herbicide application techniques for control of tree tobacco. Three herbicides were evaluated (glyphosate, imazapyr, and triclopyr ester) for canopy reduction using foliar, drizzle, basal bark and cut stump treatments. All treatments were made in both fall and late spring. Results indicate that both glyphosate and imazapyr provided excellent control of tree tobacco using all application techniques and rates tested, in either the fall or spring. Triclopyr ester showed excellent control as a foliar and drizzle application in the spring, but was slightly less effective as a fall application. Triclopyr ester also gave excellent control as a basal bark or cut stump treatment in either the fall or spring. Lopping provided some control in the fall, but was ineffective in the spring. The weed wrench was effective in either the fall or spring as long as the entire root was extracted. These results demonstrate that effective control of tree tobacco can be achieved with either spring or fall treatments using both chemical and mechanical methods. [122]

CONTROLLING DOWNY BROME ON MONTANA RANGELAND. Jane Mangold*, Montana State University, Bozeman; Celestine Duncan, Weed Management Services, Helena, MT; Peter Rice, University of Montana, Missoula; Jim Jacobs, Natural Resources Conservation Services, Bozeman, MT.

Downy brome (*Bromus tectorum L.*) is an invasive annual grass that has been increasing on rangeland across Montana over the past several years. While considerable information is available about control options for rangeland in the western U.S., especially the Great Basin, less information is available for managing downy brome on Montana rangeland. In an effort to develop effective management recommendations for control of downy brome on Montana rangeland, we compiled data from over 20 studies across the state that investigated efficacy of multiple herbicides applied at various rates and timings. One of the commonly prescribed treatments for downy brome, and one that was consistently tested in our pool of studies, is an application of imazapic at 0.03 kg a.i./ha to 0.21 kg a.i./ha . We looked for trends regarding application rate, stage of downy brome at time of application (pre-emergent, early post-emergent, post-emergent, spring), and use of surfactant. Across stages of downy brome at time of application, imazapic applied at 0.11 kg a.i./ha to 0.21 kg a.i./ha resulted in better control of downy brome (52-65% control) compared to the 0.03 or 0.07 kg a.i./ha rate (5-18% control) nine to 12 months following application. Across application rates, applying imazapic to downy brome early post-emergent (1-2 leaf stage) resulted in better control (>80%) than applying imazapic pre-emergent, post-emergent (2+ leaf stage), or in the spring. Applying imazapic with methylated seed oil doubled downy brome control compared to applying imazapic with non-ionic surfactant. From our pooled data we plan to investigate additional factors (e.g. presence of litter and other vegetation, site characteristics) and other herbicides commonly tested in our studies so that rangeland managers facing downy brome infestations might be equipped with the most effective options available. [124]

POTENTIAL OF TEBUTHIURON FOR DOWNY BROME CONTROL ON WESTERN RANGELAND. Celestine Duncan*, Weed Management Services, Helena, MT; Mary Halstvedt, Vanelle F. Peterson, Dow AgroSciences, Billings, MT and Mulino, OR; and Jane Mangold, Montana State University, Bozeman, MT.

Downy brome (*Bromus tectorum*), or cheatgrass, is an invasive annual grass occurring as a dominant component of the plant community on over 56 million acres of rangeland and wildland in the western US. Field trials were established in 2004 through 2008 to test efficacy of fall-applied tebuthiuron alone and in combination with aminopyralid on downy brome, compared to a standard imazapic treatment. Field sites were established near Walla Walla, WA, and in western and southcentral MT. Applications in 2004 through 2007 were made prior to downy brome emergence in WA and early post-emergence in western MT. Tebuthiuron was applied at rates of 8, 12, and 16 oz ai/A, aminopyralid at 1.75 oz ae/A, and imazapic at 2 oz ai/A. Additional studies were established in late summer and fall 2008 to compare efficacy of reduced tebuthiuron rates alone and in combination with aminopyralid applied pre- and post-emergence to downy brome. Aminopyralid was applied alone at 1.25 oz ae/A, and in combination with tebuthiuron at 4, 6, and 8 oz ai/A prior to downy brome germination. Post-emergence applications included tebuthiuron at 4, 6 and 8 oz ai/A and imazapic at 2 oz ai/A. Herbicide treatments were applied with a CO2 backpack sprayer at 13 to 20 gpa in a randomized complete block design with three to four replications per treatment. Visual percent control of downy brome was taken 7 to 8 MAT (months after treatment). Visual percent injury to perennial grasses was evaluated at 2 Montana locations. Results of herbicide treatments indicate that tebuthiuron at 4, 6, 8, 12, and 16 oz ai/A provided an average of 58, 79, 89, 98 and 96% control respectively across sites. Tebuthiuron rates of 6 oz ai/A and above provided significantly ($P<0.05$) greater control than imazapic at 2 oz ai/A which averaged 60% control. Aminopyralid alone provided inconsistent downy brome control among replications and between sites. At the WA location, aminopyralid at 1.75 oz ae/A applied prior to downy brome emergence, provided good control (85%) 7 MAT. In MT, aminopyralid at 1.25 pre-emergence and 1.75 oz ae/A applied post-emergence provided <15% control. The addition of aminopyralid to tebuthiuron did not improve downy brome control compared to tebuthiuron alone. Perennial grass injury 7 MAT at Montana locations increased with increasing rate of tebuthiuron at some sites. Level of injury was dependent on soil type and grass species present. Perennial grass injury declined the second year following treatment. In conclusion, tebuthiuron alone applied in fall at rates of 8 oz ai/A and above provided excellent downy brome control with a high level of consistency across sites compared to standard herbicide treatments. Additional research is needed to quantify perennial grass injury and potential for reseeding desirable grasses on tebuthiuron-treated lands. [125]

MANAGING DOWNY BROME SEED PRODUCTION AND LITTER TO EXHAUST ITS SOIL SEED RESERVE. Ryan Edwards*, Nicholas Krick, K. George Beck, James R. Sebastian, Colorado State University, Ft. Collins.

A study was established in spring 2009 to determine whether the soil seed reserve (SSR) of downy brome (*Bromus tectorum* L.) can be exhausted by management. The experiment was designed as 3 mowing heights (0, 2, and 6 inches) by 2 litter treatments (remove and leave) by 2 herbicide treatments (Imazapic at 2 oz ai/A and none) factorial arranged as a RCB with four replications. Mowing occurred on June 18, 2009 and herbicide treatments were applied on July 15, 2009 preemergence to downy brome. Percent downy brome cover data were collected three times (June baseline, October, and November) in four 0.25 m2 quadrats in each plot. Soil cores (16 per plot) were taken to determine the downy brome SSR. Cores were taken in June, October and November 2009, and were subjected to germination tests. Data were analyzed by analysis of variance ($\alpha=0.05$). In October, downy brome cover in plots that were mowed to a 2 inch height, litter collected and imazapic applied, were 99% less than in control plots where mowing, litter collection, and herbicide application did not occur. October germination data revealed about 61 and 67% fewer seeds in plots mowed to a 2 inch height, litter collected but no herbicide was applied compared to plots that were mowed to 6 inches, litter not collected and no herbicide was applied and in control plots, respectively. No differences were detected for the November SSR data. Treatments will be re-applied in 2010 and 2011 and results followed through 2012. [126]

POST-FIRE CHEATGRASS DYNAMICS IN THE SOUTHERN WIND RIVER RANGE OF WYOMING. Brian A. Mealor, University of Wyoming, Laramie; D. Terrance Booth, Samuel Cox, USDA-ARS, Cheyenne, WY; and Holly Copeland, The Nature Conservancy, Lander, WY.

The invasive annual grass cheatgrass, or downy brome (*Bromus tectorum*), has become the most ubiquitous weed in sagebrush systems of Western North America. The invasion center has largely been the Great Basin region, but increases in abundance and distribution have occurred in the Rocky Mountain states. We used repeat very-large scale aerial (VLSA) imagery and ground-based digital photography to document changes in vegetation composition immediately after, and five years after, prescribed fires and a wildfire in Wyoming's southern Wind River Mountain Range in an elevation range from 1700 m to over 2500 m. We computed long-term mean annual temperature, and mean temperatures for spring and fall, to assess trends in temperature change through time. VLSA imagery and ground imagery were equally effective at detecting canopy cover of downy brome. Although downy brome was recorded at sites over 2500 m, its frequency was greatest at lower elevations. Total vegetation cover increased across all burned sites from 2002-2008 (post-fire). Downy brome canopy cover increased across the entire study area from 2002 (1.77% ± 0.72 SE) to 2008 (10.39% ± 1.98 SE; $p < 0.0001$), whereas downy brome cover showed no change in the unburned reference area ($p > 0.54$). We documented an increase in mean annual temperature over a 60 year period, with the greatest increase during March; an important time for downy brome germination and growth. Our results indicate that VLSA imagery is a useful tool for documenting downy brome invasion in relatively complex rangeland ecosystems, and confirms the capacity of downy brome to invade and expand at high elevations in Wyoming. [127]

SOIL SEEDBANK CHANGES FOLLOWING LEAFY SPURGE (*EUPHORBIA ESULA* L.) CONTROL WITH APHTHONA SPP. BIOCONTROL AGENTS. Cassandra Setter and Rodney G. Lym, North Dakota State University, Fargo.

Aphthona spp. flea beetles were released in the Little Missouri National Grasslands in western North Dakota in 1999 to control leafy spurge. The change in soil seedbank composition and leafy spurge density were evaluated 5 and 10 yr after Aphthona release to monitor the effectiveness of the beetles and resulting weed control on associated plant communities. A total of 480 soil cores were excavated from release and non-release sites. Desirable (high-seral) forbs increased and leafy spurge populations declined 5 and 10 yr after the Aphthona release. In loamy overflow and loamy ecological sites, leafy spurge stem density decreased from about 94 stems/m² in 1999 to 8 and 5 stems/m² in 2004 and 2009, respectively. From 1999 to 2004, leafy spurge seedling density decreased from about 68% to 14% of the total seedbank at both ecological sites and continued to decline through 2009. In 1999 and 2004, leafy spurge was a major species in the soil seedbank, but in the current study, Kentucky bluegrass (*Poa pratensis* L.) was the most prevalent plant species. Since 1999, there has been a slight increase in native plant species, but also an increase in non-target weedy species such as Kentucky bluegrass and quackgrass [*Elymus repens* (L.) Gould]. The recovery rate of native vegetation has been slow; however, the increase in native plant seed and the successful long-term control of leafy spurge suggests the soil seedbank is gradually moving towards recovery and reestablishment of native species in the Little Missouri National Grasslands. [128]

INFLUENCE OF PRESCRIBED FIRE ON CANADA THISTLE (*CIRSIUM ARVENSE*) CONTROL AND NATIVE GRASS AND FORBS PRODUCTION. Gustavo M. Sbatella* and Robert G. Wilson, University of Nebraska, Scottsbluff.

In March of 2009 approximately 25 acres of rangeland infested mainly with Canada thistle near Mitchell, NE, was burned as part of a restoration program aimed to improve grass quality and reduce weedy species. A field trial was established to evaluate if Canada thistle control with herbicides was affected by early season fire. A section of the plot area was located in the burned area and a second section, similar in size and degree of Canada thistle infestation, was located in an adjacent unburned area. Treatments included aminopyralid at 0.05 and 0.12 kg ai/ha, clopyralid at 0.42 kg ai/ha, aminopyralid plus clopyralid at 0.05 plus 0.23 kg ai/ha, and aminopyralid plus 2, 4 D amine at 0.05 and 0.43 kg ai/ha respectively. Herbicides applications were timed at Canada thistle emergence or late bolting. On April 23 the burned are was sprayed for the first timing, while the unburned area was not sprayed until May 6. The second time of application was sprayed on June 6 in both sections. Visual evaluation of thistle control 90 days after treatment (DAT) ranged from 65 % with aminopyralid plus clopyralid (unburned, late bolting) to 99 % when the herbicide combination was applied in the burned area after thistle emergence. Biomass collected 150 days after the fire suggests a major change in biomass composition. Thistle biomass was reduced by 49% and only 5 % of the dead biomass remained after the fire. Grass biomass increased from 659 to 1377 kg/ha in the burned area. [129]

SOIL MOISTURE STRESS TOLERANCE OF A LEADING PERENNIAL BIOFUEL GRASS IS SIMILAR TO THE INVASIVE PLANT GIANT REED. Jeremiah Mann*, Jacob Barney, Guy Kyser, and Joe DiTomaso, University of California, Davis .

Crops grown for bioenergy production are a mandated component of California's energy portfolio. Miscanthus (Miscanthus x giganteus) is a leading bioenergy crop and is similar in habit to the invasive plant Arundo donax that was included in this greenhouse study. We subjected both species to soil moisture conditions of -0.3 and -4.0 MPa, standing water, and a control. We constructed two groups of plants: group 1 had 8 weeks of growth followed by 8 weeks under treatment conditions, and group 2 under treatment conditions for 16 weeks. Total biomass of both species under standing water conditions was not different from the control regardless of age. However, drought did affect the two levels of establishment differently–in group 1 the -0.3 and -4.0 MPa treatment resulted in a 56% and 66% reduction in biomass respectively compared to the control averaged over both species. Likewise, in group 2 the -0.3 and -4.0 MPa treatments resulted in a 92% and 94% reduction in biomass averaged over both species. No species differences existed in drought treatments. Although our results do not indicate that miscanthus has the potential to escape and establish in upland wildland ecosystems, it does show a similar habitat preference as Arundo donax in lowland systems. [145]

THE ROLE OF DISTURBANCE IN TERRESTRIAL PLANT INVASIONS. Stephen L. Young, University of Nebraska, North Platte.

Much of the landscape has been disturbed by natural or anthropogenic forces. The establishment of undesirable terrestrial plant species often occurs in habitats that have been altered in some way. Many of the issues associated with invasive plant species can be traced to a form of disturbance. In the developed and developing world, weeds are synonymous with agronomic and horticultural cropping systems. The natural and pristine ecosystems of the world are not immune from invasive plant species, particularly where climate is conducive to human activity. Disturbance will continue in agronomic and ecological settings, which will continue to allow for the propagation of undesirable plant populations. In less intensively managed systems, revegetation is critical to offset the advance of the invading species. [146]

PROJECT 2: WEED OF HORTICULTURAL CROPS

SOUTHWESTERN CUPGRASS CONTROL IN TURFGRASS . Kai Umeda, University of Arizona Cooperative Extension, Phoenix, AZ.

Southwestern cupgrass is a summer annual weed that appears very similar to crabgrass when it is mowed in turfgrasses. It is differentiated by its seedhead and lack of hairs compared to crabgrass. MSMA effectively controls cupgrass when applied postemergence (POST); however, MSMA is now restricted in its uses on various turfgrass sites. Previously, quinclorac when formulated as a dry flowable was not efficacious against cupgrass. A liquid formulation was introduced with potential to control a wider range of growth stages of crabgrass and possibly control an expanded spectrum of grass weeds. Foramsulfuron, sulfosulfuron, flazasulfuron, and fenoxaprop are labeled for turf use against various weeds but cupgrass activity is unknown so a series of experiments was conducted to investigate POST herbicides for cupgrass control in turf. Quinclorac formulated as liquid Drive XLR8 or Onetime (premix with MCPP and dicamba) was active against southwestern cupgrass. Drive XLR8 plus ammonium sulfate tended to be slightly more active than the addition of methylated seed oil (MSO), non-ionic surfactant (NIS), or if nothing was added. Quinclorac at 0.75 lb a.e./A gave near complete control of cupgrass in a second experiment at 36 days after treatment. Performance of foramsulfuron at 0.038 lb a.i./A was variable and was very effective against cupgrass in one experiment while exhibiting moderate efficacy in another. Comparison of ALS-inhibiting herbicides showed flazasulfuron causing stunting with moderate control while sulfosulfuron was not effective against cupgrass. Fenoxaprop also did not control cupgrass. [130]

NEW PRODUCTS FOR WEED MANAGEMENT IN TEXAS TURF. Paul A. Baumann, Travis W. Janak and Mathew E. Matocha, Texas AgriLIFE Extension, College Station, TX.

Celsius (dicamba + thiencarbazone-methyl + iodosulfuron) was evaluated in 2009 to determine its' effectiveness for controlling dallisgrass (*Paspalum dilitatum*), dichondra (*Dichondra carolinensis*), slender aster (*Aster subulatus*), and sprawling horseweed (*Calyptocarpus vialis*). All are common weeds in central Texas turf grass. When Celsius was applied POST to dallisgrass at 4, 5.33, and 6.0 oz./A on 4-6 inch perennial plants, initial activity (26 DAT) ranged from 38 to 70 % control, but dissipated to 7 to 25% by the 55 DAT rating date. When applied POST to dichondra at rates of 4 and 5.33 oz./A, control at the 35 DAT rating ranged from 92 to 95%. This activity diminished by 71 DAT to 68 to 88% control, however, sequential applications applied at the 71 DAT evaluation date elevated control back to greater than 99% by late season. Celsius provided excellent season-long control of slender aster when treated at rates ranging from 2.46 to 5.33 oz./A. Applications were made when the slender aster was 2-3 in. and in the leafy stage of growth. At 14 DAT, control ranged from 75 to 87%, but increased to 99 to 100%

by the 42 DAT rating date and was maintained at this level throughout the season (> 90 DAT). Celsius provided good-excellent (72 to 88%) control of sprawling horseweed when applied to 1-3 in. plants at rates ranging from 4 to 6 oz./A and evaluated 26 DAT. By 55 DAT, control had increased to greater than 93% from all treatments. In a separate study conducted on sprawling horseweed, Celsius efficacy was evaluated when applied alone at 3.97 and 4.92 oz./A ,with 0.5% or 1.0% (v/v) of MSO, or 0.25% (v/v) of NIS. Control of this specie ranged from 25 to 40% at 12 DAT up to 75 to 89% at 56 DAT. No significant differences in efficacy were seen between any of the treatments, suggesting no positive benefit from the surfactants when Celsius was applied at these rates on this species. In all of these experiments, weed infestations were severe enough to make turf tolerance assessments non-feasible. [131]

PERFORMANCE OF INDAZIFLAM FOR BROAD SPECTRUM RESIDUAL WEED CONTROL. Darren Unland*, Bayer CropScience, Research Triangle Park, NC.

Bayer CropScience is developing the new active ingredient indaziflam for weed control in perennial fruit, nut, and vine crops. Upon EPA approval, indaziflam will be marketed as Alion® to be used alone or in a tankmix with other herbicides for preemergence control of monocot and dicot weeds. More than 500 field trials have been conducted by universities, private researchers, and Bayer CropScience throughout the US since 2003 and have demonstrated that 73 – 95 g ai ha-1 Alion® will provide excellent control of key weeds for several months after treatment. Over 40 broadleaf weed species that commonly occur in tree fruits, nuts, and vine crops will be included on the initial label including pigweeds (*Amaranthus species*), hairy fleabane (*Conyza bonariensis*), horseweed (*Conyza canadensis*), kochia (*Kochia scoparia*), annual sowthistle (*Sonchus oleraceus*), and swinecress (*Coronopus didymus*), Alion® will also control many of the most important monocot weeds such as annual bluegrass (*Poa annua*), bearded sprangletop (*Leptochloa fusca*), bromes (*Bromus species*), foxtails (*Setaria species*), large crabgrass (*Digitaria sanguinalis*), and Italian ryegrass (*Lolium multiflorum*), Length of control has been equal to or longer than all other registered products tested at the manufacturer's recommended use rates. Best control has been obtained when irrigation is applied or precipitation occurs soon after Alion® has been applied. [132]

INDAZIFLAM - A NEW HERBICIDE FOR PREEMERGENT CONTROL OF GRASS AND BROADLEAF WEEDS IN PERENNIAL CROPS. Hank Mager* and Darren Unland, Bayer CropScience, Research Triangle Park, NC.

Indaziflam is a new cellulose biosynthesis inhibitor under development as a preemergence broadspectrum herbicide for use in perennial fruit, nut, and vine crops. This new active ingredient from Bayer CropScience will be formulated as a suspension concentrate and branded as Alion® for use in these crops. Pending approval by EPA, Alion® will provide residual preemergence control of monocot and dicot weeds for several months with excellent crop safety. Alion® readily mixes with postemergence herbicides to add residual control to burndown products such as glufosinate. Alion® will be an effective tool to prevent or manage weed populations that are resistant to other modes of action including EPSP synthase inhibitors, ALS inhibitors, and PSII inhibitors. Alion® has very favorable toxicological properties with no evidence of effects on immunotoxicity, developmental toxicity, reproductive toxicity, genotoxicity or carcinogenicity. Based on residue tests results, Bayer CropScience anticipates a

14 day or less preharvest interval for all crops and no commodity trade restrictions. The use rate will be 73 – 95 g ai ha-1 per application with an annual maximum limit of 150 g ai ha-1. [133]

INDAZIFLAM - A NEW PRE-EMERGENT HERBICIDE FOR WEED CONTROL IN TURF, ORNAMENTALS, AND INDUSTRIAL AREAS. Hans C. Olsen, David R. Spak, and Donald F. Myers, Bayer Environmental Science RTP, NC.

Indaziflam (BCS-AA10717) is a new herbicide being developed for pre-emergence control of annual monocot and dicot weeds in turf, ornamentals, and industrial areas. Indaziflam is a cellulose biosynthesis inhibitor (CBI) and is classified as a HRAC Group L herbicide. Indaziflam is one of the most active CBI herbicides discovered to date, and therefore requires very low rates for effective weed control. It works by inhibiting crystalline cellulose deposition in the cell wall which severely affects cell wall formation as well as cell elongation and division. Thus, only actively growing meristematic regions are affected by indaziflam. Indaziflam acts primarily as a pre-emergent herbicide, but has early post-emergent control of some weed species such as annual bluegrass (*Poa annua*). However, best weed control of most weed species is achieved when indaziflam is applied prior to weed germination. Perennial weeds emerging from rhizomes or roots will not likely be controlled. Indaziflam has a water solubility of 2.8 mg/L with low soil mobility and moderate soil degradation rates. Use rates of indaziflam range between 30 and 100 g ai/ha depending on the weed species, use-site, and pattern of use. Since 2003, indaziflam has been evaluated in over 150 trials for turfgrass tolerance and weed control. Sprayable (WP and SC) and fertilizer granular formulations have been evaluated at rates of 12.5 to 150 g ai/ha. Warm season turfgrasses such as bermudagrass (*Cynodon dactylon*), centipedegrass (*Eremochloa ophiuroides*), seashore paspalum (*Paspalum vaginatum*), St. Augustinegrass (*Stenotaphrum secundatum*), and zoysiagrass (*Zoysia spp.*) show excellent tolerance to indaziflam. Cool-season turfgrasses generally do not have sufficient tolerance to indaziflam and will not be labeled for use. Primary weeds controlled include large and smooth crabgrass (*Digitaria spp.*), goosegrass (*Eleusine indica*), annual bluegrass, annual sedges (*Cyperus spp.*) and kyllinga (*Kyllinga spp.*), as well as many broadleaf weeds. In ornamentals, indaziflam was safe when applied as a directed spray in field grown ornamentals or sprayed over-the-top of dormant, woody deciduous plants and conifers. Several granular formulations of indaziflam have been evaluated for weed control in newly-planted container ornamentals. Woody plants show very good tolerance of indaziflam at rates up to (60 to 90 g ai/ha). Indaziflam also provided excellent residual control of many annual weeds including several difficult to control weeds such as eclipta (*Eclipta alba*) and doveweed (*Murdannia nudiflora*). Initial uses for industrial vegetation management include forestry, roadside, and railroad rights-of-way. Trials have been conducted for several years evaluating indaziflam at rates from 50 to 150 g ai/ha alone and in combination with other residual and postemergence herbicides for weed control in bareground situations. Indaziflam is currently pending an expected registration with EPA in 2010. [134]

PRE-EMERGENCE HERBICIDE SCREENING FOR TRANSPLANTED *SPOROBOLUS VIRGINICUS* (L.) KUNTH PLUGS, A NATIVE HAWAIIAN GRASS WITH ROADSIDE RE-VEGETATION POTENTIAL. Orville C. Baldos*, Joseph DeFrank University of Hawaii, Manoa and Glenn Sakamoto, USDA-NRCS Plant Materials Center, Hoolehua, HI.

Sporobolus virginicus (L.) Kunth is a salt and drought tolerant grass with potential use as a native, low maintenance turf for roadside right of way areas in Hawaii. In order to develop a successful establishment protocol, screening of pre-emergence herbicides that are both safe and effective is essential. In this study, dithiopyr (0.28 and 0.56 kg a.i./ha), trifluralin + isoxaben (2.24 + 0.56 kg a.i./ha and 4.48 + 1.12 kg a.i./ha), oxyfluorfen (0.28 and 0.56 kg a.i./ha), oxadiazon (2.24 and 4.48 kg a.i./ha) and table salt (448 kg a.i./ha) were evaluated for crop safety and weed control in transplanted Sporobolus virginicus plugs. Results after two sequential applications (2 and 80 days after planting) indicate that both high and low rates of oxadiazon and oxyfluorfen provided the best level of pre-emergence weed control and crop safety. Although applications of dithiopyr and trifluralin + isoxaben showed acceptable weed control ratings, these herbicides reduced dry weight accumulation of Sporobolus virginicus. Table salt provided the lowest level of weed control and altered surface soil structure and drainage. [135]

PENOXSULAM - NEW RESIDUAL HERBICIDE FOR USE IN TREE NUT CROPS. Jesse M. Richardson, Richard K. Mann, Monica M. Sorribas, Marc L. Fisher, Barat Bisabri, James P. Mueller, Debbie G. Shatley, Dow AgroSciences, Indianapolis, IN.

Penoxsulam is a new broadleaf herbicide that will be sold under the trade names PindarTM and PindarTM GT (a penoxsulam+oxyfluorfen pre-mix) for use in tree nut crops. This herbicide is a member of the triazolopyrimidine sulfonamide chemical family developed by Dow AgroSciences LLC. Penoxsulam is an ALS inhibitor which is absorbed via leaves, shoots, and roots and transported to meristematic tissue. Penoxsulam provides preemergence, residual herbicidal activity at low use rates from 17.5 to 35 g ai/ha (0.015 to 0.03 lb ai/acre) compared to commonly used tree nut crop herbicides. At correct use rates and proper timing of application, penoxsulam can provide up to 6 months residual control of susceptible weeds. Penoxsulam also provides postemergence weed control activity at use rates mentioned above. Penoxsulam alone (PindarTM) provides outstanding preemergence control of most of the key broadleaf weeds, including horseweed (*Conyza canadensis*), hairy fleabane (*Conyza bonariensis*), shepherd's-purse (*Capsella bursa-pastoris*), coast fiddleneck (*Amsinckia menziesii* var. intermedia), common chickweed (*Stellaria media*), London rocket (*Sisymbrium irio*), sowthistle (*Sonchus spp*), common lambsquarters (*Chenopodium album*) and white clover (*Trifolium repens*). PindarTM GT controls a broader spectrum of weeds including but not limited to dandelion (*Taraxacum officinale*), mallow (*Malva spp*), redstem filaree (*Erodium cicutarium*), and Palmer amaranth (*Amaranthus palmeri*). It also provides pre- and postemergence control of many grass weeds in tree nut orchards. In summary, penoxsulam is a new active ingredient for effective pre- and post-emergence weed control in tree nut crops. TMTrademark of Dow AgroSciences LLC. State restrictions on the sale and use of PindarTM and PindarTM GT apply. Consult the label prior to purchase or use for full details. Always read and follow label directions. [136]

THE RESPONSE OF WEEDS AND CUT STEMS OF *SPOROBOLUS VIRGINICUS* (L.) KUNTH (A NATIVE HAWAIIAN GROUND COVER) TO TWO FORMS OF OXADIAZON APPLIED AS A COMPONENT OF A HYDROMULCH CAP IN A SIMULATED PLANTING FOR ROADSIDE ESTABLISHMENT. Scott Lukas*, Joseph DeFrank, Orville C. Baldos, University of Hawaii, Manoa and Glenn Sakamoto, USDA-NRCS Plant Materials Cener, Hoolehua, HI.

United States Department of Transportation initiatives are calling for increased use of native plants for highway rights-of-way re-vegetation. In Hawaii Sporobolus virginicus, a coastal native grass has been planted on roadsides on Maui with no contractor specified protocols for weed control during establishment. While roadside plantings of S. virginicus can be successfully accomplished by hydromulch capping of cut stems, weed management is important for successful establishment. In this study, the efficacy and safety of pre-emergence herbicides applied with the hydromulch cap over cut stems was evaluated. Oxadiazon in two forms, granule and suspension concentrate, was applied at 0.91 and 1.36 kg ai/ha. S. virginicus response was recorded as counts of new green shoots 48 days after planting (DAP), aboveground biomass at 110 DAP, and percent visual coverage at 110 DAP. Data indicated that number of new green shoots was not significantly affected by the hydromulch cap treatments and that the highest level of S. virginicus biomass and visual coverage occurred with the G form of oxadiazon at 0.91 kg ai/ha, all other herbicide treatments were not significantly different than the control. Weed control was excellent (80-100%) for all herbicide treatments. The G-form of oxadiazon, in the hydromulch cap, can provide commercially acceptable weed control and improve establishment of cut stems of S. virginicus in roadside plantings. [137]

FLUMIOXAZIN AND V-10206 FOR WEED CONTROL IN POTATO. Pamela Hutchinson*, Brent Beutler, and JaNan Farr, Aberdeen Research and Extension Center, University of Idaho .

A potato weed control study was conducted in 2008 and 2009 in SE Idaho including a factorial arrangement of V-10206 at three rates, 0, 0.106, or 0.213 lb ai/A, and four tank-mix partners (TMP), none, flumioxazin at 0.047, s-metolachlor at 1.2, or dimethenamid-p at 0.84 lb ai/A. Russet Burbank were planted and treatments were applied preemergence and sprinkler-incorporated shortly after hilling. Injury and control ratings were conducted periodically. Tubers were harvested from the two center rows of each plot. No crop injury occurred in 2008, however, early-season stunting in 2009 increased from 0 to 10% as the rate of V-10206 applied alone increased from 0 to 0.213 lb/A. Spring 2009 conditions were unusually wet and cold compared with 2008 conditions. Rate by TMP interactions were significant each yr for season-long common lambsquarters and hairy nightshade control so these data were sorted by TMP and analyzed separately. Combined across yrs, common lambsquarters control with flumioxazin, s-metolachlor, or dimethenamid-p mixtures increased from 64 to 96, 85 to 99, or 87 to 99%, respectively, as the V-10206 rate increased from 0 to 0.213 lb/A. Hairy nightshade control was 97 to 100% with all combinations except s-metolachlor mixtures which provided 67 to 100% as the V-10206 rate increased from 0 to 0.213 lb/A. In 2008, slight U.S. No. 1 tuber yields reductions occurred with some treatments most likely due to lower common lambsquarters control by those treatments. Total tuber yield reductions occurred in 2009 with some treatments possibly related to early-season crop injury. [138]

HAIRY NIGHTSHADE CONTROL WITH FOMESAFEN IN CUCURBITS. Ed Peachey*, Oregon State University, Corvallis; and Doug Doohan, Ohio State University, Wooster.

The objective of these experiments was to measure the effect of fomesafen on hairy nightshade (*Solanum sarrachoides*) and cucurbit crops such as cucumbers, zucchini, and winter squash. Hairy nightshade can be very competitive in cucurbit production, but also produces copious amounts of seed that may impact production of rotational crops such as snap beans. Experiments were located on a silt loam soil in both years near Corvallis, OR. Crops planted in 2008 were two cucumber varieties (*Cucumis sativus* vars. Speedway and Muncher), zucchini (*Cucurbita pepo* var. Tigress), and Hubbard winter squash (*Cucurbita maxima* var. Golden Delicious); zucchini (Elite), two butternut varieties (*Cucurbita moschata* var. Dickinson and Ultra), and Hubbard winter squash (Golden Delicious) were planted in 2009. Cucurbit crops were seeded on May 14, 2008 and May 26, 2009 with a belt planter at 1 seed per foot of row and 1.25 inches deep. Herbicides were applied the following day with a backpack sprayer at 25 PSI delivering 20 GPA and incorporated with 0.5 inch of water within one day after planting. Plots were cultivated after the initial weed and crop evaluations at approximately 4 weeks after cracking. Hairy nightshade control in both years ranged from 95 to 100 percent with fomesafen applied at 0.25 lbs ai/A. The Hubbard winter squash was more tolerant than zucchini to fomesafen. Cucumber emergence was very poor when fomesafen was applied at 0.5 lbs ai/A, and crop growth was reduced by 24 and 59 percent at 4 and 7 weeks after treatment, respectively. In 2009, a severe thunderstorm delivered 0.75 inches of water in 20 minutes just after cracking that flooded several plots in one replication. The storm also caused splashing of treated soil onto seedlings as they were emerging from the soil. Despite the heavy rainfall and damage to crops in some plots, the crops recovered quickly and yield was not reduced at the low rate of fomesafen. Similar results were noted in a companion trial in Wooster, Ohio following a severe thunderstorm. Crop injury was evident for all crops early in the season but was greater for the butternut varieties and zucchini than Hubbard winter squash. The Hubbard winter squash was the most tolerant of the cucurbits in both years. The butternut cultivars were injured early in the season, but yield was not reduced significantly. All crops except zucchini produced as much fruit at 0.5 lbs ai fomesafen/A than at 0.25 lbs ai/A. [139]

USING ACTIVATED CARBON AS A SAFENER FOR PRE-EMERGENCE APPLIED S-METOLACHLOR AND DIMETHENAMID-P ON DIRECT SEEDED DRY BULB ONIONS. Joel Felix* and Joey Ishida, Oregon State University, Malheur Experiment Station, Ontario.

The herbicides s-metolachlor and dimethenamid-p are registered for use on direct seeded onions, but only after the seedlings have reached the 2-leaf stage. Depending on planting date and soil temperatures, approximately 5 to 7 weeks are needed for direct seeded onions to reach the 2-lf stage, at which time most of yellow nutsedge has emerged. In order to provide adequate control of yellow nutsedge (C*yperus esculentus*), s-metolachlor and dimethenamid-p have to be applied pre-emergence (PRE) to the weeds. Therefore, a field study was conducted at the Malheur Experiment Station, Ontario, OR in 2009 to evaluate the potential use of activated carbon to detoxify s-metolachlor and dimethenmid-p herbicides when applied PRE on direct seeded onions. The field was harrowed and planted to onion variety ‘Vaquero’ in March. Activated carbon was applied at 14 and 28 kg/ha in 189 liters of water and banded either directly on the ground behind the press wheel and drag chain or in-furrow directly behind the planter shoe. s-metolachlor was applied PRE at 1 or 1.4 kg ai/ha and dimethenamid-p at 1.1 or 0.55 kg ai/ha followed by another 0.55 kg ai/ha when onions were at the 2-leaf stage. Onion stand was reduced 43 and 35% when s-metolachlor and dimethenamid-p were applied PRE on dry bulb onions without activated carbon. Onion stand was 100,100 and 107,933 plants/ha when s-metolachlor and dimethenamid-p, respectively, were applied PRE with activated carbon. Banding of activated carbon directly over the onion row provided complete protection of emerging onion seedlings from PRE applied s-metolachlor and dimethenamid-p. Marketable dry bulb onion yield ranged from 63 to 124 T/ha, with the low yield obtained when s-metolachlor was applied PRE without activated carbon protection. Applying s-metolachlor and dimethenamid-p caused 35 and 28% injury to direct seeded onions, respectively. Application of activated charcoal at the time of onion planting effectively neutralized s-metolachlor and dimethenamid-p and no injury to direct seeded onions was observed. Future studies will evaluate irrigation/no irrigation to simulate the effect of rain after planting and application of PRE herbicides to direct seeded dry bulb onions. [140]

PROJECT 3: WEEDS OF AGRONOMIC CROPS

OPTIMUM® GAT® CORN – HERBICIDE PROGRAMS FOR THE WESTERN STATES. David W. Saunders*, Norman D. McKinley, James D. Harbour, and Keith D. Johnson, DuPont Crop Protection, Johnston, IA.

Weed control programs designed for use on corn containing the Optimum® GAT® trait are under development. Integrated herbicide programs making use of preemergence, postemergence, and 2-pass weed control strategies were evaluated by DuPont, university, and contract investigators in 2009. Data will be presented supporting the use of Optimum® GAT® trait crops as new tools for managing weed control problems including herbicide resistance weeds across the United States. Results indicate that new herbicides underdevelopment for use on corn containing the Optimum® GAT® trait will provide effective control of important grass and broadleaf weeds. Seed products with the Optimum® GAT® trait will be available for sale pending regulatory approvals and field testing. New DuPont herbicides for the Optimum® GAT trait® are not currently registered for sale or use in the United States. [88]

OPTIMUM® GAT® SOYBEANS – HERBICIDE PROGRAMS FOR THE WESTERN STATES. David W. Saunders*, Norman D. McKinley, James D. Harbour, and Keith D. Johnson, DuPont Crop Protection, Johnston, IA.

Weed control programs designed for use on soybeans containing the Optimum® GAT® trait are under development. Integrated herbicide programs making use of preemergence, postemergence, and 2-pass weed control strategies were evaluated by DuPont, university, and contract investigators in 2009. Data will be presented supporting the use of Optimum® GAT® trait crops as new tools for managing weed control problems including herbicide resistance weeds across the United States. Results indicate that new herbicides underdevelopment for use on soybeans containing the Optimum® GAT® trait will provide effective control of important grass and broadleaf weeds. Seed products with the Optimum® GAT® trait will be available for sale pending regulatory approvals and field testing. New DuPont herbicides for the Optimum® GAT® trait are not currently registered for sale or use in the United States. [89]

PULSARTM: NEW HERBICIDE FOR BROADLEAF WEED CONTROL IN WHEAT AND BARLEY. Marty Schraer*, Don Porter, Pete Forester, Scott Clewis, and Kathrin Schirmacher, Syngenta Crop Protection, Greensboro, NC.

PulsarTM is a new selective postemergence herbicide being developed for the US market by Syngenta Crop Protection for the control of broadleaf weeds in wheat and barley. Pulsar is a novel premix formulation that contains two active ingredients: dicamba and fluroxypyr. Pulsar at 8.3 fl oz/A + MCPA ester at 8.6 fl oz/A provides control of a broad spectrum of broadleaf weeds including kochia (*Kochia scoparia*), wild buckwheat (*Polygonum convolvulus*), common lambsquarters (*Chenopodium album)* and redroot pigweed (*Amaranthus retroflexus*). Pulsar can be tank mixed with other broadleaf herbicide partners to increase the weed control spectrum. In addition, Pulsar may be tank mixed with graminicides for one-pass broadleaf and grass control. Pulsar has excellent crop safety and rotational crop flexibility and may be applied to all varieties of spring wheat, winter wheat, durum and barley. Pulsar will be launched in the US market in 2010. [90]

CROP SUSCEPTIBILITY TO AMINOPYRALID SOIL RESIDUE. Jonathan R. Mikkelson* and Rodney G. Lym, North Dakota State University, Fargo.

Aminopyralid often is used for invasive weed control on Conservation Reserve Program (CRP) land. As CRP land is returned to crop production, aminopyralid persistence in soil could limit future planting options. Field experiments were established near Fargo, ND in 2006 and Casselton, ND in 2008 to evaluate the effect of aminopyralid soil residue on alfalfa, corn, soybean, and sunflower. Aminopyralid at 60, 120, and 240 g ae/ha, and picloram at 560 g ae/ha were applied in mid-June or late-September. Crops were seeded across treatments in mid-May (approximately 20 or 23 mo after treatment (MAT) in Fargo and 8 or 11 MAT in Casselton). Crop injury was visually evaluated 7 to 60 d after emergence and yield determined. No injury or yield differences were observed in alfalfa, corn, or sunflower regardless of herbicide, rate, application timing, or evaluation date in Fargo. Soybean yield in Fargo declined by 29 and 41% when aminopyralid was applied at 240 g/ha in June or September, respectively, compared to the untreated control. At Casselton, aminopyralid applied in September caused much greater crop injury than when applied in June 1 yr after treatment (YAT). For example, aminopyralid at 120 g/ha applied in September caused 95, 100, and 94% injury to alfalfa, soybean, and sunflower, respectively, compared to 10, 44, and 8% injury when applied in June. Soybean, sunflower, and alfalfa should not be seeded in aminopyralid-treated soils 1 YAT, but corn, alfalfa, and sunflower were not injured when planted 2 YAT in eastern ND soils. [91]

GROUP 2 HERBICIDE RESISTANCE IN A DIRECT SEED WHEAT CROPPING SYSTEM. Joan Campbell* and Donn Thill, University of Idaho, Moscow, ID.

Group 2 herbicide resistant weeds are increasing in wheat cropping systems. Managing weed control systems to attempt prevention of herbicide resistant weeds is essential. A study was initiated in 1995 to determine the rate of group 2 herbicide-resistant weed enrichment in dry land wheat production systems in the Pacific Northwest. Various combinations of "on-year" and "off-year" applications of group 2 herbicides were applied. Plots were 60 ft by 60 ft and had a 60 ft border around each plot. Treatments were (1) group 2 herbicide applied every year, (2) non-group 2 herbicide applied every year, (3) group 2 and non-group 2 herbicide applied in alternating years (4) group 2 herbicides applied two years and non-group 2 herbicide applied every third year, (5) group 2 herbicide applied every year with plants cut off before seed was produced, and (6) group 2 herbicide applied 3 years, non-group 2 applied 3 years. Crops were grown under conventional tillage systems the first 6 years and direct seeded the last 6 years of the study. The experimental design is a randomized complete block with four replications. Two cycles of the longest application regime (3 years on / 3 years off) was completed in 2006. Prickly lettuce and annual sowthistle seed collected in 2005 and 2006 were tested in the greenhouse and were confirmed resistant to group 2 herbicides. All plots were treated with non-group 2 herbicides in 2007 and no prickly lettuce or annual sowthistle seed was produced. In 2008, all plots were treated with group 2 herbicide except the treatment that never receives group 2 herbicide. In 2008, prickly lettuce population was highest in the always on plots (195 and 238 plants/plot) and lowest in the always off plot (0.25 plant/plot). In 2009, treatments 2, 3 and 4 were treated with non-group 2 and treatments 1, 5 and 6 were treated with group 2 herbicide. Prickly lettuce population was similar to 2008, with highest population in the always on plots (475 and 512 plants/plot) and lowest in the always off plot (4 plants/plot). Prickly lettuce population was higher in treatments 3 and 4 (1 year on/1 year off and 2 years on/1 year off) compared to treatment 2 (group 2 never applied) but the means were not statistically different. Pea seed yield followed a similar trend as treatments 1 and 5 were lower (318 lb/a) than treatments 3 and 4 (636 plant/plot). All prickly lettuce seed screened in 2008 and 2009 was group 2 herbicide resistant. [92]

THE FIRST REPORT OF GLUFOSINATE-RESISTANCE IN WEED SPECIES . Wilson V. Avila* and Carol Mallory-Smith. Oregon State University, Corvallis, OR.

Glufosinate is a nonselective post emergence herbicide that is commonly used in orchards, vineyards, and glufosinate-resistant GMO crops such as canola, corn, and soybean. Although different patterns of glufosinate sensitivity have been reported among weed species, resistance has not been reported. Italian ryegrass (*Lolium multiflorum*) is a common weed in filbert orchards in Oregon. Its control has been based primarily on the intensive use of glyphosate. However, glyphosate-resistance Italian ryegrass was found in a filbert orchard in 2005. In addition, reduced control with glufosinate has been observed. Therefore, dose-response bioassays were conducted to test sensitivity to glufosinate. Seven rates of glufosinate (from 0.0625 to 4.0 kg ai ha-1) were applied to three glyphosate-resistant Italian ryegrass populations collected from filbert orchards in Oregon. Resistant/susceptible ratios for the populations ranged from 2.2 to 2.7, confirming glufosinate-resistance in all three populations. Dead/alive ratios showed a high percentage of segregating survivors at glufosinate rates of 1 and 2 kg ai ha-1. These data suggest that the resistance ratios could be underestimated. [93]

SULFONYLUREA AND QUIZALOFOP TOLERANCE TRAITS IN SORGHUM - NEW WEED MANAGEMENT TOOLS FOR SORGHUM PRODUCTION. Robert N. Rupp*, Douglas J. Meadows, Dave W. Saunders and Wayne J. Schumacher, DuPont Crop Protection, Denver, CO.

Kansas State University Researchers have developed non-GMO sulfonylurea and quizalofop herbicide tolerance traits in sorghum. DuPont Crop Protection has acquired exclusive commercial rights to both tolerance traits and to the use of chemistries enabled by those traits. DuPont Crop Protection will license these herbicide tolerance traits to interested sorghum seed companies. Herbicide active ingredients including nicosulfuron, rimsulfuron and metsulfuron methyl are being evaluated for the sulfonylurea tolerant sorghum and Assure® II for the quizalofop tolerant sorghum. New herbicide offerings enabled by the traits will allow sorghum producers to use new postemergence solutions for grass and broadleaf control in sorghum that have previously not been available. The sulfonylurea trait enables the use of herbicides that control grass and broadleaf weeds with both contact and residual activity. The quizalofop trait enables the use of Assure® II for postemergence control of grass species. A parallel launch of sorghum seed products with complimentary DuPont Crop Protection herbicides is planned, pending herbicide trait development and EPA registration of herbicides. [94]

VERNALIZATION EFFECTS ON IMAZAMOX TRANSLOCATION AND ALS ACTIVITY IN FERAL RYE. Michael H. Ostlie*, Phillip P. Westra, Colorado State University, Ft. Collins; Dale L. Shaner, USDA-ARS, Ft. Collins, CO.

Feral rye, an obligate out-crossing winter annual grass of the same species as cultivated rye, is a major crop pest in Colorado wheat. Recent studies indicate great genetic plasticity in regards to feral rye imazamox tolerance in Colorado and Oklahoma populations. Notably, feral rye had a greater survival rate when exposed to cold temperature shortly after application, than without cold temperatures. Since imazamox can be applied in the fall in imazamox tolerant winter wheat, cold temperatures can be a factor in management decisions. To study cold weather effects, experiments were established to measure imazamox behavior in warm and cold temperatures. One experiment was designed to measure ALS enzyme activity via the in-vivo enzyme assay, and whole plant decline after imazamox treatment in warm and cold temperatures. A second experiment was designed to quantify imazamox translocation to different feral rye tissues before, during, and after vernalization. ALS activity in warm and cold treatments was completely inhibited by imazamox initially, however, cold treated plants regained activity over time and recovery correlated to a 10% survival rate of plants compared to no surviving plants in the warm treatment. Leaf wash data indicate much slower in-take of imazamox in cold temperatures and reduced translocation to the growing points. However, the feral rye continued to slowly metabolize the herbicide under cold temperatures. Increased tolerance of feral rye to imazamox under cold temperatures may be primarily due to decreased translocation of herbicide along with slow metabolism of the herbicide to non-toxic forms, allowing plant recovery. [95]

HERBICIDE RESISTANT SORGHUM: NEW OPPORTUNITIES FOR WEED MANAGEMENT. Kassim Al-Khatib* and Mitch Tuinstra, Kansas State University and Purdue University.

Herbicides are an important component in grain sorghum weed management. Currently, many grain sorghum producers use preplant herbicides such as atrazine and metolachlor, followed by postemergence herbicides such as atrazine, 2,4-D, and dicamba. However, lack of soil moisture may decrease the efficacy of preplant herbicides, and postemergence herbicides may cause crop injury. Furthermore, postemergence herbicides may exhibit poor control of grass weeds such as barnyardgrass, foxtails, crabgrass, fall panicum, field sandbur, longspine sandbur, Texas panicum, and wooly cupgrass. In many parts of the sorghum producing areas, there are no effective postemergence herbicides available to control grass weeds in sorghum. Nicosulfuron and rimsulfuron are acetolactate synthase (ALS)-inhibiting herbicides that widely used to control broadleaf and grass weeds in corn. Quizalofop is acetyl CoA carboxylase (ACC)-inhibiting herbicide that is effectively used to control grasses in soybean and other crops. Unfortunately, nicosulfuron, rimsulfuron, and quizalofop cannot be used on sorghum because sorghum is susceptible to these herbicides. A project was initiated in 2003 to develop and ultimately commercialize sorghum varieties with tolerance to ALS- and ACC-inhibiting herbicides. The development of this technology would allow for more effective postemergence grass control for sorghum producers and also improve crop rotation and replant options for farmers interested in planting sorghum in fields sprayed with ALS-inhibiting herbicides in the previous crop (e.g. hail- or frost-damaged wheat or cotton). An herbicide-resistant sorghum (HRS) accessions that tolerates ALS-inhibiting herbicides and Acetyl CoA carboxylase has been identified. The resistant genes were obtained from a wild relative of sorghum and successfully transferred to grain sorghum hybrids. Herbicide resistance is controlled by a single dominate gene. This technology has excellent potential for postemergence control of grass weeds in sorghum. Three sets of sorghum materials have been released in 2007 and 2009. The first set of materials was released with seed of 18 ALS-herbicide tolerant sorghum families representing an array of commercially important sorghum seed and pollinator genetic backgrounds made available to commercial seed industry. A second release of 34 ALS herbicide tolerant sorghum inbred lines was released as potential parent lines for development of ALS-herbicide tolerant hybrids. A third release of stack ALS- and ACC-resistant sorghum was made in October 2009. Currently, IR-4 program is conducting nicosulfuron rimsulfuron, and quizalofop residue studies to obtain registration of these herbicides in grain and forage sorghum. We expected that all residue data will be completed and sent to EPA by October 2010. Extension specialist from different sorghum producing areas, industry representatives, and National Sorghum Producer are working closely to develop stewardship program for sorghum producers to effectively utilize these technologies. [96]

DRY PEA, CHICKPEA, AND LENTIL CULTIVAR TOLERANCE TO PPO-INHIBITORS . Jordan L. Hoefing* and Brian M. Jenks, North Dakota State University, Minot.

It has been documented that PPO-inhibititors such as sulfentrazone and flumioxazin have caused significant injury to some soybean cultivars. The objective of this study was to evaluate injury to two cultivars of dry pea, chickpea, and lentil caused by saflufenacil. Seeds were imbibed with varying concentrations of saflufenacil up to 200 ppb in a growth chamber at 30 degrees Celsius and 65% relative humidity. After 24 hours they were transferred to seed germination pouches and watered with the same concentration they were imbibed with. To compare differences between cultivars and rates, effect on crop growth was estimated by measuring root and hypocotyls lengths. The measurements were taken in millimeters and the data analyzed as a CRD in SAS. No significant differences among treatments were recorded; however, there was a trend that showed as rates increased, root and hypocotyl length decreased. When looking at root length, there were no significant differences between varieties and the said trend was only obvious among the peas. When looking at hypocotyl length, there were no significant differences among varieties and the said trend was obvious among the lentils and peas. [97]

WEED MANAGEMENT IN GAT CORN AND ALS-TOLERANT SORGHUM IN CENTRAL TEXAS. Mathew E. Matocha, Paul A. Baumann and Travis W. Janak, Texas AgriLIFE Extension, College Station, TX.

Weed management in corn and sorghum becomes ever more challenging with issues such as herbicide resistant weeds. Therefore, field studies were conducted in 2008 and 2009 to evaluate the performance of Optimum® GAT® corn and ALS-tolerant sorghum using varied rates and combinations of ALS-inhibitor herbicides (and premixes) for combating common weeds in the Central Texas Blacklands. The treatment regime employed allows a broader spectrum of weeds controlled, and provides both postemergent and residual control necessary for the management of herbicide resistant species. Studies were conducted at the Stiles Farm Foundation located in Thrall, TX. Weed species evaluated included Texas panicum (*Panicum texanum*), Johnsongrass (*Sorghum halepense*), and Palmer amaranth (*Amaranthus palmeri*). Visual weed control ratings were made and crop injury was assessed (none observed in corn). Corn yields were not taken due to crop destruction requirements. Sorghum yield was not taken due to the earliness of development of the sorghum hybrid utilized in the study. Applications were made with either a CO2 Backpack or tractor- mounted CO2 sprayer with a spray volume of 15 gallons per acre (GPA). The products that were evaluated for the premixes in the corn studies included Instigate™(Resolve™ + Classic® + mesotrione), Trigate™(Resolve™ + Express® + mesotrione) and Freestyle™(Harmony®GT XP + Express®+ Classic®). Treatments that were evaluated in corn in 2008 either included a preemergence (PRE) alone, a PRE followed by a late-post (LP), or a single mid-post (MP) treatment. PRE treatments included were Harness® Xtra (1.53 or 2.3 qt/A), Resolve™ (1 or 1.5 oz/A), Classic® (2 or 3 oz/A), Harness® (1.5 pt/A), and Atrazine 90 DF (1.38 lb/A). Mid-post treatments consisted of Touchdown® Total (1.5 pt/A) applied alone, and Touchdown® Total (1.5 pt/A) tank-mixed with Freestyle™ (1.5 oz/A), Resolve™ (1 oz/A), Classic® (1 oz/A), and Callisto®. In addition, a mid-post treatment of Freestyle™ (1.5 oz/A) and Callisto® (2.5 oz/A), and Liberty® (32 oz/a) + Freestyle™ (1.5 oz/A) was utilized. Late-post treatments included a tank-mix of Touchdown® Total (1.5 pt/A) and Freestyle™ (1.5 oz/A), Liberty® (32 oz/a) + Freestyle™ (1.5 oz/A). Herbicides evaluated in corn in 2009 included PRE treatments of Instigate™ (6.9 oz/A) tank-mixed with Bicep II Magnum® (1.4 qt/A), , Instigate™ (6.9 oz/A) + Atrazine 90 DF (1.38 lb/A), and Bicep II Magnum® (2.1 qt/A) and Dual II Magnum (1pt/A) applied alone. Herbicides evaluated in the ALS-tolerant sorghum applied at the PRE timing were Atrazine 90 DF (1.11 lb/a) and Bicep II Magnum (2.1 qt/A) as a stand alone. Those treatments that received Atrazine 90 DF were followed by an early-post application of various combinations of Accent® (0.66 oz/A) tank-mixed with either Atrazine 90 DF (1.11 lb/A), Ally® XP (0.10 oz/A), or Resolve™ (0.75 oz/A), and a synthetic auxin (Barrage® 8 oz/A, Clarity® 8 oz/A, or Starane® 4oz/A). Results from the 2008 corn study revealed that all treatments that received a mid-post application of Freestyle™ tank-mixed with either Touchdown® Total or Callisto® provided excellent (>95%) early season control of Texas panicum and Palmer amaranth. Likewise, soil applied treatments followed by a late-post application of Touchdown® Total alone or Freestyle™ tank-mixed with either Touchdown® Total or Liberty® provided very effective control of Texas panicum and Palmer amaranth at 27 days after the late-post timing. In the 2009 corn study, treatments receiving a mid-post application of Touchdown® Total tank-mixed with either Trigate™ and Atrazine 90 DF, or Bicep II Magnum® or Freestyle™, provided excellent (>93%, 23 DA-MP) control of Texas panicum and Palmer Amaranth with or without a soil applied treatment. Soil applied treatments of Instigate™ + Bicep II Magnum® (or Atrazine 90 DF) resulted in excellent control of both Texas panicum and Palmer amaranth when followed by a mid-post application of Touchdown® Total. Data from the 2009 ALS-tolerant sorghum study revealed that all early-post applications of Accent® plus a tank-mix partner provided excellent control (>93%, 14 DA-EP) of Johnsongrass and performed significantly better than Bicep II Magnum® alone, applied PRE. At 58 DA-EP Johnsongrass control ranged from 81 to 93%. Furthermore, all treatments provided excellent late-season control of Palmer amaranth at 58 DA-EP. At the 14 DA-EP rating date the sorghum exhibited substantial crop injury (lodging) wherever the synthetic auxin herbicides were included in the treatments, however, these effects were dramatically reduced by 27 DA-EP and continued to diminish over time. [98]

BENCHMARK STUDY: VARIATION IN WEED MANAGEMENT TACTICS IMPLEMENTED IN GLYPHOSATE-RESISTANT CROPPING SYSTEMS. Gustavo M. Sbatella, Robert G. Wilson, University of Nebraska; Bryan G. Young, Joseph L. Matthews, Southern Illinois University; David L. Jordan, North Carolina State University; Michael D. K. Owen, Philip Dixon, Iowa State University; David R. Shaw, Mississippi State University; Stephen C. Weller, William G. Johnson, Purdue University.

During 2006 and 2007 a total of 155 commercial fields in Illinois, Indiana, Iowa, Nebraska, North Carolina, and Mississippi were the foundation for comparing weed management tactics implemented by growers versus management practices recommended by a state university weed specialist. The recommendations provided by the university specialist were targeted at deterring the selection of glyphosate-resistant weed species. Each field was divided into two sections with half managed as typical for the grower and the other half managed following university recommendations. Fields were categorized into three cropping systems: 1) a single continuous glyphosate-resistant (GR) crop, 2) a rotation of two GR crops, and 3) a GR crop rotated with a non-GR crop. Over both grower and university sections, the frequency of glyphosate applications used for weed management was greatest in a single continuous GR crop (2 applications/year) followed by a rotation of two GR crops (1.6 applications/year) and least with a GR crop rotated with a non-GR crop (1 application/year). In most instances, the university recommendation did not reduce the frequency of glyphosate applications compared with grower practices. However, growers used 3 applications of glyphosate on an annual basis in GR cotton compared with an average of 2 and 1.2 applications, respectively, for GR soybean and corn. The rate of glyphosate used per application was similar between grower and university (~ 840 g ae/ha). The application rate of glyphosate increased from 763 to 913 g/ha, respectively, as the cropping system moved from a GR crop rotated with a non-GR crop to a continuous monoculture of a GR crop.

Averaged over all crops and fields, growers used glyphosate as the only herbicide for weed management in 40% of the sites compared with only 3% for the university recommendation. Instead of excluding glyphosate as a weed management tool, the university recommendation utilized soil residual herbicides or tank-mixtures with glyphosate twice as frequently as growers. At 68% of the sites, university weed scientists recommended using a preplant residual herbicide in addition to glyphosate. [99]

BENCHMARK STUDY: IMPACT OF GLYPHOSATE-RESISTANT CROPS ON SEEDBANK AND WEED POPULATION DENSITY. Robert G. Wilson*, Gustavo M. Sbatella, University of Nebraska, Scottsbluff; Stephen C. Weller, Purdue University, West Lafayette, IN; Bryan G. Young, Southern Illinois University, Carbondale; David L. Jordan, North Carolina State University, Raleigh; Micheal D.K. Owen, Philip Dixon, Iowa State University, Ames; and David R. Shaw, Mississippi State University, Mississippi State.

A multi-state, four-year field scale study was initiated in 2006 to assess the impact of weed management tactics on weed populations in glyphosate-resistant (GR) crops. A total of 155 commercial fields in Illinois, Indiana, Iowa, Mississippi, Nebraska and North Carolina were included in the study and seedbank, weed populations and yields were enumerated during the growing season. Fields selected had been in a glyphosate-resistant cropping system for the previous 3 yr. Each field was divided into two sections with half managed for weed control as typical for the grower and the other half managed following recommendations by the university weed specialist within the state. Forty sample points were established throughout each field with GPS coordinates within the two sides of the study site. Cropping systems examined included; continuous GR crop (corn, soybean, and cotton), a rotation of two GR crops and a rotation of a GR crop and a non-GR crop. The seedbank was sampled each spring by taking a 6.4 cm diameter by 15 cm deep soil core in 20 locations in each half of the field. Soil samples were kept separate and placed in a greenhouse and exposed to three cycles of wetting, drying and freezing conditions over a 104-day period and weed seedling emergence was utilized to estimate the weed seedbank during each cycle. In-crop weed density was measured in the spring prior to crop planting, after crop emergence, two weeks after the last postemergence herbicide application and at crop harvest in both years. Weed counts by species were taken in a 0.5 m2 area in the 20 sampling points in each half of the field. In the spring of 2006 seedbank sampling indicated that weed seed density was similar in the grower and university sections of the field for each of the seven cropping systems. However the seedbank in fields that had previously been in continuous glyphosate-resistant soybean (GRS) had a greater seed density than fields in a cropping system of continuous glyphosate-resistant corn (GRC). Interestingly by rotating GRS with another glyphosate-resistant crop, the number of weed seed in the seedbank was reduced. In 2006, prior to crop planting, fields in a monoculture of cotton had greater weed density than all other cropping systems. After crop emergence weed density was greater in a monoculture of GR corn but weed density was reduced in fields where GR corn was rotated with a different GR crop or with a non-GR crop. At harvest weed density was similar in fields cropped continuously with GR corn, cotton or soybeans but in fields practicing rotation, weed density was reduced compared to continuous GR soybean or GR corn. In 2007 the weed density measurements followed a similar pattern as in 2006 with the highest weed densities occurring in fields where a GR crop was grown in monoculture with no rotation. Weed density after the last postemergence herbicide application was greatest in continuous corn compared to continuous soybean or cotton but densities were reduced when rotation with another crop was practiced. In comparisons of weed densities in grower versus university sides of the fields in both 2006 and 2007, there was a trend towards reduced weed density on the university side, this was most likely due to including a soil applied preemergence herbicide with glyphosate on the researcher side versus growers relying solely on glyphosate. These results suggest that both cropping system and weed control programs play a critical role in the density of weeds in glyphosate-resistant crops. [100]

GLYPHOSATE RESISTANT CORN CONTROL IN GLYPHOSATE RESISTANT SUGARBEET. Abdel O. Mesbah* and Randall Violett, University of Wyoming, Powell.

Volunteer glyphosate resistant corn is becoming a troublesome weed in glyphosate resistant sugarbeet. Preliminary competition studies at the University of Wyoming Research and Extension Center, Lingle, Wyoming have shown that volunteer corn densities of 1 plant per 50, 20, and 10 ft2 reduced sugarbeet root yield by 2.5, 9, and 23%; respectively. A one year study was conducted in 2009 at the University of Wyoming Research and Extension Center, Powell, Wyoming to evaluate volunteer glyphosate resistant corn control and glyphosate resistant sugarbeet response to tank mixing several grass herbicides with glyphosate. Herbicide treatments consisted of glyphosate at (22 oz/A) tank mixed with clethodim, sethoxydim, or quizalofop and applied at 4” (early application) and/or 8” (late application) tall corn. All treatments were compared to glyphosate applied alone. Glyphosate resistant corn infestation was heavy 15 to 20 plants/10 ft. of row and uniform throughout the experimental site. All treatments containing grass herbicides plus crop oil concentrate caused 5% sugarbeet injury with early application. No injury was recorded with any of the other treatments. Glyphosate resistant corn control with early application of quizalofop or clethodim without crop oil concentrate was 77 and 85%; respectively. The addition of crop oil concentrate to these two herbicides increased volunteer corn control by at least 15% with both early and late application. Excellent volunteer corn control without causing any sugarbeet injury was achieved with split application of clethodim or quizalofop. Volunteer corn control with sethoxydim treatments with or without crop oil concentrate applied early, late, or as a split application was poor (40-50%). Sugarbeet yield was 7.5 to 16.9 tons/A higher in plots treated with grass herbicides as compared to plots treated with glyphosate alone (13.4 tons/A). In general, sugarbeet root yield was closely related to volunteer corn control. No significant effect was recorded with any of the treatments concerning sucrose content. [101]

THE IMPORTANCE OF CROP FERTILIZATION PROGRAMS ON WEED MANAGEMENT. Robert E. Blackshaw, Agriculture and Agri-Food Canada Research Center, Lethbridge, AB.

Several greenhouse and field experiments were conducted over the last decade to determine weed and crop responses to various crop fertilization programs. A greenhouse study evaluating 23 agricultural weeds found that 65% and 74% of the weed species were more responsive than wheat to N and P, respectively. This indicates that indiscriminate use of N and P fertilizer can have unintended negative effects on crop-weed competition. A multi-year field study examined N fertilizer (ammonium nitrate) timing (fall vs. spring) and placement (surface broadcast, subsurface banded, point-injected) effects on weed management in zero-till spring wheat. Weed density and biomass was often lower and spring wheat yield was usually higher with spring-applied fertilizer. Weed growth was greatest with surface broadcast N fertilizer. Depending on the weed species, the weed seedbank at the conclusion of the four-year study was 25 to 63% lower with banded or point-injected N compared with broadcast N fertilizer. Another study conducted with urea N fertilizer evaluated the effects of placement (seed-placed or side-banded 7.5 cm away from the seed row) and rate (0, 30, 60, 90 or 120 kg/ha) on wild oat competition with barley. Seed-placed, but not side-banded, urea at 60 kg/ha or greater reduced barley density and vigor resulting in 600% increase in wild oat seed production. A multi-site study was conducted to determine the effect of polymer-coated urea on weed management in barley and canola. The slow release nature of this coated urea product greatly reduced crop injury and no negative effects on crop competitiveness occurred. Furthermore, results indicated that less N was taken up by weeds before they were killed with in-crop herbicides and thus more N was available for the crop later in the growing season. A P fertilizer placement study found that weed biomass and weed seedbank were reduced with seed-placed or subsurface banded P compared with surface broadcast P fertilizer. Field studies with fresh and composted beef manure found that yield of both spring wheat and winter wheat increased markedly when grown under weed-free, but not weed-infested, conditions. Depending on the weed species, the weed seedbank at the conclusion of the four-year study was 68 to 210% greater with fresh or composted manure compared with subsurface banded N fertilizer. Overall results indicate that strategic fertilizer management can inhibit weed growth, reduce dependence on herbicides for weed management, and increase crop profitability. [141]

BROADLEAF WEED MANAGEMENT IN SEEDLING GRASSES GROWN FOR SEED. Andrew G. Hulting*, Daniel Curtis, Barbara Hinds-Cook, Bill Brewster and Carol Mallory-Smith, Oregon State University, Corvallis.

Spring-seeded tall fescue grown for seed in the Willamette Valley, Oregon requires intensive broadleaf weed management following seeding to ensure stand establishment and high seed yields in subsequent production years. Labeled chemical control options are few for difficult to control weed species such as wild carrot and sharppoint fluvellin that often form dense monocultures in these spring-seeded tall fescue plantings. Field trials were conducted in 2008 and 2009 to evaluate tall fescue tolerance and weed control efficacy for early postemergence treatments of oxyfluorfen, mesotrione, pyrasulfotole + bromoxynil, tribenuron and bromoxynil + MCPA ester applied alone and in combinations. Two combinations of herbicides resulted in acceptable control of sharppoint fluevellin during 2008. Mesotrione + tribenuron applied at 0.188 lbs ai/A and 0.0078 lbs ai/A, respectively resulted in 70% control of the sharppoint fluevellin and oxyfluorfen + tribenuron applied at 0.047 lbs ai/A and 0.0078 lbs ai/A, respectively resulted in 85 % control of the sharrpoint fluevelin. Neither treatment injured the seedling tall fescue. Pyrasulfotole + bromoxynil treatments resulted in the greatest control of sharppoint fluvellin in 2009. Application rates ranged from 0.25 -0.50 lbs ai/A with the highest rate resulting in 95% control of the sharppoint fluvellin. Mesotrione applied at rates ranging from 0.094-0.188 lbs ai/A resulted in slightly lower levels of control in 2009 with the highest rate resulting in 85% control of the sharppoint fluvellin. The pyrasulfotole + bromoxynil and mesotrione treatments appear to be safe when applied to seedling tall fescue with no crop injury documented. Oxyfluorfen applied alone at 0.047 lbs ai/A resulted in little control of the sharppoint fluvellin in either year. [142]

THE REQUIREMENTS TO HAVE SUCCESS WITH SKIP-ROW CORN. Robert N. Klein* and Jeffrey A. Golus, University of Nebraska West Central Research and Extension Center, North Platte, NE.

Weed management and evaporation are two challenges to being successful with using the skip-row corn system. Crop residue from a good winter wheat crop aids in meeting these two challenges. The crop residue can reduce weed pressure by as much as 80% over bare soil. Crop residues reduce the E (evaporation) in ET (evapotranspiration), leaving more soil water available to the crop. Research with irrigated corn in the area has demonstrated up to 10.16 centimeters of soil water loss through evaporation on bare soil as compared to soil with 80 to 100% crop residue cover. Most of this soil water loss occurs before canopy closure. Even when using the skip row system to conserve water, minimal residue will be a disadvantage since we usually do not get canopy closure in the skip row system, especially with the plant-two skip-two configuration. One of the keys to success with the skip-row corn system then is to produce a good winter wheat crop with a program that controls weeds in the growing winter wheat crop and post-harvest. Combine this with practices that maintain as much crop residue as possible, such as harvesting with a stripper header. In addition, on the corn planter remove or lift out of the way the planting units not used if possible. In the planting units being used replace the gauge wheels with a narrow type from a drill to reduce the amount of crop residue destroyed at planting. All spraying and fertilizing should be accomplished with row crop equipment; again, to reduce the amount of crop residue destroyed. [143]

POSTEMERGENCE HERBICIDE TANKMIXES IN ACETYL-COENZYME A CARBOXYLASE RESISTANT GRAIN SORGHUM. M. Joy M. Abit, Kassim Al-Khatib, Phillip W. Stahlman, Patrick W. Geier, Curtis R. Thompson, Alan J. Schlegel, and Jonathon D. Holman, Kansas State University, Manhattan.

Postemergence herbicide grass control is very limited in conventional grain sorghum production due to its high susceptibility to these herbicides. The development of acetyl-coenzyme A carboxylase (ACC) resistant grain sorghum has broaden postemergence grass control in grain sorghum. Field experiments were conducted at Dodge City, Garden City, Hays, Manhattan, and Tribune, KS to determine the efficacy of quizalofop tank mixes in ACC resistant grain sorghum. Quizalofop was applied alone or in combination with dicamba, 2,4-D, prosulfuron, 2,4-D + metsulfuron methyl, and halosulfuron + dicamba. Herbicides were applied when weeds were 8 to 20 cm in height. No sorghum injury was observed with all herbicides except with treatments that included 2,4-D. At 2 weeks after treatment (WAT) grass weed control was greater than 90% when quizalofop was applied alone or in combination with dicamba or prosulfuron or halosulfuron methyl + dicamba except in Hays site. Broadleaf weed control was greater than 90% in all treatments except when quizalofop was applied alone 2 WAT. Grain sorghum yield was greater in all herbicide treatments compared to the weedy check. This research showed that application of quizalofop in combination with broadleaf weed control herbicides provided excellent weed control in sorghum. [143A]

CHATEAU SW HERBICIDE IN CA ALFALFA - FINDINGS FROM 2009 GROWER DEMO TRIALS. Michael J. Ansolabehere, Valent U. S. A. Corporation, Fresno, CA.

Flumioxazin received registration in CA alfalfa in the fall of 2008 and was used commercially in fall/winter 2008/2009. Flumioxazin offers pre-emergence control of many winter annual weeds that infest alfalfa, including common groundsel which is a noxious weed to livestock. Flumioxazin has the advantage of more favorable plant-back restrictions than other alfalfa herbicides making it a better choice in the last year of an alfalfa stand. It is also a new mode of action (PPO inhibitor) for weed control in alfalfa. A number or grower fields in the San Joaquin Valley of CA were monitored to evaluate the success of commercial applications. A key finding from the commercial applications was that flumioxazin should be used for pre-emergence control of common groundsel and other key weeds and a burn-down product should be added to control emerged weeds. The best timing for the use of flumioxazin in this alfalfa growing area was mid-November through December. This timing provided weed control through the first cutting. Tank-mix herbicides were needed to control certain weeds such as burclover and common knotweed. There was an acceptable level of alfalfa burn when flumioxazin was used and alfalfa growth was normal at the first harvest. [150]

VOLUNTEER CORN COMPETITION AND CONTROL IN DRY EDIBLE BEANS. Emmanuel Omondi* and Andrew R. Kniss, University of Wyoming, Laramie; Robert G. Wilson and Gustavo M. Sbatella, University of Nebraska, Lincoln .

Volunteer corn (*Zea mays* L.) can be a troublesome weed in dry edible beans (*Phaseolus vulgaris*) grown in regions where corn is a rotational crop. A field study was conducted at the Sustainable Agriculture Research and Extension Center near Lingle, Wyoming, in 2009 to evaluate volunteer corn density and time of removal effects on dry bean yield. 'Orion' Great Northern beans were planted into 30-inch rows at a density of 72,000 seeds per acre. Volunteer corn was planted at rates of 0, 0.02, 0.06, 0.112, and 0.22 plants/square foot. Corn removal treatments consisted of Assure II at a rate of 0.062 lbs ai/acre or hand weeding. Removal dates were 2, 4, 6, and 8 weeks after emergence. Dry bean yields were largely unaffected by volunteer corn competition if the volunteer corn was removed by 6 weeks after bean emergence. Removal method did not have a consistent impact on bean yields. Volunteer corn duration of competition had no impact on dry bean seed weights. Leaf area index (LAI) and light interception measured above the bean canopy increased as volunteer corn density increased. Bean yields were negatively correlated with LAI and light interception above the bean canopy. LAI above the bean canopy explained 29% of the variability in dry bean yields. [151]

THE CRITICAL PERIOD OF WEED CONTROL IN LENTILS. Jamin Smitchger*, Joseph P. Yenish, and Ian C. Burke, Washington State University, Pullman.

The critical periods of weed control for ‘Pardina’ (small seeded) and ‘Brewer’ (large seeded) lentils were determined in field experiments near Pullman, WA in 2008 and 2009. Field trials were kept free of weeds for periods of 0, 14, 25, 35, 45, 60, 75, or 100 days after emergence (DAE), or weeds were allowed to grow before removal for periods of 0, 14, 25, 35, 45, 60, 75, or 100 DAE. Nontreated weedy control treatments of ‘Pardina’ had 19% and 19.5% less seed yield than weed-free treatments during 2008 and 2009, respectively. Nontreated weedy control treatments of 'Brewer' Lentils had 39% and 44% less seed yield than weed-free treatments in the same respective years. When measured at crop maturity, an incremental increase of 4.89 g of dry weed biomass/m2 resulted in an additional 1% loss in lentil seed yield. Based on a 5% yield loss threshold, critical periods of weed control for 'Pardina' were estimated to be 17 to 77 and 53 to 60 DAE during 2008 and 2009, respectively. Based on the same criteria, critical periods of weed control for 'Brewer' were estimated to be 19 to 90 and 22 to 30 DAE, during the same respective years. When averaged over years and varieties, the critical period of weed control was estimated 28 to 64 days based on a 5% yield loss threshold. Competitiveness of the weeds and the period of emergence influenced the critical period - prickly lettuce and spiny sowthistle emerged and competed with the lentil crop 1 to 3 weeks later than mayweed chamomile. [152]

SAFLUFENACIL AND SUFENTRAZONE COMBINATIONS FOR BROADLEAF WEED CONTROL IN CHICKPEA. Eric N. Johnson*, Agriculture and Agri-Food Canada (AAFC), Scott, SK, Canada, Robert E. Blackshaw, AAFC, Lethbridge, AB, Canada, Frederick A. Holm and Ken L. Sapsford, University of Saskatchewan, Saskatoon, SK, Canada.

The area seeded to chickpea (I>I L.) has varied from 43,000 to 486,000 ha in Western Canada over the past decade. The main production challenges facing chickpea producers are managing plant disease and controlling broadleaf weeds. Sulfentrazone and saflufencil are protoporphyrinogen oxidase inhibitor herbicides, a relatively unique mode of action to Western Canada. Sulfentrazone has a conditional registration in chickpea in Western Canada. In previous studies, sulfentrazone controlled kochia [*Kochia scoparia* (L.) Schrad.], wild buckwheat (*Polygonum convolvulus* L.), redroot pigweed (*Amaranthus retroflexus* L.), and lambs-quarters (*Chenopodium album* L.) but did not provide sufficient control of cruciferous weeds. Saflufenacil is a new herbicide which has both contact and residual activity; however, residual activity is rate dependent. Studies were conducted at Lethbridge, AB (2008), Scott, SK (2008, 2009) and Saskatoon, SK (2008, 2009) to determine if combinations of sulfentrazone and saflufenacil could control a range of broadleaf weeds in chickpea. Treatments included sulfentrazone applied at rates of 70 and 140 g ai ha-1; saflufenacil applied at rates of 18, 36, 50, and 100 g ai ha-1; and sulfentrazone / saflufenacil combinations applied at rates of 70/18, 70/36, 70/50, 140/18, 140/36, and 140/50 g ai ha-1. Chickpea was tolerant to all herbicide treatments. Sulfentrazone when applied alone did not control wild mustard (*Sinapis arvensis* L.) at Lethbridge or Scott and did not control stinkweed (*Thlapsi arvense* L.) at Saskatoon. Saflufenacil and saflufenacil / sulfentrazone combinations provided higher levels of control of wild mustard than sulfentrazone alone, but control levels varied from 50 to over 80%. Saflufenacil and saflufenacil / sulfentrazone combinations controlled stinkweed in Saskatoon. Sulfentrazone and saflufenacil / sulfentrazone combinations were effective in controlling kochia, wild buckwheat and redroot pigweed. Highest chickpea yields were obtained with saflufenacil at 100 g ai ha-1 and most of the saflufenacil / sulfentrazone combinations. Preliminary studies conducted in field pea (*Pisum sativum* L.) in 2009 at Lethbridge and Scott provided similar results. Combinations of saflufenacil and sulfentrazone have potential to control a number of broadleaf weeds in chickpea; however, further refinement of rates is required. [153]

SAFLUFENACIL EFFICACY IN LENTIL AND FIELD PEA ON THE CANADIAN PRAIRIES. Robert E. Blackshaw*, Agriculture and Agri-Food Canada, Lethbridge, AB; and Eric N. Johnson, Agriculture and Agri-Food Canada, Scott, SK.

A series of field experiments were conducted from 2006 through 2009 to determine the suitability of saflufenacil applied alone and in tank mixes with glyphosate for improved preseed weed management in lentil and field pea on the Canadian prairies. Saflufenacil has some soil residual activity so potential crop injury and residual weed control were also evaluated. Field pea completely tolerated saflufenacil at rates up to 50 g/ha, the highest rate evaluated in our studies. However, lentil tolerance to saflufenacil was much less than that of field pea. Saflufenacil applied at 12.5, 18 or 25 g/ha did not injure lentil but rates of 38 or 50 g/ha often caused season-long lentil injury and concurrent yield reductions. The ranking of weed susceptibility to saflufenacil was volunteer canola > sheperd's-purse > wild mustard > common lambsquarters > redroot pigweed > redstem filaree > round-leaved mallow > kochia > wild buckwheat. Saflufenacil at rates of 18 to 25 g/ha effectively improved preseed weed control compared to glyphosate alone at 450 g/ha but residual weed control was minimal at these relatively low rates. Saflufenacil efficacy was slightly reduced with low spray volumes of 45 L/ha compared with either 85 or 125 L/ha. Similarly, very coarse compared with medium sized spray droplets caused a slight reduction in saflufenacil efficacy. Saflufenacil tank-mixed with glyphosate can be expected to provide superior control of several weed species compared to glyphosate alone and it provides another mode of action that will aid in herbicide resistance management. [154]

UTILIZATION OF FALL APPLIED FLUMIOXAZIN IN SPRING SEEDED PULSE CROPS. Trevor M. Dale*, Len Welch, Pat Clay, and John A. Pawlak, Valent USA Corporation, Walnut Creek, CA.

Pulse crop growers have very few registered herbicides to choose from, and most of the currently registered herbicides have been used for decades. Flumioxazin is a preemerge herbicide commonly applied in many annual and perennial crops. The transition from conventional tillage to minimum or no-till has resulted in weed shifts and greater problems with winter annual weeds. Over the last decade, fall application of residual herbicides has become a common practice throughout the corn belt and Southern region of the US. Over the past 3 years, the utility of fall-applied flumioxazin prior to many crops grown in North Dakota, especially pulse crops, has been evaluated across the Western portion of North Dakota. Flumioxazin is very effective at controlling numerous troublesome winter and summer annual weed species affecting these crops. Two trials were established to determine crop response from three different fall application timings of flumioxazin. Targeted application timings were September 1st, October 1st, and November 1st which represents an early, mid, and late application. Flumioxazin was applied at 0.064 and 0.094 lb ai/a at each timing. Pulse crops planted in the spring were field pea, chickpea, and lentil. There was no significant crop injury regardless of application timing or rate of flumioxazin at Hettinger, ND. Yields of field pea and chickpea increased as the flumioxazin applications were applied later in the fall. However, lentil yields were the opposite and trended downward as the flumioxazin application was applied later in the fall. Control of Russian thistle and kochia increased when flumioxazin was delayed for both herbicide rates. At Minot, lentil injury ranged from 2-4% with flumioxazin regardless of application timing, and was more prevalent with the 0.094 lb ai/a use rate. This was not considered biologically significant and was only recorded at one of the three recording dates. Crop yields at Minot were relatively flat and showed no response to herbicide treatments or timings. [155]

HIGH SPEED PHOTOGRAPHY AND VIDEO FOR COMPARISON OF NOZZLES AND ADJUVANTS FOR SPRAY COVERAGE AND REDUCING SPRAY DRIFT. Gregory K. Dahl*, Joe V. Gednalske, and Eric Spandl, Winfield Solutions LLC. St. Paul, MN.

Effects on droplet size and spray distribution and different drift reducing technologies can be presented to diverse audiences using a combination of quantitative and visual materials. Laser spray droplet analyzers provide quantitative evaluations of spray distribution and droplet size and provide concise measurement of treatment effects. Presenting those materials is generally limited to tables or graphs. Integrating current technology, by using a high speed video camera, has allowed us to develop visual evaluations that support the laser analysis. Droplets were analyzed with the laser for treatments including TeeJet AI, AIXR, and XR nozzles and various spray mixtures. The spray mixtures included water alone, a simulated glyphosate adjuvant system, and the simulated glyphosate adjuvant system with a modified vegetable oil deposition aid and drift control adjuvant or a guar-type adjuvant. Combinations of nozzle type and spray mixtures were photographed and videotaped with and without wind. A Hasselblad 553 camera and a Prism SPOT strobe were used for still photos to illustrate individual droplets and the spray pattern. Spray patterns were also recorded with a high-speed video camera. Video is played back in slow motion to show droplet distribution and movement. High speed photography and video provide excellent detail of the spray droplets and distribution in the spray patterns that are not seen in real time. Nozzles, spray mixtures, and wind significantly impacted results. Treatment effects are clearly illustrated using video or photography and correlate well with laser droplet analysis. The quantity of fine droplets can be significantly reduced by the combination of the proper nozzle and a drift reducing adjuvant. [156]

ADJUVANT ENHANCEMENT OF OPTIMUM GAT HERBICIDES. David J. Carruth* and Richard K. Zollinger, North Dakota State University, Fargo.

Trigate (rimsulfuron, tribenuron, mesotrione) and Freestyle (chlorimuron, thifensulfuron, tribenuron) herbicides have been developed for the Optimum GAT technology. Research has shown adjuvant enhancement of these active ingredients alone but not in combination. Field experiments were conducted to evaluate the enhancement of eighteen classes of adjuvants with Trigate and Freestyle herbicides. Treatments were applied to flax, Chenopodium quinoa, tame buckwheat, and conventional corn. Herbicide rates were reduced by two thirds to detect differences between treatments. Control was evaluated 14 and 28 days after application. Minimal differences were seen between treatments on flax when an adjuvant was added with Trigate. The addition of a methylated seed oil or a basic pH blend adjuvant to Trigate greatly increased control of quinoa. Class Act NG, Quad 7, Prime Oil, or Renegade plus Trigate showed significantly greater control of tame buckwheat compared to other adjuvants. Adding Class Act NG or Alliance to Trigate provided the greatest control of conventional corn. N-Tense, Class Act NG, or Alliance plus Freestyle presented significantly greater control of flax and tame buckwheat. The addition of several different adjuvants to Freestyle greatly enhanced control of quinoa. Class Act or Alliance plus Freestyle provided the greatest control of conventional corn. Cut Rate combined with Freestyle gave the worst control on all four species. The addition of

Flame to Trigate or Freestyle forced these herbicides to precipitate and plug nozzle screens. This data reveals that specific adjuvants can be used with Trigate and Freestyle herbicides to enhance the control of certain species. [157]

DRT IMPLICATIONS FOR WEED CONTROL. Kirk A. Howatt* and Roberto Luciano, North Dakota State University, Fargo.

Recent litigation has led to EPA legislation intended to eliminate spray drift. One result of this legislation will be the encouragement or mandate of certain language on the herbicide label related to drift reduction technologies (DRT). Increasing spray droplet size, or spray quality, is one DRT method used to reduce drift, but the implications of larger droplets for herbicide efficacy often is overlooked. Control of several species with paraquat at 4 oz ai/A or 2,4-D at 8 oz ae/A was evaluated under four spray qualities: fine, medium, coarse, and very coarse. Paraquat efficacy with very coarse droplets generally was less than 55% control, while control with smaller droplet sizes was 75 to 98%. Paraquat gave 75, 66, and 25% common mallow control and 95, 90, and 47% flax control with medium, coarse, and very coarse spray qualities, respectively. 2,4-D efficacy decreased as droplet size increased. For example, control of canola with 2,4-D was 92 to 96% with fine spray droplet size compared with 70 to 77% control when spray quality was very coarse. Likewise, buckwheat control was 67 to 78% when equipment was set to deliver fine droplet sizes but only 23 to 47% with very coarse droplets. Herbicide applied in fine and medium spray qualities often provided similar control that tended to be greater than control with coarse spray quality, and much greater than control with very coarse spray quality. DRT based on encapsulation or polymer adjuvants were not able to consistently compensate for the effect of spray quality. [158]

COMPARISONS OF NEW NOZZLE TYPES FOR IMPROVED WEED CONTROL. Robert E. Wolf*, Kansas State University, Manhattan.

A laboratory experiment was conducted to compare droplet spectra characteristics for flat-fan nozzle types designed to reduce drift while providing adequate coverage for weed control when making postemergence herbicide applications. Twelve nozzle types consisting of both single and double orifices were used in this study. Nozzle types included were a conventional extended range flat-fan (XR) and chamber style flat-fan nozzle, the turbo flat-fan from Spraying Systems (TT); four older venturi styles, the AirMix from Greenleaf (AM), the Ultra LoDrift from Hypro (ULD), and the Air Induction and Turbo TeeJet Air Induction from TeeJet (AI and TTI); two new venturi style nozzles, the Air Induction Extended Range from TeeJet (AIXR) and the GuardianAir from Hypro (GA); a new design chamber nozzle, the Turbo Twin flat-fan from TeeJet (TTJ60); a new venturi design from Greenleaf; a TurboDrop High Speed Twin Fan (TDHSTF); a drift reduction flat-fan from Wilger (DR); and a venturi flat-fan from Air Bubble Jet Agri (ABJ). The nozzles were either proven or new nozzle types that are marketed for postemergence herbicide applications which included conventional, chamber, and older and newer venturi flat-fan designs. Operating pressures selected were based on a combination of previous research completed and manufacturer recommendations for each. Orifice sizes were selected to deliver a flow rate resulting in a spray volume of 70 L/ha at 16 km/h (7.5 GPA at 10 MPH). The flow rates were attained by selecting the following orifice sizes: XR11003 (193 kPa, 28 PSI), TT110025, AM110025, DR110-025, TTJ60110025, BFS110025, GA110025, AIXR110025 (all at 276 kPa, 40 PSI), AIC11002, TTI11002, ULD12002, and TDHSTF11002 (all at 483 kPa, 70 PSI). A spray track device, designed and fabricated to simulate actual field spraying conditions and to facilitate multiple treatments and replications in a laboratory was used to make the applications. The spray track has an aluminum bar 7.3 m long with an electric motor and chain driven sprayer boom that will propel the sprayer boom 16 Km/h over the collection area. The sprayer boom consists of two nozzles spaced at 51 cm and located 51 cm above the target that are controlled by a solenoid valve which was activated by a battery-operated remote control. The pressure for each treatment was created by using an air compressor. A regulating valve and digital pressure gauge were used to monitor the pressure for each treatment. The treatment solution was tap water and was placed in 500 ml high pressure spray bottles that were attached to the spray boom to complete the trials. Multiple water sensitive papers (wsp's) were placed under the simulated spray boom to collect spray droplets from each nozzle treatment. There were three repetitions for each treatment. DropletScan, a trademarked software, was used to measure the droplet stains on the water sensitive paper and compare differences in DV0.5 (volume median diameter, VMD), percent area coverage (PAC), and deposition (GPA). Significant differences were found in VMD for the twelve nozzles. The range in VMD was 540 to 372µ (microns) with the LSD at 19.5. The smallest droplets were with the XR11003 (372µ) and the TTJ60110025 (377µ). They were not significant from each other. The largest droplets were measured from the TTI11002 (540µ), which were significantly larger than all nozzle types. For the twelve nozzles compared, PAC ranged from 17.4 to 10.7 percent with the LSD at 1.2. The most coverage on the water sensitive paper resulted from the XR11003 (17.3%), followed by the ULD12002 (16.9%). These two nozzles were not significantly different from each other and were significantly higher than the others. The lowest amount of coverage was attained by the TTI11002 (10.7%), which was significantly lower than all the other nozzle treatments. Significant differences in deposition (GPA) were also found among all nozzle treatments. The range in deposition was from 7.0 to 3.8 GPA with the LSD at 0.4. The XR11003 (7.0 GPA) had significantly more deposition than all other nozzle compared. The next best deposition was the ULD12002 (6.5 GPA). It was also significantly better than all nozzles with lower deposition. The lowest deposition occurred with the TTI11002 (3.8 GPA). It was significantly the lowest. The results of this study, comparing droplet spectrums with water sensitive paper as the collector, would support that nozzles with smaller droplet spectra tend to have better coverage and deposition. The data also support that the newer venturi designs tend to provide the best coverage and deposition when compared to the older venturi designs. [159]

INFLUENCE OF WATER VOLUME/SPRAY PRESSURE ON WEED CONTROL IN COTTON, TREES, AND DITCHBANKS IN CALIFORNIA. Steven D. Wright, Gerardo Banuelos, Kurt Hembree, University of California, Tulare and Fresno; Anil Shreshta, California State University, Fresno.

Several studies were conducted during 2007 to 2009 to compare the effectiveness of glufosinate and glyphosate at different water volumes for control of tall morningglory (*Ipomoea purpurea*) Johnsongrass (*Sorghum halepense*), field bindweed (*Convolvulus arvensis*), and purple nutsedge (*Cyperus rotundus*), in cotton. Studies were conducted near Tulare and also at the Westside Research and Extension Center, in Five Points. Cotton varieties were Fibermax Liberty Link cotton and Phytogen 72 Roundup Ready Flex cotton. Applications were made with either a quad, tractor driven or hand sprayed at 30 psi using 8002 flat fan nozzles. In comparing 5, 10, 15, and

20 gpa treatments all treatments gave excellent control of tall morningglory using glufosinate or glufosinate tank mix combinations. Glufosinate at 10 gpa and at 15 gpa were most effective for suppression of field bindweed. There were no differences in gallonages in most tall morningglory studies using glyphosate. In 2008 glyphosate at 5 gpa produced lower control over morningglory 21 days after treatment than 10, 15, and 20 gpa. In 2009 gallonages at lower rates (5 and10 gpa) produced better control over tall morningglory than at higher rates (15 and 20 gpa). All treatments using Roundup to control Johnsongrass gave complete control 21 days after treatment. Spray gallonage studies were conducted in pistachios in 2007 in Porterville, California. The objective of this trial was to evaluate rimsulfuron, flumioxazin, and glufosinate at 20 and 40 gpa for control of glyphosate resistant horseweed (*Conyza canadensis*) and hairy fleabane (*Erigeron annuus*). Glufosinate treatments gave excellent control over horseweed 10 inches or smaller and at both gallonages. Rimsulfuron produced better control of all horseweed at 40 gpa, while it produced better control of fleabane at 20 gpa. Flumeoxiden gave fair control at rates of 20 and 40 gpa, but produced better results at 40 gpa. On fleabane smaller than 10 inches the 20 gpa gave better results than the 40 gpa. A gallonage study in almonds was conducted in Richgrove, California in 2009 to evaluate several herbicides for control of fleabane, puncture vine (*Tribulus terrestris*), barnyard grass, (*Echinochloa crus-galli*), morningglory, feather fingergrass (*Chloris virgata*), redroot pigweed (*Amaranthus retroflexus*), prostrate pigweed, malva, and prickly lettuce (*Lactuca serriola*). Glufosinate at 5 pints and glyphosate + AMS at 1 quart + 2 pounds were applied at 20 and 40 gpa. At 20 gpa, glufosinate produced better control over barnyardgrass and feather finger grass, while all other weeds were controlled best at 40 gpa. At 20 gpa glyphosate gave better control over barnyardgrass, but gave best results with all other weeds at 40 gpa. Glyphosate had poor control over hairy fleabane at both 20 and 40 gpa. A ditchbank gallonage comparison study was conducted in 2009 near Corcoran, California to evaluate the effectiveness of glyphosate, glufosinate, and clethoxidim using three gallonages at controlling sprangletop (*Leptochloa uninervia*) and hairy fleabane. The herbicides were applied at volumes of 10, 15, and 20 GPA with a spray pressure of 30 PSI. All treatments produced excellent to complete control over sprangletop with two applications, but gave less desirable results over hairy fleabane. A ditchbank gallonage comparison study in Dinuba, California evaluated the effectiveness of glyphosate, glufosinate, aminopyralid and KJM44 at 20 or 40 gpa at controlling horseweed, fiddleneck, redstem Filaree(*Erodium cicutarium*), malva (*Malva parviflora*) panicle willow (*Epilobium paniculatum*), and London rocket (*Sisymbrium irio*). At 20 gpa, panicle willow and London rocket produced better control than 40 GPA, while all other weed species showed no significant difference in gallonages. [160]

DEVELOPMENT OF A RESIDUAL USE PATTERN FOR FLUCARBAZONE-SODIUM. Chad Effertz*, Patrick Haikal, Kevin Staska, and Brian Schilling, Arysta LifeScience North America, Velva, ND .

Flucarbazone-sodium has been used effectively as a postemergent grass herbicide in cereal crop production since 2001. Recently, Arysta LifeScience has investigated flucarbazone-sodium's soil activity. Flucarbazone-sodium provides control or suppression of numerous grass and broadleaf weeds when applied preplant or preemergent at 15 g ai/ha. This use rate is half of the full use rate allowed for postemergent uses. Averaged over years, a preplant application of flucarbazone-sodium provides 70% residual control of wild oat (*Avena fatua*). Preplant control of wild oat ranged from 30-100% which allowed for a sequential treatment of a reduced rate of flucarbazone-sodium, if required. The split application treatment resulted in 94% wild oat control. In combination with a glyphosate burndown, flucarbazone-sodium provides additional control of emerged weeds, particularly large winter annual mustards. Flucarbazone-sodium also proved to be effective when applied early posteemergent providing excellent control of emerged and non-emerged wild oat. Time of weed removal studies were conducted and yield results showed a 20-25% increase in wheat yield by removing wild oat at the two leaf stage versus the six leaf stage. In addition nitrogen content in wild oat increased 10 fold from the two leaf stage to the six leaf stage. After multiple years of research flucarbazone-sodium proved it has utility as a residual herbicide in cereal production applied either preplant or early postemergent. [161]

THIENCARBAZONE-METHYL COMBINATIONS FOR PRE AND POSTEMERGENCE WEED CONTROL IN WESTERN CORN. Charles Hicks*, Brent Philbrook and Jim Bloomberg, Bayer CropScience, Research Triangle Park, NC.

Thiencarbazone-methyl is a new sulfonyl-amino-carbonyl-triazolinone (SACT) from Bayer CropScience that will be combined as a premixture with Isoxaflutole for preemergence weed control in dent corn. The two active ingredients, which complement each other, will be combined with the new proprietary herbicide safener Cyprosulfamide to provide additional crop safety. This new herbicide premixture will be marketed under the trade name of Corvus and can be applied from prior to planting through the second leaf-collar stage of corn. Field studies have demonstrated that Corvus can be used alone or in combination with other herbicides such as atrazine to control the full spectrum of monocot and dicot weeds in corn. Capreno is a new postemergence corn herbicide premix from Bayer CropScience that consists of Thiencarbazone-methyl + Tembotrione + Isoxadifen-ethyl. Early postemegence applications (V1 to V5) of Capreno combined with crop oil concentrate and a nitrogen fertilizer source provided control of most annual grass and broadleaf weeds. The addition of atrazine to this combination enhanced the weed control (~ 5%) provided by this treatment. Early postemergence Capreno applications provided superior weed control as compared to mid-postemergence applications. Capreno provided residual control of both grass and broadleaf weed up to crop canopy closure. [171]

BROADLEAF WEED CONTROL IN FIELD CORN WITH PREEMERGENCE FOLLOWED BY SEQUENTIAL POSTEMERGENCE HERBICIDES. Richard N. Arnold*, Michael K. O'Neill, and Kevin Lombard, New Mexico State University Agricultural Science Center, Farmington, NM.

Research plots were established on May 7, 2009, at New Mexico State University's Agricultural Science Center at Farmington, New Mexico, to evaluate the response of field corn (var. Pioneer PO541HR) and annual broadleaf weeds to preemergence followed by sequential postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 0.5%. The experimental design was a randomized complete block with three replications. Individual plots were four, 34 in rows 30 ft long. On May 7, field corn was planted with flexi-planters equipped with disk openers. Preemergence treatments were applied on May 11 and were immediately incorporated with approximately 0.75 in of sprinkler applied water. Sequential postemergence treatments were applied on June 24 when field corn was in the 8th to 10th leaf stage with weed heights averaging approximately 10 inch. All sequential postemergence treatments were applied with a non-ionic surfactant and sprayable ammonium sulfate at 0.25% and 5 lbs/A. All treatments were applied with a compressed air backpack sprayer equipped with 11004 nozzles calibrated to deliver 30 gal/A at 35 psi. Preemergence treatments were evaluated on June 10 and preemergence followed by sequential postemergence treatments were evaluated on July 24. All preemergence and preemergence followed by sequential postemergence treatments gave excellent control of Russian thistle, redroot and prostrate pigweed, black nightshade, and common lambsquarters except the weedy check and glyphosate applied preemergence and as a sequential postemergence treatment, with both treatments being applied at 22 oz/A. [172]

CORN RESPONSE TO NITROGEN AND TIMING OF WEED CONTROL. Gregory J. Endres*, North Dakota State University, Carrington; Jeremy D. Pederson, North Dakota State University, Minot; and David W. Franzen, North Dakota State University, Fargo.

A field study commenced in 2009 at NDSU Research Extension Centers in Carrington and Minot to examine the combination of soil nitrogen (N) and timing of weed control impacting corn grain yield and quality. Experimental design was a randomized complete block with split-plot arrangement and four replicates. The dryland trials were conducted using reduced- or no-till systems on a loam soils with 5.9 to 6.6 pH and 3.6 to 4.2% organic matter. Targeted N levels (main plot) at 0- to 24-inch soil depth were 50, 100 and 150 lb/A. Primary N fertilizer source was preplant urea, surface-applied into barley stubble at Carrington and soil-placed with a disc opener at Minot. Additional N was preplant applied 11-52-0 at Minot and POST UAN to 4-leaf corn at Carrington. Roundup Ready corn was planted May 15 at Carrington and May 21 at Minot in 30-inch rows. Weed management treatments (split plot) included weedy check, weed free (PRE herbicides plus glyphosate and/or hand-weeding), early POST = control targeted at 2- to 6-inch weed height, and late POST = control targeted at 8- to 12-inch weed height. Primary weeds included kochia, yellow woodsorrel, common lambsquarters, volunteer barley, quackgrass, shepardspurse, and horseweed at Carrington, and green foxtail and wild buckwheat at Minot. Corn was harvested with plot combines on November 5 at Minot and November 23 at Carrington. Average trial corn yield was 60 bu/A at Carrington and 96 bu/A at Minot. Compared to low soil N, yield improved at Carrington 20 and 49% with medium and high N, respectively, while yield was similar among N levels at Minot. At Carrington, weed-free and early-POST treatments provided the highest yield ranging from 75 to 80 bu/A, compared to yield of 27 and 60 bu/A with the weedy check and late POST, respectively. Weed control treatments at Minot improved yield 69 to 88% compared to the weedy check, and weed free and early POST had greater yield compared to late POST. At both sites, the highest soil N level did not increase yield when weed control was delayed with late POST. [173] [173]

PERFORMANCE OF PYRASULFOTOLE COMBINATIONS FOR GRASS AND BROADLEAF WEED CONTROL IN NORTHERN PLAINS CEREALS. Dean W. Maruska*, Kevin B. Thorsness, Steven R. King, Michael C. Smith, George S. Simkins, Bradley E. Ruden, Mary D. Paulsgrove and Mark A. Wrucke, Field Development and Technical Service Representatives, Product Development Manager, and Market Support Manager, Bayer CropScience, Research Triangle Park, NC 27709.

Pyrasulfotole is a key molecule for broadleaf weed control found in WolverineTM and HuskieTM herbicides recently introduced for use in North Dakota, Minnesota, South Dakota and

Montana. Huskie is a new broad spectrum postemergence broadleaf herbicide that was introduced in 2008 by Bayer CropScience. Huskie is registered for use in spring wheat, durum, winter wheat, barley and triticale. Huskie is a mixture of pyrasulfotole, bromoxynil, and mefenpyr-diethyl, the highly effective cereal herbicide safener. The inclusion of two different modes of action, an HPPD and PSII inhibitor provides a product with unique resistance management characteristics. Wolverine is a new broad spectrum postemergence grass and broadleaf herbicide that was introduced in 2009 by Bayer CropScience. Wolverine is registered for use in spring wheat, durum, winter wheat, and barley. Wolverine is a mixture of pyrasulfotole, bromoxynil, fenoxaprop, and mefenpyr-diethyl. Wolverine and Huskie have been tested on key grass weed species and more than 50 broadleaf weed species at many locations in numerous field experiments in the northern cereal production area of the United States. Wolverine controlled the key grass weeds such as green and yellow foxtails, barnyardgrass, and wild oat. Wolverine and Huskie controlled key broadleaf weeds such as kochia, pigweed sp., wild buckwheat, common lambsquarters, mustard sp., Russian thistle, field pennycress, prickly lettuce, common waterhemp, white cockle and nightshade sp. Wolverine and Huskie also controlled sulfonylurea resistant weeds such as kochia, prickly lettuce and Russian thistle biotypes. Crop tolerance with Wolverine and Huskie has been excellent and was tested on many different varieties of spring wheat, durum wheat, and barley. Huskie was commercially applied on 3.3 million acres of cereals in the United States in 2008 and Wolverine was applied on 1.1 million acres in 2009. Applications of Wolverine and Huskie across such broad acreage were successfully made with various types of commercial application equipment and overall weed control and crop tolerance was excellent in spite of being applied during some challenging environmental conditions. Grower satisfaction with both Wolverine and Huskie was very high with a high level of re-use intentions for 2010. Broad spectrum weed control, combined with crop safety and a favorable crop rotation profile makes both Wolverine and Huskie valuable tools for wheat and barley producers. [174]

AMARANTHUS CONTROL WITH PYRASULFOTOLE IN GRAIN SORGHUM. Mary D. Paulsgrove*, Greg W. Hudec, Charlie P. Hicks, Gary L. Schwarzlose, Kevin K. Watteyne, Bayer CropScience, RTP, NC; Manhattan, KS; Livermore, CO; Spring Branch, TX; Lincoln, NE.

Pyrasulfotole is a 4-HPPD inhibitor labeled for use in wheat, triticale and barley. HuskieTM herbicide contains the active ingredients pyrasulfotole and bromoxynil and controls a broad spectrum of dicot weeds postemergence. In 64 trials since 2007, Huskie has been tested in grain sorghum in KS, OK, TX, CO, NE, IA, SD, and MO to evaluate the crop response and postemergence efficacy on susceptible and triazine, auxin or ALS resistant Amaranthus species. Amaranthus weed species in the trials included redroot pigweed (*Amaranthus retroflexus*), Palmer amaranth (*Amaranthus palmeri*), tumble pigweed (Amaranthus albus), common waterhemp (*Amaranthus rudis*) and tall waterhemp (*Amaranthus tuberculatus*). Best weed control was achieved with 235 - 289 g ai ha-1 Huskie tankmixed with 560 g ai ha-1 atrazine and 1.43 kg ha-1 AMS. Common and tall waterhemp were controlled on average 97-99% respectively. Mean control of Palmer amaranth was 92%, redroot pigweed 98% and tumble pigweed 100% control. In trials containing devil's-claw (*Proboscidea louisianica*) and puncturevine (*Tribulus terrestris*), Huskie treatments controlled devil's-claw 99% (n=6) and puncturevine 92% (n=18). The mean maximum crop response with Huskie dose rate between 235 - 289 g ai ha-1 when combined with atrazine and AMS was 15%. The maximum crop response observed ranged from 5 – 33%. Transitory leaf burn and stunting were the predominant crop response symptoms. Symptoms generally dissipated within 21 days and did not negatively affect yield. Utilizing both HPPD and PSII inhibition, Huskie will be an effective postemergence tool in the management of weed populations that are resistant to ALS inhibitors, triazines, synthetic auxins and EPSP synthase inhibitors. [175]

PROGRESS OF THE OKANOLA PROJECT FOR MANAGING WEEDS IN WHEAT. Thomas F. Peeper, Mark C. Boyles, B. Heath Sanders, Jon-Joseph Q. Armstrong, and Joshua A. Bushong, Oklahoma State University, Stillwater, OK.

Persistent difficulties in managing winter annual grass weeds in continuous winter wheat in OK suggested the need to develop alternative weed management strategies. There was a clear need to introduce a rotational crop, preferably a broadleaf crop, into the traditional wheat after wheat system, yet an economically feasible rotational crop was elusive. Investigations of winter canola indicated that it was a good candidate as a successful rotational crop. Once glyphosate tolerant winter canola varieties became available for research in 2002, a project, later named the Okanola Project, was initiated to develop winter canola production practices and to rapidly introduce the crop to wheat growers. To introduce a new crop, major hurdles had to be overcome. From an agronomic perspective, seeding practices, fertility practices, insect control and harvesting procedures all had to be developed. Registered herbicides were efficacious on weedy grasses. Our initial focus was on agronomics, but other major issues remained before growers could adopt winter canola. These included availablility of crop insurance, willingness of local grain buyers to accept the crop at harvest, lack of a regional crushing facility, hesitation of agricultural lenders to finance a new crop, and hesitation of landlords to allow a new crop on rented farms. Thus, the Okanola project has taken us far from traditional weed science research. However, all these obstacles are being overcome. Approximately 85,000 acres were seeded in the fall of 2009, and further acreage increases are expected. A statewide checkoff was approved by the OK Legislature which will aid research funding. The recent increases in herbicide resistant weeds emphasize the need to pursue such alternative weed management strategies. [176]

TUMBLE MUSTARD CONTROL IN JAGALINE WINTER WHEAT . Dan Smeal* Richard N. Arnold, and Michael K. O'Neill, New Mexico State University Agricultural Science Center at Farmington, NM .

Research plots were established on September 10, 2008 at the Agricultural Science Center, Farmington, New Mexico, to evaluate the response of winter wheat (var. Jagaline) and tumble mustard to postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with four replications. Winter wheat was planted at 100 lb/A on September 10, 2008. Postemergence treatments were applied on March 2, 2009 when winter wheat was in the fourth or fifth tiller stage and tumble mustard was in the two inch rosette stage. Postemergence treatments were applied with a crop oil concentrate and Uran 32 at 0.5 and 1% v/v. Treatments were applied with a compressed air backpack sprayer equipped with 11004 nozzles calibrated to deliver 30 gal/A at 35 psi. Tumble mustard infestations were heavy throughout the experimental area. Treatments were evaluated for winter wheat injury and tumble mustard control on April 2. Winter wheat was harvested for yield on July 30, 2009. No winter wheat injury was noted from any of the treatments. All treatments except the weedy check gave over 90% or better control of tumble mustard. Yields were 3602 to 3961 lb/A higher in the herbicide treated plots as compared to the weedy check. [177]

FUMITORY CONTROL IN WINTER WHEAT. Edward S. Davis*, Montana State University, Bozeman, MT.

Fumitory (*Fumaria officinalis*) is a winter annual broadleaf weed increasing in occurrence and severity of infestation in winter wheat throughout Montana. Historically, fumitory in Montana existed as a nuisance weed encroaching along field edges. However, with the adaptation of no-till practices in winter wheat production, fumitory has become a major competitor in winter wheat capable of severely reducing grain yields. Field trials conducted between 1994 and 2001 indicated combinations of bromoxynil and sulfonylurea herbicides provided the best control, but did not exceed 86%. With increasing reports from producers and crop consultants of inadequate control of fumitory in recent years, herbicide trials were conducted in 2008-2009 to investigate the activity of new herbicides on fumitory. Huskie herbicide containing the active ingredients of pyrasulfotole and bromoxynil provided excellent control of fumitory with good crop safety in winter wheat when applied early spring. Delaying spring herbicide application until flowering of fumitory resulted in reduced control. [178]

EVALUATION OF FLUMIOXAZIN APPLIED PRE-PLANT FOR WEED CONTROL IN WINTER WHEAT. Patrick Clay*, Len Welch, Trevor Dale, Dawn Refsell, Bill Odle, and John Pawlak, Valent U.S.A. Corporation, Walnut Creek, CA.

Flumioxazin (Valor) is registered for use as part of preplant burndown programs prior planting winter wheat. Current labeling allows for applications of flumioxazin at least 30 days prior to planting wheat. Ten trials (6 in the western U.S.) were conducted to evaluate weed control and crop response when flumioxazin was applied at 0.063 lb ai/A at 30, 14, 7 and 0 days before planting. Downy brome (Cheatgrass) control (burndown and residual) was good to excellent when flumioxazin was combined with glyphosate. In trial locations without glyphosate, flumioxazin did not provide adequate control if downy brome had already emerged at the time of application. Weed spectrum varied by location but excellent control of flixweed, tumble mustard, tansy mustard, kochia, common lambsquarters, henbit, and other species was observed. Wheat injury was variable by location, however when averaged across locations wheat injury increased as the timing of flumioxazin application approached planting. Mean crop injury in the early spring for applications made 30 days prior to planting was 3%, 14 days was 6%, 7 days was 11% and 0 days was 16.5%. Overall, the injury levels were relatively low for the 7 and 14 day preplant timings. However, minimum and maximum injury levels by location (minimum 0% and maximum 25-30%) suggest that applications made closer planting could result in significant injury. A number of factors could be involved (residue cover from previous crop, planting depth, rainfall/moisture at emergence, and wheat variety) and additional research will be required to determine if injury can be reduced. [179]

MANAGEMENT OF DIFFICULT TO CONTROL GRASS SPECIES WITH MESOSULFURON-METHYL PLUS PROPOXYCARBAZONE IN WHEAT GROWN IN THE NORTHERN PLAINS. Steven R. King*, Mary D. Paulsgrove, Kevin B. Thorsness, Dean W. Maruska, Bradley E. Ruden, and Charlie Hicks, Technical Service and Field Development Representatives and Product Development Manager, Bayer Cropscience, Research Triangle Park, NC.

Rimfire Max is a postemergence herbicide with the ability to control many problematic grass and broadleaf weeds in winter, spring, and durum wheat. Rimfire Max is a new formulation of Rimfire herbicide that contains the ALS-inhibiting compounds mesosulfuron-methyl and propoxycarbazone-sodium and the safener, mefenpyr-diethyl. Rimfire Max contains an increased level of mesosulfuron-methyl and twice the amount of safener as compared to Rimfire. The new formulation effectively controls a greater number of grass weeds with more consistency than Rimfire while increasing crop safety. Rimfire Max has a wide application window and can be applied to wheat from 1-leaf up to flag leaf emergence. It is formulated as a 6.67% WDG and must be applied with one of several effective surfactant systems. Surfactant options include 1.75 l/ha methylated seed oil, 1% v/v basic blend adjuvant, or NIS plus UAN at 0.5% v/v and 4.7 l/ha, respectively. The application rate of Rimfire Max is 13.97 g ai/ha. Rimfire Max has excellent crop rotation flexibility and wheat and millet can be planted 4 months following application. Alfalfa, barley, canola, corn, dry beans, flax, lentils, oats, peas, soybeans, safflower, sugarbeets, and sunflower can be planted 10 months after application. Rimfire Max effectively controls both ACC-ase resistant and susceptible wild oats. It also controls yellow and green foxtail, barnyardgrass, Persian darnel, Japanese brome, true cheat, and foxtail barley when applied prior to tillering. Partial control of downy brome and quackgrass can also be successfully achieved with an application of Rimfire Max. Broadleaf weed control includes many mustard species, volunteer canola, wild radish and wild beet. Rimfire Max can be tankmixed with many broadleaf herbicides, such as Huskie, to provide broad spectrum weed control in cereals without causing a reduction in grass control. Section 3 registration for Rimfire Max was received from the EPA on 8/28/2009 and it will be available for use in winter, spring, and durum wheat in the spring of 2010. [180]

PYROXSULAM EFFICACY ON TOUGH-TO-CONTROL BROMES IN CENTRAL PLAINS WINTER WHEAT. D. Chad Cummings, Gary A. Finn, Jeffery M. Ellis, Dow AgroSciences LLC, Indianapolis, IN.

Field research was conducted in multiple locations across the central Great Plains to determine the effect of application timing on the control of Bromus spp. With pyroxsulam versus competitive standards. Three grass species, *B. tectorum* (downy brome), *B. cartharticus* (rescuegrass), and *B. secalinus* (true cheat) are all common winter annual grass species in winter wheat across the central and southern plains. A total of 11 trials were conducted in 2008-09 in Colorado, Kansas, Oklahoma, and Texas. In the studies, pyroxsulam (18.4 g ha -1) was compared against propoxycarbazone (44 g ha -1), sulfosulfuron (35 g ha -1), and the premix (Olympus Flex) propoxycarbazone-sodium + mesosulfuron-methyl (25 g ha -1). The two application timings were fall and spring. Pyroxsulam controlled B. tectorum when applied in the fall and was equal to the competitive standards (>80% control). Applications in the fall provided greater B. tectorum and B. cartharticus control versus the spring applications for pyroxsulam, propoxycarbazone, sulfosulfuron, and Olympus Flex. Fall applications resulted in consistently greater efficacy on winter annual grasses than spring applications. Pyroxsulam provided better control of B. secalinus than B. tectorum at both application timings. Application timing of pyroxsulam did not affect the control of B. secalinus, resulting in 95-100% control across all application timings. These studies indicate that Bromus spp. Control with pyroxsulam is best achieved when applied to actively growing plants < 2 tillers in size. Control of Bromus tectorum and B. cartharticus was reduced when pyroxsulam or standards were applied to winter or drought dormant plants, or with spring applications compared to fall applications. [181]

PROJECT 4: TEACHING AND TECHNOLOGY TRANSFER

WINTER WHEAT MEETINGS AND PLOT TOURS. Robert N. Klein*, University of Nebraska West Central Research and Extension Center North Platte, NE.

The success of the rainfed cropping system in western Nebraska depends on having adequate crop residue. A high-yielding winter wheat crop will provide the crop residue needed for successful production of rainfed corn, grain sorghum, proso millet, and sunflower. In the past winter wheat plot tours were held to educate the producer on the new winter wheat varieties being grown in the area plus a few varieties to measure progress in the winter wheat breeding program. A limited amount of time at these tours was spent on winter wheat production practices. Now the tours are preceded with a meeting on production practices which enables the producers to make the most of the yield potential of the new winter wheat varieties. Many of the topics at the meetings are introduced with the use of the “clickers” which enables the presenter to gain information on the audience’s knowledge. More or less time can be used as needed on the subjects being presented. [102]

WSSA SUBJECT MATTER EXPERT FOR THE OFFICE OF PESTICIDE PROGRAMS AT THE USEPA: GOALS, ACTIVITIES, VISION. Jill Schroeder*, New Mexico State University, Las Cruces; Kurt Getsinger, US Army Engineer Research and Development Center, Vicksburg, MS; Dan Kenny, US Environmental Protection Agency; and Lee VanWychen, National and Regional Weed Science Societies, Washington, DC.

With the concurrence of the US Environmental Protection Agency’s (EPA) Office of Pesticide Programs (OPP), the Weed Science Society of America (WSSA) Board of Directors created the position of Academic Weed Science Subject Matter Expert (SME) in May, 2007. This innovative position is designed as a partnership between WSSA and EPA-OPP’s Registration Division – Herbicide Branch. The first terrestrial SME to serve at EPA was Steve Dewey, Utah State University, from June 2007 through December 2008. Jill Schroeder, New Mexico State University, was selected to the position beginning in January 2009 through June 2010. A primary function of this position is to develop a technical relationship between the academic weed science community and the EPA in order to provide useful information that will assist the Agency in addressing terrestrial weed issues impacting practitioners and stakeholders. Much of the technical interaction revolves around invasive plants that are infesting non-crop sites (e.g. rangelands, forests, riparian zones, rights-of-ways and transportation corridors, and wild lands) and allows the Agency better access to the most current information in dealing with the broad range of issues that arise as well as answering highly specific technical questions. The position was modeled after the aquatic weed SME assignment held since 2003 by Kurt Getsinger, U.S. Army Engineer Research and Development Center. Drs. Schroeder and Getsinger work collaboratively with the WSSA Director of Science Policy, Lee Van Wychen, and others, to represent the overall weed science discipline and to identify key weed scientists who can provide input on topics of mutual concern to the Agency and the weed management community. Two key issues that are being addressed include: the impact of a US court decision to require National Pollution Discharge Elimination System (NPDES) permits for application of pesticides on, near, or over water under the Clean Water Act (CWA); and, management of herbicide resistant weeds. To provide insight into the problem of aquatic weeds and mosquitoes, and the potential regulation of pesticides labeled to manage them via NPDES-CWA, Dr. Getsinger and Bill Haller, University of Florida, coordinated a fact-finding tour of aquatic ecosystems in southern Florida for EPA staff. This interaction has led to increased dialogue and information exchange with the EPA Office of Water, and other interested parties, on the impact of NPDES on managing the nation's water resources. To provide information on efforts to evaluate herbicide resistant weed management strategies, Dr. Schroeder coordinated a seminar at the Agency that was presented by David Shaw, Mississippi State University. Dr. Shaw described collaborative research conducted across six states to compare Best Management Practices with current grower practice in glyphosate tolerant crops. The goals were to show an example of work that is being conducted, to describe efforts by WSSA, regions, and states to address management of herbicide resistant weeds, and to discuss issues related to grower adoption of these practices with EPA staff. The success, benefits, and momentum generated by the new WSSA – EPA terrestrial SME relationship clearly indicates the need to consider a long-term partnership between the Agency and the weed science community. [103]

25 YEARS OF PESTICIDE USE SURVEYS - WHAT HAVE WE LEARNED? Richard K. Zollinger*, North Dakota State University, Fargo.

Eight surveys of pesticide usage on agricultural land in North Dakota were taken from 1978 to 2008 in 4 years cycles. The surveys were conducted to regularly assess pesticide usage as an important indicator of changes in pesticide preference in major and minor crops and the relative severity of pests in the state. The survey instrument was developed by NDSU and NDDOA specialists and the survey was conducted by the ND Agricultural Statistics Service (NDASS). In 2008, herbicides, insecticides, and fungicides were applied one or more times to 21.4, 4.0, and 5.9 million acres, respectively. Herbicides applied one or more times have increased from 17.4 million acres in 1978 to 21.4 million acres in 2008. Herbicides applied multiple times have increased from 24.8 million acres in 1978 to 21.4 million acres in 2008. Herbicides applied to all combined cropland, pasture, hay, CRP and summer fallow have increased from 43.1% in 1978 to 54.9% in 2008. In 2008, crops that received over 90% herbicide applications were wheat, barley, corn, soybean, dry bean, field pea, sunflower, flax, canola, and sugarbeet. Percent herbicide treated acres for other crops were: oat (42%), safflower (77%), lentil (89%), mustard (27%), potato (52%), hay (0.5%), other hay (2.4%), CRP (13%), pasture (2%), and fallow (36%). As a comparison, the percentage of acres treated at least once with herbicides in 2000 was over 90% for wheat, barley, and soybean, over 80% for flax, corn, sunflower, lentil, dry bean, and canola, less than 2% for alfalfa hay, other hay, and pasture, 7.9% for CRP, and 19% for summer fallow. Acres planted to genetically modified crops have increased from 2000 to 2008: 11.7% to 49% for Bt-corn, 8.1% to 49% for herbicide resistance corn, 28.7% to 97% for Roundup Ready soybean, and 55.8% to 97% for herbicide resistant canola. In 2008, acres planted to herbicide resistant sunflower was 31% and glyphosate resistant sugarbeet was 66%. The most used herbicides (ranked from 1 to 6) in 1978 were 2,4-D, trifluralin, MCPA, triallate, barban, and EPTC, in 1992 were 2,4-D, MCPA, dicamba, trifluralin, tribenuron, and thifensulfuron, in 2004 were glyphosate, MCPA, fenoxaprop, 2,4-D, bromoxynil, and dicamba, and in 2008 was glyphosate, clopyralid, bromoxynil, MCPA, fenoxaprop, and 2,4-D. Reasons for change in herbicide use include more CRP acres broken out for crop production, availability of herbicide resistant crops, increase in no-till acres, more registrations and greater use of postemergence herbicides, and greater herbicide premixes that are safe on registered crops and are less antagonistic when mixed with grass herbicides. [104]

GROWER, CROP ADVISOR, AND EXTENSION AGENT PERCEPTIONS ABOUT GLYPHOSATE RESISTANT WEEDS IN KANSAS. Dallas Peterson, Curtis Thompson, Douglas Shoup, Brian Olson, Jeanne Falk, and Kent Martin, Kansas State University, Manhattan.

Glyphosate currently is applied to more acres of land than any other herbicide. Glyphosate effectiveness, the development of glyphosate resistant crops, and the relatively low price of glyphosate have led to abundant glyphosate use. With the increased intensity of glyphosate use, continued development and management of glyphosate resistant weeds is a growing concern. Several weed species have been confirmed with glyphosate resistance in Kansas, but the actual scope of glyphosate resistance is not fully known. Identifying and managing herbicide resistance is a major component of the extension weed management programs in Kansas. As part of that educational program, a survey of meeting participants during late 2008 and early 2009 using “Turning Point” interactive software technology was conducted to engage audience participation and gather information on public perceptions of the occurrence of glyphosate resistant weeds and management practices. The survey was conducted at meetings with three different audience groups; county extension agents, crop advisors, and general public meetings with a predominance of farmers. Over 600 people participated in the meeting surveys. Survey results were not statistically analyzed and the results presented are raw data with author interpretations and observations. Responses generally were similar among the county extension agents, crop advisors, and grower groups. The biggest differences in responses occurred by geography between eastern and western Kansas. The difference in geography would be expected because of the difference in precipitation, soil types, cropping systems, and weed problems from eastern to western Kansas. Eighty five percent of respondents were concerned about glyphosate resistant weeds and 66% believe they have glyphosate resistant weeds on their farm or in their area. Statewide, respondents reporting glyphosate resistance was 60% for horseweed, 43% for waterhemp, 34% for kochia, and 38% for Palmer amaranth. Kochia and waterhemp responses varied greatly by geography, with much more kochia resistance reported in western Kansas and much more waterhemp resistance reported in eastern Kansas. The number of respondents reporting glyphosate resistant Palmer amaranth was surprising considering that glyphosate resistant Palmer amaranth has not yet been confirmed in Kansas. Although glyphosate resistance is probably overestimated in this survey, the results indicate awareness and concern about glyphosate resistance. According to the survey participants, over 90% of the soybeans planted were glyphosate resistant, and only about 25% of those soybeans were treated with a residual preemergence herbicide or a tank-mix partner with the postemergence glyphosate applications. Approximately 70% of the corn acres planted were glyphosate resistant, with about 50% of those acres treated with a residual preemergence herbicide and about 50% treated with a postemergence tank-mix partner. Glyphosate only weed control programs in soybeans have been very cost-effective and continue to be utilized, despite a high risk for selection of glyphosate resistant weeds. Over 75% of the fallow and burndown glyphosate treatments included a herbicide tank-mix partner. About half the fields planted to a glyphosate resistant crop were planted in rotation with a non-glyphosate resistant crop and about half were planted continuously to glyphosate resistant crops. Although glyphosate resistant weeds are a major concern to Kansas farmers, short term economics still has a big influence on weed management decisions, and resistant management strategies often are not implemented until resistance develops. [105]

THE VALUE OF SYSTEMATIC SURVEY FOR INVASIVE PLANTS IN AN EARLY DETECTION/RAPID RESPONSE PROGRAM. John L. Baker* and Kim K. Johnson, Fremont County Weed and Pest, Lander, WY.

Fremont County Weed and Pest Control District has been mapping weeds using GPS and GIS technology for 15 years. Most of the early weed mapping was a byproduct of weed control activities where herbicide treatments were recorded. After several years an impressive number of points had been accumulated. However, as the maps began to develop, it was apparent that our crews were returning to the same sites every year. On an annual basis we were looking at 60,000 acres every year, but they were the same acres. Thus only about 1.0% of the county's 6 million acres was actually being surveyed for weeds on a regular basis. A national discussion on Early Detection and Rapid Response combined with regular discovery of new species in Fremont County heightened interest in discovering our real level of weed infestation. In 2005, the District began systematically mapping weeds across the county and has covered 2.1 million acres to date. During that time we have identified 1,081 infestations that were small enough and far enough from the beaten track that they would not have been discovered for decades. Since 2006, we have ranked 4,181 small insipient infestations with good chances for eradication as high priority. In 2009, we treated 1,938 (46%) of those sites. Altogether, 437 (10%) high priority weed infestations have been revisited where no living plants can now be found. The District is re-evaluating our survey approach and staffing to identify efficiencies that would result in more acres surveyed and our priority ranking parameters so that we focus on species of greatest concern. The greatest benefit accrues from eliminating small patches of weeds maintaining large expanses of the native ecosystem relatively intact and resistant to invasion reducing the need for expensive restoration efforts. [106]

ESTABLISHING PRIORITY WEEDS FOR EARLY DETECTION AND RAPID RESPONSE (EDRR) EDUCATION IN NEVADA. Lisa Blecker* and Jay Davison, University of Nevada, Fallon; J. Earl Creech, Utah State University, Logan.

Early detection of new weed species involves diligent monitoring for new invasions, and requires the ability to correctly identify existing weeds and potential invaders. Once a new, high priority weed has been detected in an area, eradication, or complete elimination, of the weed is essential. Traditionally, new weed invasions are not detected or addressed until they are so dense and widespread that eradication is not a viable option. To address this issue, we developed and completed county-based, in-person weed surveys in Nevada and phone and email surveys in bordering counties in Arizona, California, Idaho, Oregon and Utah. The surveys were aimed at elucidating the general abundance (acres infested) and rate of spread (declining, stable, increasing or increasing rapidly) of all the Nevada noxious weeds, plus any weed that occurred on two or more other western states' noxious weed lists. These data were synthesized using Arc Map to illustrate the current distribution and abundance of each weed surveyed. Using these maps alongside a set of criteria, we developed a list of "new" weeds that are likely to spread into each county. The criteria for being added to a county list included: any weed found in a bordering county, any weed found at low levels (less than 10 net acres) in the county, and the number of western states' noxious weed lists on which it was found. These weeds are highlighted in "Weeds to Watch" posters and handouts. The posters have high quality photos of each weed, a brief description of identifying characteristics and where each weed is likely to be found. These lists allow us to tailor weed identification and eradication education efforts to each county. We will conduct workshops to introduce the posters and the idea of weed prevention and early detection to participants. We intend to track early detection and removal of the weeds featured on these posters by having a contact person in each county (listed on the poster) and by doing follow-up surveys. [107]

AUDIENCE RESPONSE SYSTEMS AS A PESTICIDE EDUCATION TOOL. Sandra K. McDonald*, Mountain West Pesticide Education & Safety Training, Fort Collins, CO.

Audience Response System (ARS) is a software and wireless hardware (keypads and receiver) system that allows presenters/instructors to present questions and allows participants to respond by using a keypad. The keypads are often referred to as a clicker. When the instructor presents an interactive polling slide via a presentation, the participant presses the number on the keypad that corresponds to the answer of their choice. The keypad immediately sends a signal to the wireless receiver attached to the computer running the presentation. The software will automatically generate percentage and graph totals of each question's answers. This information can then be projected and/or recorded for evaluation and assessment purposes. ARS technology works well both for large lecture halls and for smaller classes. It engages the trainees through audience participation by transforming a passive learning environment into an active one. ARS also provides instant feedback for participants and instructors. [108]

PROJECT 5: BASIC BIOLOGY AND ECOLOGY

MCPA-ESTER IMPROVES FERAL RYE CONTROL WITH IMAZAMOX. Andrew R. Kniss*, University of Wyoming, Laramie; Drew J. Lyon, University of Nebraska, Scottsbluff; Joseph D. Vassios, and Scott J. Nissen, Colorado State University, Fort Collins.

Field studies conducted in Nebraska and Wyoming have indicated that addition of MCPA-ester to imazamox herbicide can significantly improve control of feral rye. A greenhouse study was conducted to confirm whether MCPA-ester synergizes imazamox on feral rye. A full factorial arrangement of imazamox rates (ranging from 0 to 67 g/ha) and MCPA-ester rates (ranging from 0 to 560 g/ha) were applied to feral rye at the 3- to 5-leaf growth stage. All treatments included urea ammonium nitrate (UAN) at 1% v/v plus non-ionic surfactant (NIS) at 0.25% v/v. Above ground biomass was harvested 28 days after treatment, dried for 48h at 60 C, and weighed. The study contained 5 replicates, and was conducted twice. Dry weight data were analyzed using non-linear regression. When no MCPA-ester was included, the GR50 for imazamox on feral rye was 33 g/ha. Adding MCPA ester at 70, 140, 280, or 560 g/ha reduced the imazamox GR50 to 20, 17, 14, and 12 g/ha, respectively. Greenhouse results confirmed the synergistic effect of MCPA-ester for control of feral rye with imazamox. A laboratory study was then conducted to determine whether the addition of MCPA-ester increased absorption of imazamox in feral rye. 14C-imazamox was applied to feral rye plants at the 3- to 5-leaf growth stage in various combinations of UAN plus NIS, MSO, and MCPA-ester. Prior to application of 14C-imazamox, all plants were oversprayed with the same treatment combination in a moving-nozzle spray chamber. Plants were harvested 0, 2, 4, 8, and 24 hours after treatment (HAT). At harvest, the treated leaf was excised, placed in a wash solution and shaken for 20 minutes. The rinse was then analyzed for 14C content to determine the amount of applied radioactivity that was absorbed into the plant. Each treatment consisted of 3 replicates and the study was repeated. MCPA-ester increased imazamox absorption by 15% 4 HAT when added to imazamox plus UAN plus NIS. These results indicate that increased absorption is at least partially responsible for the synergistic effect of MCPA-ester with imazamox on feral rye. [109]

AMIMOCYLCOPYRACHLOR METHYL ESTER VOLATILITY. Scott Nissen*, Brad Lindenmayer, Phil Westra, Colorado State University, Ft. Collins, CO; Bekir Bukun, Harran University, Sanliurfa, Turkey; Dale Shaner, USDA-ARS, Ft. Collins, CO; Stephen Strachan, Mark Casini, Kathleen Heldreth, and Joseph Scocas, DuPont Crop Protection, Newark, DE.

Aminocyclopyrachlor (DPX-MAT28), a newly discovered synthetic auxin herbicide, and its methyl ester (DPX-KJM44) control a number of perennial broadleaf weeds. The potential volatility of this new herbicide and its methyl ester were determined under laboratory conditions and were also compared to dicamba and aminopyralid using enclosed chamber and open air plant bioassays. Bioassays consisting of visual estimates of epinastic responses and kidney bean and soybean leaf width measurements were developed to measure vapor release from glass and plastic. Vapor release of aminocyclopyrachlor from glass surfaces was undetectable under laboratory conditions, and no phytotoxic responses were observed when plants were exposed to vapors emanating from various surfaces. Results were similar with aminopyralid indicating the risk of plant injury from vapor movement of aminocyclopyrachlor and aminopyralid was very low. When combined with 1% MSO, vapor release of aminocyclopyrachlor methyl ester reached 86% 192 hour after application to glass surfaces. Phytotoxic responses of plants exposed to vapors emanating from various surfaces treated with aminocyclopyrachlor methyl ester were similar to responses to dicamba under enclosed incubation conditions but were less in outdoor, open-air environments. Studies are needed to better understand the risk of injury to non-target plants due to vapor movement of aminocyclopyrachlor methyl ester under field applications. [110]

RESISTANCE TO GLYPHOSATE IN A PALMER AMARANTH (*AMARANTHUS PALMERI*) POPULATION FROM NEW MEXICO. Mohsen Mohseni-Moghadam, Jamshid Ashigh*, Jill Schroeder, and Richard Heerema, New Mexico State University, Las Cruces.

In the year 2007, a population of Palmer amaranth was reported to have survived several applications of glyphosate in a pecan orchard in Doña Ana County in New Mexico. This has raised concerns over the management of Palmer amaranth and future use of glyphosate for control of this weed. The objectives of this study were to confirm the resistance, to evaluate the level of resistance and to determine the spectrum of resistance to alternative modes of action herbicides in that population. Greenhouse experiments indicated that the resistant population was able to survive glyphosate at 900 g ai ha-1. Compared to a susceptible population, resistant population had 7-fold resistance to glyphosate. Post-emergence application of alternative modes of action herbicides flumioxazin, oxyfluorfen, carfentrazone-ethyl, imazethapyr, primisulfuron, imazamox, prosulfuron and pyrithiobac-sodium, dicamba, 2,4-D, glufosinate, and atrazine all provided at least 93% control of both R and S populations when applied at their recommended field rates. Pre-emergence application of trifluralin and metolachlor, at their recommended field rates, also provided more than 95% control of R and S populations. This glyphosate-resistant Palmer amaranth population can be controlled by alternative modes of action herbicides. [111]

CHARACTERIZATION OF RUBBER PRODUCTION IN EASTERN WASHINGTON PRICKLY LETTUCE BIOTYPES. Jared Bell*, Ian C. Burke, and Michael Neff, Washington State University, Pullman.

To explore the potential of prickly lettuce (*Lactuca serriola*) as an alternative source of natural rubber, twenty Washington biotypes were collected and grown in common greenhouse and field gardens. The biotypes were morphological variable and many were Group 2 herbicide resistant. Prickly lettuce latex was tapped from stems of both greenhouse and field grown plants. Collected latex was dried under vacuum for 48 h at 35ºC and solvent extracted to yield percent latex components by weight. ANOVA indicated that latex composition was similar among environments. Prickly lettuce latex composition, averaged over environment, was composed of water (61.9%), insolubles (23.6%), acetone soluble (14.0%), and Hex/THF soluble material (3.0%). The amount of extractable rubber material ranged from 2.0% to 4.6% by weight between biotypes. The rubber fraction was further analyzed by gel permeation chromatography (GPC) HPLC, with refractive index detector to evaluate rubber (polyisoprene) polymer chain length. GPC software was used in conjunction with polystyrene standards to give an estimation of average molecular weight (Mn), weighted average molecular weight (Mw), and polydispersity. All collected biotypes have an average polymer molecular weight (Mw) considered high quality (>1x106 g/mol) with several producing polymers greater than 2x106 g/mol. Average polydispersity was 2.83 and ranged from 2.15 to 3.46 between biotypes. To understand the genetic control of rubber production, 45 ESTs carrying class I SSRs (≥20 nucleotides) markers have been developed. Phenotypic and genetic analysis will advance the prospect of prickly lettuce becoming a nonconventional source of natural rubber. [112]

DETECTION AND PERSISTENCE OF IMAZETHAPYR IN A PALOUSE SILT LOAM. Ian C. Burke*, Jared Bell, Washington State University, Pullman; Traci Rauch, Donn Thill, University of Idaho, Moscow; Dan A. Ball, Oregon State University, Pendleton; and Joseph P. Yenish, Washington State University.

Imazethapyr injury to winter wheat continues to be a concern among growers in the inland PNW that utilize a winter wheat – spring pulse rotation. In 2008 and 2009, field trials were conducted in Moscow, ID, and Pullman, WA, to determine the soil persistence and resulting yield loss caused by increasing rates of imazethapyr. Imazethapyr was applied at 6 rates based on the 52 g/ha 1X rate: 52, 26, 5.2, 2.6, 0.5, and 0.3 g/ha. A nontreated control was included for comparison purposes. The imazethapyr was applied preplant incorporated to activate the herbicide prior to planting wheat. After application, wheat varieties ‘Brundage96’, ‘Tubbs06’, and ‘ORCF-102’ were conventionally planted into the study area. At planting and at intervals following planting, soil samples were taken from plots receiving 52 and 26 g/ha at 0, 1, 2, 3, and 4 wks after treatment. Cores were then collected on a monthly basis. Four cores were taken from each plot and combined. To extract the imazethapyr residue, composite samples were dried, ground and thoroughly mixed before extraction. A sub-sample (10 g) was removed for analysis. The sample was extracted with 0.5 N NaOH. The extract was acidified and particulate removed using a combination of Celite 545 stirring for 30 min and vacuum filtration. The filtrate was extracted with 3 x 50 mL of dichloromethane and the extract was dried by addition of a small amount of anhydrous sodium sulfate (Na2SO4) to remove residual water. The residue was further dehydrated and quantitatively transferred to a screw-cap vial. Derivitization was carried out in the screw-cap vial containing the extract in acetone by adding 160 µL of tetrabutylammonium hydroxide solution (1.0 M in methanol) and 320 µL of iodomethane to the acetone solution. The samples were analyzed for imazethapyr residue using a GC-MS. A half-life of 57 to 90 d was observed in a Palouse silt loam averaged over 2 site-years, however, the rate of imazethapyr degradation was likely affected by cold soil temperatures over the winter. The rate of degradation may be different during the summer depending on temperature and moisture availability. The rate of imazethapyr necessary to cause a yield loss in non-Clearfield winter wheat was greater than a 2.6 g/ha application at planting. Based on the degradation rate for a fall application, this would indicate that a single application of imazethapyr at the labeled rate is sufficiently persistent to cause injury or yield loss when applied 307 ± 24 d or less before winter wheat is planted. Imazethapyr is degraded primarily by soil microbial activity and is not strongly adsorbed to soil, but sorption increases as organic matter and clay content increase and, more importantly, as pH and moisture content decrease. The inland Pacific Northwest production region is a Mediterranean environment. The lack of moisture to keep imazethapyr in the soil water solution during the summer months when microbial activity and thus degradation rates would be highest could be contributing to increased imazethapyr soil persistence and reduced yields in winter wheat. A study to determine the persistence of imazethapyr after a spring application is currently being conducted. [113]

WEED SEEDS AND GROUND BEETLES: HOW AGRONOMIC MANAGEMENT INFLUENCES COMMUNITY DYNAMICS AND SEED PREDATION. Jessica Green* and R. Edward Peachey, Oregon State University, Corvallis.

Predatory ground beetles (Coleoptera: Carabidae) are important, beneficial insects in agro-ecosystems; they are known to consume aphids, slugs, and other soft-bodied pests. Carabids are gaining clout as biological control agents against weeds due to post-dispersal seed predation and granivory. In order to predict the efficacy of Carabidae as a weed management tool, it is imperative to understand how farming practices influence ground beetle assemblages. The objective of this study was to quantify the effects of agricultural management on carabid activity-density (AD) and weed seed predation. A factorial RBCD field study with six replications was established in 2007 by applying treatments to 10 X 20m plots. Plastic landscape fencing (15cm) was installed to limit beetle movement between treatments. Treatment variables included: 1) Primary tillage prior to snap bean planting in the spring (conventional vs. strip-till); 2) Soil-applied insecticide after planting and at first bloom (+/- INS); and 3) Tillage level prior to seeding the cover crop in the fall (conventional vs. direct-seed). These treatments were applied to a snap bean (*Phaseolus vulgaris*) crop in Year 1, followed by a winter cover crop of Steptoe barley and vetch in the fall, and a crop of winter squash (*Cucurbita maxima*) in Year 2. Treatments were reapplied to snap beans in Year 3. Beetle activity-density (AD) was sampled via dry pitfall traps from May through September of each year. Weed seed removal was calculated using vertebrate-excluding seed stations. Also, strips of weed seeds were sown in 2007 and emergence was recorded in 2008. There was no effect of treatment on any variable in Year 1 (2007). Emergence of hairy nightshade in year 2 was greatest in plots with rotational tillage (CV then DS) and no insecticide (F=6.19**). Year 3 average seed removal of hairy nightshade was 38 percent in conventionally spring tilled versus 13 percent in reduced (F=4.85**). Removal of pigweed seed was 53 percent higher in insecticide treated plots during year 3 (F=2.38*). Beetle AD response to management was species-specific. In the final year, there was significantly more Pterostichus melanarius found in insecticide-treated plots (F=10.1***). (Asterisks denote significance of P*0.1, P**0.05, P***0.001). [114]

THE EFFECT OF INSECT HERBIVORY ON PERFORMANCE OF COMMON MULLEIN (*VERBASCUM THAPSUS*). Hannah D. Wilbur*, Christina Alba-Lynn and Ruth A. Hufbauer, Colorado State University, Fort Collins.

Prior to embarking on a biological control program, it is important to evaluate the role that enemies native to the introduced range might play in regulating populations of the invader. To test the effect of native and introduced insect herbivores on common mullein (*Verbascum thapsus),* a non-native noxious weed growing throughout the United States, insects were chemically excluded from the plants during the 2009 growing season. Biomass and size measurements were taken from first year plants and from second year plants, seed samples and height measurements were taken. The effect of treatment (full vs. reduced insect herbivory) on plant performance was evaluated. Rosette size of first year plants increased significantly with reduced herbivory (P = 0.007). In contrast, neither plant height nor inflorescence length was affected in second year plants by herbivory (P = 0.303). This suggests that herbivory may play a more critical role in plant performance during the first year, and the experiment will be extended into the second year to test this hypothesis. [116]

THE CURRENT STATUS OF KOCHIA RESEARCH IN THE CENTRAL GREAT PLAINS. Philip Westra*, Sarah Ward and Darci Giacamini, Colorado State University, Ft. Collins, Dale Shaner, USDA-ARS, Ft. Collins, Phil Stahlman, Kansas State University, Hays, Kassim Al-Katib, Kansas State University, Manhattan,, and Robert G. Wilson, University of Nebraska, Scottsbluff .

In the Central Great Plains and Western States of the United States, kochia (*kochia scoparia*) remains one of the most common and widespread broadleaf weeds infesting a wide range of ecosystems and cropping systems. As a tumbleweed it readily spreads unique alleles across the landscape when abscised plants blow across the land in strong winds. With the first development of ALS resistant kochia (1987), it was common to see long streaks of resistant kochia plants in small grain fields that had been sprayed with Ally or Glean. Herbicide resistance to triazines (1976), ALS herbicides, fluroxypyr, and dicamba has variably been well documented in kochia. Twenty plus years of research by multiple university programs in the western US have helped document herbicide resistance in kochia, and in some cases the possible mechanisms of resistance. Ongoing research is evaluating the response of kochia populations to HPPD chemistry which is generally known to provide good kochia control. Within the past few years, there have been sporadic reports of kochia that was hard to control with glyphosate. With its propensity to develop resistance to multiple classes of herbicides, it may be that glyphosate use in fallow or recently adopted Roundup Ready crops has increased the likelihood of selecting for kochia populations with increased tolerance to glyphosate. Detailed research in several University programs is currently underway to evaluate the response of "suspect" kochia populations to glyphosate. With increased research, we are learning more about the genetics, molecular aspects, and growth penalties associated with herbicide resistance in kochia. [118]

EFFICACY OF PREEMERGENCE HERBICIDES IN CALIFORNIA BELL PEPPERS. Michelle LeStrange and Richard F. Smith, University of California.

Peppers are grown in coastal and inland valley areas of California and can be subject to flushes of both winter and summer weeds over the course of their relatively long growing season. Since peppers are poor competitors with weeds, control is critical in the first 40-60 days following transplanting. The preemergence herbicides registered for use in peppers have gaps in the spectrum of weeds that they control. As a result growers may spend $200-400 per acre on weed management. Six years of field studies have been conducted on the Central Coast and in the Central Valley of California investigating the utility of new formulations of oxyfluorfen and pendimethalin, dimethenamid, flumioxazin, and s-metolachlor in comparison to DCPA or napropamide when applied preplant, at planting, and/or at layby. They were evaluated for crop injury and efficacy on several weeds including black nightshade (*Solanum nigrum*), pigweed (*Amaranthus spp.*), common lambsquarters (*Chenopodium album*), shepherdspurse (*Capsella bursa-pastoris*), common purslane (*Portulaca oleracea*), and when possible, little mallow (*Malva parviflora*). At planting applications of s-metolachlor at 1.43 lbs a.i. per acre, dimethenamid at 0.60 lbs a.i. per acre, and pendimethalin at 1.50 lbs a.i. per acre provided very good weed control (85 - 95%) of broadleaf weeds at 85 days after transplanting. By 134 days after transplanting, at planting and layby herbicide applications still had measurable reductions in weed pressure. Marketable yields of peppers were not significantly different. At planting application of flumioxazin at 0.093 and 1.188 lbs a.i. per acre resulted in unacceptable pepper injury, but when applied as a directed spray at layby provided excellent weed control and minor crop phytotoxicity with no yield reduction. Hand weeding times were significantly reduced in all treatments when compared to an unweeded check plot. [148]

EVALUATION OF AN IN-ROW ROBOTIC CULTIVATOR IN VEGETABLE CROPS. Steven Fennimore, University of California, Davis, Salinas; Richard Smith, University of California Cooperative Extension, Salinas; Michelle LeStrange University of California Cooperative Extension, Tulare; and Laura Tourte University of California Cooperative Extension, Watsonville.

We are evaluating a robotic cultivator to determine if it can be used to increase the efficiency of vegetable production by removing weeds from between lettuce and tomato plants in the row. Additionally, we will determine if this machine can be used to thin direct seeded lettuce and tomato to desired stands. Hand weeding is a significant expense for vegetable growers because vegetable herbicides do not adequately control weeds. Currently the only way to remove weeds from within the crop row is by hoeing, hand weeding and selective herbicides. The Tillet rotating cultivator (a robotic cultivator), being sold commercially in England, is capable of removing weeds from the crop row. Direct-seeded crops are generally planted at high stands and then thinned by hand to desired stands at $80 to $150/acre. A mechanical crop thinner could potentially reduce production costs for direct seeded crops if handweeding can be reduced or eliminated. The purpose of this project is to test the rotating cultivator in typical California vegetable production systems and determine if it is effective at crop thinning, removing weeds and reducing time of hand thinning and weeding in lettuce and tomato. The rotating cultivator does appear to be capable of thinning lettuce to desired stands if the lettuce is seeded with at least 3 inch spacing between seedlings in the row. If the seedlings are closer than 3 inches then the cultivator is more error prone, so precision seeding is necessary for use with this cultivator. Our tests of the rotating cultivator and subsequent timing of handweeding indicate that less labor is required to hand weed lettuce or tomato cultivated with the rotating cultivator than a standard cultivator. [149]

KOCHIA ORIGIN, BIOLOGY, AND DISTRIBUTION. Curtis R. Thompson and J. Anita Dille, Kansas State University, Manhattan.

Kochia [*Kochia scoparia* (L.) Schrad. or *Bassia scoparia* (L.) A.J. Scott] also known as fireweed, Mexican fireweed, burning-bush, summer cypress, or belvedere is native to southern and eastern Russia, Europe and Asia. Kochia, a member of the Chenopodiaceae family, is a troublesome summer annual weed that was introduced to North America as an ornamental and then escaped into areas where it was adapted. Kochia has been reported in 42 of the lower 48 states and in the seven Canadian provinces neighboring the USA border. Kochia was first introduced to Southwestern Australia in 1990 to rehabilitate high saline soil areas and was used as a forage. Kochia was declared a weed in Australia in 1992 and found all across Australia except in the Northern Territory. As of 2005, Australians may have eradicated kochia from their landscape but continue to monitor the country for the weed. Kochia is an early spring germinator and is quite frost tolerant reported to survive 9 F, but can also continue to germinate throughout the growing season. Lab experiments have shown kochia to germinate at temperatures from 39 to 106 F. This herbaceous dicot has alternating branches with linear to narrow lanceolate leaves 1 to 2 inches in length. Leaves are hairy and sessile. Branches generally are long at the base and decrease in length as they progress up the plant. In the absence of competition, kochia can be very bushy in appearance and achieve heights of greater than 7 feet. Kochia can have an extensive root system. Kochia roots grew to a depth of 16 ft in a sorghum field during a drought in Kansas. A single plant has been reported to have a root system 22 feet wide. Kochia is daylength sensitive and begins to flower in the USA sometime in mid-July into August. A critical light period that triggers flowering ranges from 13 to 15 hours among kochia accessions. Kochia accessions from New Mexico required a shorter critical light period than accessions from North Dakota. Small green flowers develop in clusters in the axils of the leaves arising in the terminal spikes of the branches. Initial flowering in kochia is protogynous indicting the stigmas emerge before anther emergence. This is a possible mechanism to facilitate out-crossing, however, kochia is self-fertile and is not an obligate out-crosser. Kochia seed are brown, oval and flattened with a star shaped hull enclosing the seed. It has been reported that a single plant can produce 14,600 seed. As the kochia plant matures, an abscission layer develops in the stem near the soil surface. In the presence of wind, this weakened area allows the dried plant to sever from the root system and tumble across the landscape spreading viable seed where ever it rolls. Thus some people have also call kochia "tumbleweed". In a seed burial experiment in Nebraska, kochia seed viability was 5% after 1 year and zero after 2 years. Seed burial experiments in Colorado, however, indicated that a low percentage of both a dormant and a non-dormant kochia seed population remained viable even after 3 years. Seed viability declined more rapidly when seed was buried 4 inches or less. Experiments have documented yield reductions from kochia in many crops including sugarbeet, sunflower, wheat, and spring oats. Kochia can also cause significant harvest complications of many crops that it infests. Kochia has also become a problem from an herbicide resistance aspect. Biotypes have been found resistant to ALS inhibitors, photosystem II inhibitors, synthetic auxins, and glyphosate. Herbicide-resistant kochia has been identified in Canada, Czech Republic, and 19 states in the USA. Kochia remains a troublesome weed especially in drier climates and will likely persist for many years to come. [162]

GENETIC DIVERSITY OF KOCHIA. Michael J. Christoffers, North Dakota State University, Fargo.

Kochia is a phenotypically and genetically diverse annual broadleaf weed reproducing by seed. It is self-compatible with a mating system capable of both self-fertilization and open pollination. Kochia is well documented as morphologically variable, likely due to high genetic variation and phenotypic plasticity. Genetic diversity studies using intersimple sequence repeat (ISSR) and random amplification of polymorphic DNA (RAPD) molecular markers have indicated that kochia populations indeed maintain high levels of genetic diversity. Within-population genetic diversity may equal or exceed levels of genetic diversity seen among kochia populations. Furthermore, the diversity of acetolactate synthase (ALS) mutant alleles known to confer herbicide resistance in kochia is consistent with multiple origins of resistance, demonstrating the ability of kochia to generate allelic diversity through independent mutation events. Natural selection coupled with mixed mating, prolific seed and pollen production, and profuse seed dispersal as a tumbleweed likely contribute to the genetic diversity of kochia. Adaptation to agronomic practices including selection of herbicide-resistant variants has added to this diversity. Hybridization with related Kochia species does not appear to be a source of genetic diversity due to genomic differences that prohibit introgression. [163]

KOCHIA PROSTRATA: WEED OR DROUGHT TOLERANT FORAGE. Blair L. Waldron, USDA-ARS, Logan, UT.

Forage kochia (*Kochia prostrata* (L.) Scrad), also known as prostrate kochia, or prostrate summer cypress is a long-lived, perennial, half-shrub well adapted to the temperate, semiarid regions of central Asia and the western U.S. In these areas it is a valuable fall/winter forage plant for sheep, goats, camels, cattle, and horses. Forage kochia was first introduced to the U.S. in 1966 by researchers looking for a plant to suppress halogeton (*Halogeton glomeratus* [Stephen ex Bieb.] C.A. Mey.) on droughty and saline rangelands. The cultivar 'Immigrant' was released in 1984 based upon its persistence, production, forage nutritive value, palatability, and competitiveness with annual weeds. Immigrant remains the only released cultivar of forage kochia in the U.S., and is a short-statured, diploid type, used for livestock and wildlife forage, rangeland reclamation, and suppression of wildfires. An active breeding program is led by the author with the goal of developing larger statured, more productive forage kochia cultivars to enhance its utilization as a winter forage in the temperate deserts of the western U.S. Forage kochia is a distant relative of annual kochia (*K. scoparia* L.) and gray or green molly (*K. Americana* S. Wats), with recent research showing that these three species of Kochia are genomically distinct and lack the ability to cross hybridize. K. prostrata and K. scoparia are both sometimes referred to as 'forage kochia' and 'summer cypress'; however, K. prostrata differs in that it has a perennial growth habit, does not spread into perennial plant stands, and is not known to contain toxic levels of nitrates or oxalates. Forage kochia is extremely drought and heat tolerant, in part due to a deep tap root. It is also very salt tolerant and well adapted to some ecosystems dominated by halophytic species. Forage kochia plants are very competitive with the annual noxious weeds cheatgrass (*Bromus tectorum* L.) and halogeton and it is one of few species that can be successfully established on severely degraded, frequently burned, cheatgrass-infested rangelands. Forage kochia is increasingly being used to establish 'greenstrips' to stop the spread of wildfires, due to its high moisture content and ability to reduce the frequency of highly flammable cheatgrass. Forage kochia has been described as one of the most desirable forage species within the Chenopodiaceae family, and in Uzbekistan it is referred to as the "alfalfa of the desert." Typically yields are approximately 2000 kg/ha of biomass in environments receiving 100 to 200 mm annual precipitation, which usually represents at least a 3 to 6 fold increase in forage production as compared to previously existing vegetation. Nutritional characteristics include fall and winter crude protein levels above the 70 g/kg needed for gestating ruminants. Overall, forage kochia is not likely to become a noxious weed, but does have the potential to improve the sustainability of rangelands and ruminant production in semiarid regions that frequently experience extended drought, salinity, and wildfires. [164]

KOCHIA AND THE TRIAZINES - PAST AND PRESENT. Michael D. Johnson, Syngenta Crop Protection, Greensboro, NC.

Simazine was the first triazine herbicide introduced for use in North America. Simazine's earliest US registration, in 1957, was for use in right-of-ways and non-crop areas. The following year (1958), simazine was registered for use in corn. Atrazine received its first registrations late that same year. Shortly after introduction, Kochia scoparia was found to be an efficacious target for the triazines (as were many other troublesome weeds) and the use of the triazine herbicides expanded rapidly – both in range and intensity of use. In following years, a number of other triazines were registered and introduced as well, covering numerous crops and use-patterns. The first case of triazine resistance in Kochia scoparia was documented in Idaho in 1976. In the meantime, and since, numerous non-triazine herbicide families and mechanisms of action with activity on Kochia scoparia have been discovered, registered and put into use. The availability of these herbicide options allowed for herbicide rotations and combinations that have enabled weed managers to maintain, in large part, the utility of the triazines. Through these events, triazine use patterns and weed management practices targeting Kochia scoparia have evolved. [165]

DEVELOPMENT AND SPREAD OF ALS-HERBICIDE RESISTANT KOCHIA. Donn C. Thill, University of Idaho, Moscow.

ALS herbicide resistant kochia was discovered in 1987 in wheat fields near Sublette, KS and Reeder, ND, and in a non-crop area in CO. In all three cases, sulfonylurea herbicides had been used annually since 1982 to control kochia. ALS resistant kochia is reported to occur in three provinces of Canada, the Czech Republic, and 18 USA states. Sites infested include fields where small grain cereals and sugar beets are grown, and roadsides, railways and industrial sites. A mutation in the ALS/AHAS gene causes target site resistance and is inherited as a dominant or semi-dominant trait. Point mutations often take place at Pro-173, but can occur on other sites of the ALS gene. The potential for mutations to happen at multiple sites on the ALS gene has caused different levels of cross resistance among ALS-inhibiting herbicides. Multiple resistance to ALS (Group 2) and PSII (Group 5) herbicides exists in some kochia populations. ALS resistant kochia germinates at lower temperatures than susceptible biotypes, but the growth rate, seed production and competitiveness are similar between resistant and susceptible plants. Gene flow is an important mechanism of spread for ALS resistant kochia. Plants can tumble up to 4,000 m in 6 weeks and pollen can move over 150 m. Gene flow has increased the occurrence and distribution of ALS resistant kochia. Management of ALS resistant kochia requires an understanding of plant biology and integrated weed management. [166]

HISTORY AND CURRENT STATUS OF DICAMBA RESISTANT KOCHIA IN THE CENTRAL GREAT PLAINS. Phil Westra and Sarah M. Ward, Colorado State University, Ft. Collins; David S. Belles, Syngenta Crop Protection, Phoenix, AZ; and Chris Preston, University of Adelaide, Australia.

Research on dicamba resistant kochia at Colorado State University began in early 1993 on lack of control (LOC) populations from Colorado and Nebraska. The greenhouse screening utilized multiple rates of dicamba to characterize the response of individual plants. The most tolerant plants generally came from irrigated corn fields where higher dicamba use rates likely exerted higher selection pressure on kochia populations. Kochia plants derived from seed from LOC sites were sprayed with 0.125, 0.25, and 0.50 kg ae per hectare. The response to the average of these 3 dicamba rates ranged from 75% to 100%; that is, some populations were highly sensitive to dicamba while others survived the high application rate. From 1993 to 1997, a total of 10 separate studies were conducted as each year more and more samples would be sent in for testing. The most robust kochia survivors from the screening studies were allowed to set seed for additional basic research. Beginning in 1994 and continuing to 1997, 5 of the most robust survivors per year were maintained as small interbreeding families. Progeny from each family were sprayed and the process repeated 4 times. In 1999, single seed descent was used to develop homozygous lines. Some lines suffered from inbreeding depression, but out of 20 plus lines we were able to develop a dicamba susceptible line (7710) and a resistant line (9425) that were used for genetic studies. GR50 for the susceptible and resistant line were, respectively, 45 and 1,331 g ae ha-1. F1 crosses of these two lines were made by hand. Genetic research showed that the dicamba resistance trait is likely conferred by a single allele and is highly dominant. We continue to conduct advanced research with these lines to better understand the importance of dicamba resistance in this important weed. Fortunately, several new herbicides provide good kochia control, thus providing growers with additional tools for kochia management. [167]

SUSPECTED GLYPHOSATE RESISTANCE IN KANSAS. Richard M. Cole, Monsanto Company, St. Louis, MO.

Kochia has always been a difficult weed to control. When the plant is treated under hot and dry conditions, performance by glyphosate can vary and differential response is not unexpected. Monsanto has been evaluating difficult to control Kochia populations in conjunction with weed scientists from a number of states over the last 4-5 years. As a potential new species of glyphosate-resistant weed, we are following the recommended investigation processes of the Weed Science Society of America, which includes heritability studies and additional field trials. Variable results from year to year have made confirmation of resistance difficult, with both academic and Monsanto experts unable to reach a firm conclusion. Much of the investigation has been focused on a few Kansas populations. There are a number of factors that appear to have led to the situations under investigation, and in a number of cases, the early investigations led to conclusions of causes other than glyphosate resistance as the reason for the lack of control. Historically, kochia weed control treatments were applied to fallow ground, using combinations of products typically with plant growth regulator components in addition to glyphosate (Landmaster® and Fallow Master®). The investigations of lack of control generally were resolved as due to some reason other than glyphosate resistance. When glyphosate pricing declined, many growers began to use higher rates of glyphosate product alone, giving up the second mode of action. Subsequently, they discovered that they could manage weeds with lower rates of glyphosate and enhanced application techniques. The markets where growers decreased the glyphosate rate were the first to see the lack of control problems that could not be associated with abiotic factors. The first evaluations for Kochia resistance were in 2005 on the edge of a Roundup Ready soybean field, but greenhouse testing did not support the case for resistance. However, there was an elevated tolerance to glyphosate. Similarly, in 2007, another case of increased tolerance was discovered in wheat stubble in the same general area. And in 2007, lack of control of kochia in a soybean field in Colby, Kansas was investigated and found to be tolerant to elevated rates of glyphosate applied several times, raising the concern for selection of glyphosate-resistant kochia, again without a firm conclusion of glyphosate resistance. Since then, Monsanto has worked with academics at a number of universities on investigations into potential resistant kochia populations. Concurrently, there is ongoing activity with the universities designed to better define the appropriate management tools for the varying environmental and biological variability that leads to lack of control. [168]

CONFIRMING GLYPHOSATE RESISTANCE IN KOCHIA. Kassim Al-Khatib, University of California, Davis, CA; Phillip W. Stahlman, Kansas State University, Hays; Curtis R. Thompson and Amar S. Godar, Kansas State University, Manhattan.

Kochia in western Kanas has become increasingly difficult to control with glyphosate and several populations are thought to have developed resistance to glyphosate. The differential response of several populations to glyphosate was evaluated in a greenhouse study. Kochia seeds were collected from Ingalls, Norton, Hays, Stevens County, and Syracuse, Kansas; Eden, Jerome County, and Minidoka County, Idaho; and Irrigated Agricultural Research and Extension Center (IAREC) and grower field, Prosser, Washington. Plants were treated with glyphosate when 15 cm tall. Glyphosate rates were 1/16, 1/8, 1/4, 1/2, 1, 2, 4 and 6 times a use rate of 870 g ae/ha. Injury ratings were taken 7, 14 and 21 days after treatment (DAT) and were based on 0 =

no injury and 100 = plant mortality. Kochia height and biomass were determined 21 DAT. Glyphosate rate required to cause 50% injury was calculated (GR_{50}). Three populations with known history of repeated glyphosate usage showed resistance to glyphosate with a GR_{50} range from 2.47 to 1.52. Three other populations tested intermediately susceptible to glyphosate with a GR_{50} range from 0.79 to 0.75 and four kochia populations were susceptible to glyphosate with a GR_{50} range from 0.69 to 0.54. Glyphosate resistant index (RI) was 4.57, 3.33, 2.81, 1.46, 1.44, 1.44, 1.28, 1.28, 1.24, and 1 for Ingalls, Norton, Garden City, Syracuse, Hays, Minidoka county, Prosser, Eden, IAREC, and Jerome county, respectively. Other greenhouse and field studies were conducted on progeny from a single population near Colby, KS. Nearly 85% of 265 plants survived multiple applications of glyphosate at 560 fb 840 fb 1120 g ae/ha. Progeny from those plants were sprayed with glyphosate at 1, 2, 4, and 8-times a use rate of 840 g ae/ha when 10 to 15 cm tall. Susceptibility of kochia progeny to glyphosate from the same and different parental plants varied widely indicating high segregation. However, many progeny from individual parental plants survived 2- to 4-times the normal use rate of glyphosate, whereas all plants of a known glyphosate-susceptible population were killed with a 1x use rate. These studies confirm that at least five kochia populations in western Kansas have independently developed resistance to glyphosate. [169]

KOCHIA'S ABILITY TO RAPIDLY ADAPT TO DIFFERENT SELECTION PRESSURES MAKES THE PLANT A LONG-TERM SURVIVOR. Robert G. Wilson and Gustavo M. Sbatella, University of Nebraska, Scottsbluff.

Kochia is one of the most troublesome weeds in the western U.S. and is common in rangeland, cropland, and noncropped areas. The genetic diversity within kochia populations is very high and has allowed the plant to evolve under changing environments and selection pressures. In the deserts of the Great Basin kochia has evolved a high tolerance to salinity and seed can germinate over a wide range of temperatures. Seed can germinate in early spring under moist soil conditions or later in the spring under hot temperatures and high salinities. Kochia seed germinates at very low temperatures in range environments so the plant can take advantage of limited soil moisture before perennial range grasses initiate spring growth. In nearby farmland seeds germinate at higher temperatures so kochia can avoid destruction by spring tillage and compete with crop plants planted later in the spring. Spring tillage can also bury seeds which leads to increased secondary dormancy and persistence in the seedbank. Plants exposed to repeated preplant or postemergence herbicides experience selection intensity and in as few as 3 yr. have developed resistance to ALS herbicides. Herbicide-resistant plants can also evolve and have faster germination rates at low temperatures compared to susceptible plants. This provides further competitive advantage for resistant plants and allows them better utilization of limited spring moisture and to capture space from susceptible plants. Kochia density can quickly increase with herbicide resistance and under crowded conditions plants that germinate faster reach threshold heights and intercept sunlight and continue growth while plants that fail to reach the threshold height are restricted in growth. Repeated use of preemergence herbicides can select for kochia biotypes that avoid herbicides. Herbicides applied after planting can begin to degrade and leach shortly after application which reduces the chemical concentration. Continued selection pressure can reduce kochia populations that germinate early in the season and encourage biotypes with seed dormancy that require higher temperatures, which occur later in the season when herbicide levels are reduced. Kochia's ability to rapidly adapt to different selection pressures makes the plant a long-term survivor. [170]

KOCHIA GROWTH ACCORDING TO ALS (AHAS) MUTATION. Anne Legèré, Hugh Beckie, Brett Hrynewich, Chris Lozinksi, Agriculture and Agri-Food Canada, Saskatoon, SK, CAN; Eric Johnson*, Agriculture and Agri-Food Canada, Scott, SK, CAN; Suzanne Warwick, Agriculture and Agri-Food Canada, Ottawa, ON, CAN; F. Craig Stevenson, Statistical Consultant, Saskatoon, SK.

Over 90% of kochia (*Kochia scoparia* L.) populations from the Canadian Prairie Provinces (Manitoba, Saskatchewan, and Alberta) are resistant to acetolactate synthase (ALS/AHAS) inhibitor herbicides. In surveys of the Canadian Prairies, the most common mutation in HR kochia was Trp574 to Leu574 (70%), followed by Pro 197 to His 197 (16%). The objective of this study was to identify growth differences between HR and HS biotypes and determine whether these differences vary according to mutation (at Trp574 or Pro197) or geographical origin (Alberta, Saskatchewan, and Manitoba). Replacement series experiments were conducted in the greenhouse using homozygous HR and HS plants from 6 populations (3 from Alberta, 1 from Saskatchewan, and 2 from Manitoba). The biotype proportions between HR and HS were: 100-0; 50-50; 0-100. Growth measurements taken 1 to 72 days after seeding were germination, height, stem diameter, growth stage (BBCH scale), and final height and biomass 169 DAS. All HR biotypes grew taller than HS plants initially. Final height and biomass was greater in HR than in HS biotypes in the Manitoba population, regardless of mutation. Alberta and Saskatchewan biotypes were similar in growth and competitiveness. Growth response of Manitoba plants differed from that of Saskatchewan and Alberta. Growth of HS biotypes from Manitoba was particularly poor in pure stands but improved in mixture with HR plants. The absence of consistent biotype/mutation effects on kochia growth is likely due to the high level of within and between population variability.

KOCHIA WITH ALS (AHAS) MUTATIONS: AN ALLOMETRIC ANALYSIS OF MANITOBA ACCESSIONS. Anne Legèré, Hugh Beckie, Brett Hrynewich, Chris Lozinksi, Agriculture and Agri-Food Canada, Saskatoon, SK, CAN; Eric Johnson*, Agriculture and Agri-Food Canada, Scott, SK, CAN; Suzanne Warwick, Agriculture and Agri-Food Canada, Ottawa, ON, CAN; F. Craig Stevenson, Statistical Consultant, Saskatoon, SK.

Over 90% of kochia (*Kochia scoparia* L.) populations from Manitoba, Saskatchewan, and Alberta are resistant to acetolactate synthase (ALS/AHAS) inhibitor herbicides. In a previous greenhouse study, it was found that accessions from Manitoba differed in growth from accessions in Saskatchewan and Alberta. Growth of herbicide susceptible (HS) biotypes from Manitoba was particularly poor compared to the herbicide resistant (HR) biotypes from Manitoba. The objective of this greenhouse experiment was to determine allometric growth differences between HS and HR biotypes from Manitoba populations with different ALS mutations (MB6: Pro197-Gln; MB2: Trp574-Leu). The Manitoba HR and HS populations were chosen for a detailed growth analysis due to their geographical proximity. Growth measurements were taken on plants 169 days after seeding. These included branch length per plant, biomass per branch order, seed weight per branch. MB6 HR (Pro192-Gln) plants produced higher order branches with greater weight than MB2 HR (Trp574-Leu) biotypes or HS plants. HR plants produced more shoot and root biomass than HS plants, more so for the MB2 plants than the MB6 plants. HR plants produced much less seed biomass than HS plants, regardless of biotype.

PRESIDENTIAL ADDRESS – JESSE M. RICHARDSON

I would like to acknowledge several individuals whose contributions have been critical to the success of this meeting. Phil Motooka has worked tirelessly as Local Arrangements Chair and Joe DiTomaso has arranged a wonderful program. Charlie Hicks has organized our always-popular "What's New" session for Wednesday afternoon, while Phil Stahlman and Kassim Al Khatib have planned a first-rate symposium on Kochia. James Leary, Joe DiTomaso and Susan Cordell have prepared an excellent Perennial Grass Symposium, as well as associated field tours. I cannot overstate the contributions of Phil Banks, who is the "all-seeing eye" of this organization. He ensures that no detail is omitted -- he doesn't miss a thing. Last, but not least, I would like to recognize Ellen Richardson, my wife. Her constant support is what made it possible for me to serve in this position.

Our sustaining members provide important financial support for our organization. I hope that each of you will take time to thank these companies – Amvac Chemical, Arysta LifeScience, BASF, Bayer CropScience, Dow AgroSciences, DuPont Crop Science, FMC, Gowan, Helena Chemical, Marathon Agricultural and Environmental Consulting, Monsanto, Novozymes Biologicals, PBI Gordon, Syngenta Crop Protection, Valent USA, Wilbur-Ellis, and Winfield Solutions. Our sponsored activities were coordinated by Pete Forster. Without the following seven companies paying for food and beverages, our registration fees would have to be increased dramatically – Arysta LifeScience, BASF Corporation, Bayer CropScience, Dow AgroSciences, DuPont Crop Protection, Monsanto Company and Syngenta Crop Protection. Please join me in thanking these companies.

Several years ago, I attended the funeral of a man who had enjoyed an illustrious career. As the funeral service progressed, I was surprised how little was spoken about his professional accomplishments. The many kind things spoken about the man focused almost exclusively on three topics – family, friends and faith. As I listened, I realized that I was guilty of focusing an inordinate amount of my energies on my career, with little time left over for those things that give true meaning to life. I needed to step back and reassess my priorities, and find better balance. Today, I would like to talk about these three facets of life to which we often struggle to give adequate attention – family, friends and faith.

Let's focus first on **family**. When I was a child, the model family that was portrayed on television was something resembling the Donna Reed family, with a father, mother, and two or more children. Today's families reflect tremendous diversity, with some having two parents, some with one parent, some with children, some without, and many are single. Each one of us is a member of a family, as evidenced by the fact that we each have or had a mother. Lee Iacocca, a man who made his mark by turning around struggling companies, once said, "The only rock I know that stays steady, the only institution I know that works is the family." [1] The only institution that works? These are remarkable words from a pillar of industry. Elbert Hubbard, the nineteenth century American writer, publisher, artist and philosopher once said, "No matter what you've done for yourself or humanity, if you can't look back on having given love and attention to your family, what have you really accomplished?" [2] If these statements are true, what can we do to make our families feel more valued? I perused the internet to see if I could find some answers. I distilled what I found into the following five points. Family members need to hear words of encouragement from us. Many of us find it easy to criticize and correct, but do we encourage and uplift them with our words? They need to hear words of respect. Do we demonstrate that we value their opinions, their contributions, and speak respectfully to them? They need to hear words of love. I spoke to a man who said that he rarely told his family that he loved them, but it didn't matter because they *knew* that he loved them. Really? Words of affirmation are important. They need to hear words of apology. Many people find it difficult to admit that they are wrong. Are you one of those individuals? They need to hear words of forgiveness. It's easy to hold a grudge. But we can't afford to "dig in our heels" with those whom we should cherish.

Teenagers can cause the most even-keeled adults to lose their cool at times. Speaking of these challenging years, noted child psychologist and author James Dobson said, "Don't throw away your friendship with your teenager over behavior that has no great moral significance. There will be plenty of real issues that require you stand like a rock. Save your big guns for those crucial confrontations." [3] I know that I have had strong words with my teenage girls at times, when part-way through the discussion, I asked myself the question, "Is this the hill that I want to die on?" Most of the time, the answer is "No."

Bruce Barton, author of many best-selling guides to personal success, wrote, "Sometimes when I consider what tremendous consequences come from little things…I am tempted to think…there are no little things." [4] It's true – many times, it's the little things that mean the most. I have certainly had my share of failures when it comes to my responsibilities as a father, but one of the small things I did has turned out to be one of the big things. When my wife and I married, we discussed the number of children we wanted to have. We both agreed on four children. However, after she delivered our fourth daughter, she changed her mind – she felt that we should have more. We did have more – nine daughters in all. And she was right – four was not enough. As my oldest daughter was nearing the age to begin dating, I wanted her to know how much she meant to us. Rather than doing something trite like cleaning the shotgun when young men came to take her out on dates, I settled on something more creative. When a young man came, I met him at the door with a clip board, two sheets of paper, a pen, and a stamp pad. The two sheets of paper were entitled "Exam to Determine Worthiness to Date a Richardson Girl" and "Application and Contract to Date a Richardson Girl." The bottom of the contract had a spot for my signature and for the signature of the young man. Below his signature was a spot for his thumbprint – hence the stamp pad. I won't bore you with too many details, but I will share the last question on the exam – a math problem. "John Jones asks one of the Richardson girls on a date and she accepts the invitation. John takes the 'Date a Richardson Girl' exam and passes. On the date, he makes an inappropriate advance towards the Richardson girl and she smashes him in the face with a closed fist, breaking 12 bones in his face. When Mr. Richardson finds out what John did, he runs over John with his car, breaking an additional 96 bones. How much more effective was Mr. Richardson than his daughter at breaking John's bones?" It doesn't matter to me if the young man can come up with the number eight – hopefully he gets the message I am trying to convey. It turns out that this has meant a lot to my daughters over the years, and has brought us closer together. Joyce Brothers said, "When you look at your life, the greatest happinesses are family happinesses." [5] That's probably not good grammar, but the message rings true.

The second facet is **friends**. Great friends bring a lot of meaning to life. One of the wonderful things about this conference is the opportunity to rub shoulders with good friends. It makes the annual meeting more than just a scientific exchange. Aristotle said, "Without friends, no one would choose to live."[6] Some good rules for friendship include the following: 1) Remain equally loyal in good times and bad. Fair-weather friends are not friends at all. 2) Do what you say you will do. Loyalty is developed when others discover they can count on you. 3) Give your friendship unselfishly, not expecting anything in return. 4) Never violate your principles under the guise of friendship. Those who entice you to lower your standards cannot be mistaken for friends. 5) Be loyal to those who are not present. If you speak unflattering words about someone who is not within earshot, those listening will realize that you will do the same to them when their back is turned.

Dr. Frank Crane wrote, "A friend is someone with whom you dare to be yourself."[7] If you find that you must substantially modify the person you are to match the whims of a friend, perhaps you should re-evaluate your friendship.

The third facet is **faith**. Some years ago, our company embraced a leadership program based on Steve R. Covey's best-selling book, "The Seven Habits of Highly Effective People." In the book, Covey describes four dimensions of human nature – 1) physical, 2) mental, 3) social/emotional, and 4) spiritual.[8] In describing the fourth dimension, Covey says, "The spiritual dimension is your core, your center, your commitment to your value system. It's a very private area of life and a supremely important one. It draws upon the sources that inspire and uplift you and tie you to the timeless truths of all humanity."[9] He quotes a religious leader and then expands on the concept, "'The greatest battles of life are fought out daily in the silent chambers of the soul.' If you win the battles there, if you settle the issues that inwardly conflict, you feel a sense of peace, a sense of knowing what you're about."[10] It's difficult to be truly content if the person we are inside is substantially different than the person we try to project to others.

So this is the challenge to each of us – to find balance in these four facets of life – career, family, friends and faith. If we excel in our career, but fail to give the other three facets their proper attention, we are destined to look back on our lives with some regrets, some time down the line. I can attest that there are no easy answers, but the outcome is worth our best efforts.

1. www.sayingsnquotes.com
2. www.sayings-quotes.com/elbert_hubbard_quotes/
3. www.charlevoixcountynews.com/index
4. www.iwise.com/zQS7R
5. en.wikiquote.org/wiki/Joyce_Brothers
6. en.wikiquote.org/wiki/Aristotle
7. www.englishforums.com/English/DrFrankCraneFriend/lxhsv.post
8. Covey, Stephen R. 1989. The Seven Habits of Highly Effective People, pg. 288.
9. Ibid, pg. 292.
10. Ibid, pg. 294.

WSWS EDUCATION AND REGULATORY SECTION

THE ENDANGERED SPECIES ACT: INTERFACING WITH AGRICULTURAL AND NATURAL ECOSYSTEMS. Bernalyn McGaughey*, Compliance Services International, Lakewood Washington.

The Endangered Species Act (ESA) was enacted by the U.S. Congress in 1973 for the purpose of protecting and recovering imperiled species and the ecosystems on which they depend. Many natural resource uses and typical agricultural practices are questioned by the public and regulatory agencies because of the potential impact on endangered species.Legal and administrative modifications to the ESA have failed to remove the polarity this law seems to evoke. Progress toward achieving the goals of the ESA has been slowed by litigation from all sides, consuming agency resources in response to legal actions rather than meaningful protection of species. What the Act does not provide is (1) clear guidance on assessment, consultation, and enforcement processes; (2) consideration of the complexities of ecosystems; (3) implications of proposed actions on affected stakeholders; and (4) a mechanism for embracing sound science from nonfederal agencies or between agencies having differing regulatory drivers. The largely court-determined primacy of the ESA presents challenges for other federal, state, and local programs meant to benefit the environment, some of which programmatically, if not procedurally, already address ESA goals. Using pertinent examples of conflicts, litigation, and delays resulting from lack of procedural clarity and coordination, this commentary (1) introduces the intersections between the ESA and management of agricultural and natural ecosystems within the United States and (2) explores ways those intersections might be addressed not only to restore a process to protect critically imperiled species but also to establish process and rebuild lost trust among all affected parties.

UPDATE ON REGULATORY ISSUES IN WASHINGTON. Lee Van Wychen, Director of Science Policy, WSSA and Regional Weed Science Societies.

Dr. Van Wychen provided an update on critical regulatory issues during the Education and Regulatory Section. Topics covered included the Endangered Species Act (ESA), update and court rulings related to Non-point Source Pollution and National Pollutant Discharge Elimination System (NPDES) Permits – process and timeline

MAXIMUM RESIDUE LEVEL (MRL) 101. Dan Fay, Technology Operations Manager, Valent U.S.A. Corporation, Walnut Creek, CA and Patrick Clay*, Field Market Development Specialist, Valent U.S.A Corporation, Maricopa, AZ.

Maximum Residue Level or MRLs are the maximum legal pesticide residue level allowed in/on food or feed. Generally measured in parts per million (PPM), MRLs are an enforcement tool to ensure compliance with a registered pesticide label and as a means of ensuring that food that move in channels of commerce is safe for consumers. Currently a number of different systems are used across the globe to establish MRLs which can lead to restrictions in use of a registered pesticide. There are numerous factors that may result in differences in established MRLs including how risk analysis are conducted. Currently, there is an effort to harmonize global MRLs through a FAO/WHO program.

PROJECT 1: WEEDS OF RANGE & NATURAL AREAS

Co-chairs: Cody Gray and Jim Harbour

Topic: "*NPDES Permits and the 6th Circuit Court Ruling: Impacts on Future Pesticide Applications in and Around Water*"

The purpose of NPDES is to minimize pollutant discharge. Thus, pesticides are also considered pollutants. In order to apply pesticides, the applicator must submit appropriate notification 10 days prior to application. Problems arise from knowing when a particular pest might reach a threshold level and action must be taken within the 10 day notification of intent prior to the application. The applicator must visually assess all target and non-target species PRE and POST application. Target and non-target species include plants, fish, insects, etc. Further, the applicator must list all team members including graduate students, technicians, etc.

Threshold (pesticide levels ?) definitions are vague and open to gaping interpretation. However, because the official document has not been released, no one can make a public comment on the thresholds. Additionally, FIFRA is not exempt under the Clean Water Act (CWA). It is unclear which law will have precedence.

Research entities are not exempt from threshold definitions. The only way to become exempt is if the trial design becomes compromised or the application is covered under another permit.

Annual reporting was discussed. This will be made public. This leads to businesses potentially stealing customers from other businesses. Moreover, if someone considers a pesticide rate is not "right", lawsuits can be filed against businesses or individuals. Further, any person who despises pesticides, can use the EPA Reg. No. (from Annual Report) and file a lawsuit against any applicator. Lawsuits can also be filed if an individual/organization deems an alternative control measure, other than a pesticide, could have been used to control the target pest.

Record keeping is paramount. Fines for improper records can reach $37,500/day.

The start-date for NPDES is April 9, 2011. Infrastructure to implement this program is not set up and Regional State offices will manage the program. Also, it was mentioned the project is unfunded by the federal government. The major problem foreseen is the actual receipt of the permit once filed.

Chair-elect is Lars Baker. Cody Gray and Jim Harbour rotate off the committee.

Chair

James Leary
UNIV. HAWAII AT MANOA
3050 MAILE WAY
310 GILMORE HALL
HONOLULU, HI 96822
808-956-9268
leary@hawaii.edu

Lars Baker
Fremont Co. Weed & Pest
450 N. 2nd St, Room 325
Lander, WY 82520
307-332-1052
larsbaker@wyoming.com

PROJECT 2: WEEDS OF HORTICULTURAL CROPS
Moderator: Curtis Rainbolt, BASF, Fresno, CA

Topic: *The future of weed control in horticultural crop. With a limited number of new herbicides, what are the options?*

The discussion session, which had approximately 18 people in attendance, opened with brief presentations by Steve Fennimore (UC Davis) and Curtis Rainbolt (BASF).

Weed management tools in vegetable crops is limited – both Fennimore and Rainbolt primarily discussed leafy greens including lettuce and spinach. In vegetables, few herbicides are available and several of the important herbicides like Kerb (pronamide) are fairly mature/old technology and can have regulatory problems. This situation is not likely to change soon due to the lack of economic incentives for primary herbicide registrants (low acreage specialty crops) and high liability (high value crops = high risks for litigation). Both presenters showed graphical figures showing launches of new herbicide active ingredients in recent years. In one case, new herbicide introductions since 2000 were compared between cotton, wheat, and alfalfa (6-9 new a.i.) to melons, cole crops, and lettuce (0-1 new a.i.). Further discussion focused on the impact of glyphosate-resistant crops on the development of new a.i. for major crops and, thus on the secondary specialty crop markets.

Additionally, the specific crops and cropping systems can further limit herbicide options in vegetables. For example, certain crops like spinach seem to have relatively little natural tolerance to herbicides making selective weed control difficult. In some situations, the short but intensive cropping cycle can further limit herbicide choices for vegetable crops. Rotational crop concerns greatly limit the possibility for use of some herbicides like imazamox in lettuce that may be grown in rotation with other sensitive crops.

A point was made that it may be time for "out of the box" thinking and a long-term research approach. Research benefiting weed management in vegetable crops will require a stable source of funding. A chronic problem in vegetable crops research is the reactive approach to "acute problems" such as food safety issues (E. coli or Salmonella) compare to more "chronic problems" such as weeds. One idea that generated significant discussion was breeding for herbicide resistance in vegetable crops. This certainly will take significant time to incorporate resistance traits into commercially acceptable cultivars. Furthermore, a conventional plant breeding approach is likely to be needed due to the general lack of market acceptance (especially Asia and Europe) for transgenic food crops. One potential success in this area is sulfonylurea-tolerant lettuce that has been field tested. This butterhead cultivar was crossed with an SU-resistant prickly lettuce (Lactuca serriola) biotype from Idaho. The resulting cultivar is still a bit "weedy" but tolerates sulfosulfuron applications well. Further work is needed on development of this cultivar and on related regulatory issues.

Discussion continued on how it might be possible to unite some of the disparate commodity boards to facilitate lobbying efforts and potentially to serve as a research funding source for long-term projects like cultivar development. Some discussion was made on the future role of the IR-4 program – can we expand the role of this program or

is a parallel agency needed to provide a more modern approach to solving horticultural crop weed issues?
The discussion closed with a vote for chair-elect for the Horticultural Crops Section in 2011.
Brad Hanson (UC Davis) will be the chair in 2011 in Spokane, WA
Hank Mager (Bayer Crop Science) will be chair-elect for 2011 and will rotate to the chair position in Reno, NV in 2012.

PROJECT 3: WEEDS IN AGRONOMIC CROPS REPORT

Chairperson: Brian Olson

Topic: *Weed Issues When Converting CRP to Cropland*

The Weeds of Agronomic Discussion Session was held on Wednesday, March 10. Approximately 21 people were in attendance over the course of the session. Brian Olson chaired the discussion and Andy Hulting served as chair elect.

To start the discussion, Alan Schlegel provided background information to the attendees on research conducted in Kansas focused on determining methods to successfully bring CRP acres back into crop production. Critical questions this research addressed included how to maintain soil conservation strategies already in place, how to most effectively eliminate perennial grass species, how to develop profitable crop sequences and rotations coming out of CRP contracts and finally how to preserve the wildlife habitat that these CRP acres have contributed greatly to. Methods used to eliminate CRP in this study in Kansas included burning or not burning grass residue followed by tillage and/or herbicide (glyphosate) applications to control the perennial grasses. Crops planted following these treatments included sorghum or winter wheat. Initial findings or lessons learned from this work have included the discovery that residue removal through the use of fire is probably not critical to success in short grass CRP, that some perennial grasses will survive after multiple applications (3-4) of glyphosate or through the use of multiple tillage passes, and that crop selection and the amount of water in the soil water profile is critical for success in certain dryland production areas. It is also apparent that there is a lack of information regarding the long-term management of perennial broadleaf weeds, including Canada thistle and bindweed spp., whose populations may have built up over time in the CRP program.

The challenge that the group acknowledges is how to provide relevant recommendations to growers who will need to make management decisions soon when it may take several years to develop the science to provide answers. One suggestion to deal with this challenge was for the WSWS to make a general statement or develop a white paper about how best to bring CRP back into crop production. This idea was quickly moved away from by the attendees based on all the difficulties related to providing site specific recommendations including crop selection (i.e. the ability to use herbicide-tolerant crops like soybeans and corn in wetter areas vs. using spring and winter wheat and/or pulses in more dryland production scenarios), soil fertility recommendations in the first year of crop production and the diversity of species that need to be controlled in the CRP (examples listed by attendees included wheatgrass spp., fescue spp., switchgrass, smooth brome, downy brome, alfalfa, yellow starthistle, sagebrush spp. and rabbitbrush). However, it was mentioned that the STEEP program in the Pacific Northwest has funded work to develop an Extension-type publication to bring together already generated information for that region. That publication is due out in the fall of 2010.

Other research issues that should be addressed by WSWS membership include developing partnerships with cooperators who will be removing CRP so that appropriate data can be generated, developing strategies for dealing with potential carryover of herbicides used to manage weeds in CRP, determining the best in-crop herbicides needed based on the weed spectrum present once a cropping sequence has been established and devising a workable tillage/residue management system (conventional vs. conservation vs. zero-till) once CRP has been removed given that many CRP acres are on highly erodible landscapes.

Several important policy issues related to CRP removal were also discussed including the impact of absentee landowners and the cash rent process on profitability of farming former CRP acres and the role that crop insurance, and all the specific issues and restrictions related to being eligible for crop insurance by region will have on farm profitability if growers take on farming former CRP acres.

To conclude, Brian challenged the group to move forward on this issue and indicated that he would like to see a concerted research and Extension effort to address some of these needs and hoped that some research could be presented at the Spokane WSWS meeting related to this issue that could be disseminated more widely in the near future. Finally, Chad Asmus was nominated and elected to serve as Chair Elect. Andy Hulting will be the 2011 Chair.

2010 Chair, Brian Olson
Kansas State University
Northwest Research and Extension Center
P.O. Box 786
Colby, KS 67701
Phone: (785) 462-6281
Email: bolson@ksu.edu

2011 Chair Elect, Andrew Hulting
Oregon State University
109 Crop Science Building
Corvallis, OR 97331-3002
Phone: (541) 737-5098
Email: andrew.hulting@oregonstate.edu

2012 Chair Elect, Chad Asmus
BASF Corporation
2301 Bristol Ln.
Newton, KS 67114
Phone: (316) 804-4348
Email: chad.asmus@basf.com

PROJECT 4: TEACHING AND TECHNOLOGY TRANSFER

Sandra McDonald

Topic: *Use of audience response systems for teaching and extension*

The discussion section for the Teaching & Technology Transfer section was reasonably well attended. Many in attendance had used the technology in some form, and many benefits and issues were brought up and discussed, including cost, software compatibility, and optimal audience size. Gustavo Sbatella of the University of Nebraska was elected vice-chair, and Jamshid Ashigh of New Mexico State University will move into the chair for the 2011 meeting.

PROJECT 5: BASIC BIOLOGY AND ECOLOGY

Chair: Kassim Al-Katib Moderator: Dallas Peterson

Topic: *Stacking herbicide resistant genes for weed management: Opportunities and challenges*

Four panelists were invited to begin the discussion: Rick Cole, representing Monsanto; David Saunders, representing Dupont; Darren Unland, representing Bayer CropScience; and Phil Westra from Colorado State University providing a public researcher's perspective. After brief comments from the panelists, the audience was invited to participate.

This is a significant issue for our society and many attendees had varying opinions. There was a lack of consensus on some issues. For example, industry representatives want to provide choices to growers and agree that the market will decide what is viable and what is not. However, our public research panelist suggested that we are providing growers too many choices already.

We discussed many issues that we felt should be considered when stacking herbicide resistance genes. The one that we spent the most time on is the effect of stacked traits on herbicide resistance weed management. Whether it increases or decreases the potential for resistance will be influenced by how the traits are deployed – whether the technology encourages growers to rotate herbicides or to rely on the same mode of action year after year. Stacking traits may increase the tools available, but they need to be used wisely.

The prospect of the EPA getting involved in regulating herbicide use based on herbicide resistance was raised. All agreed that it is our obligation to educate growers and government representatives to avoid unnecessary regulation.

There are logistic and environmental concerns with stacking traits. The current litigation in alfalfa and sugarbeets was mentioned and the need for environmental impact assessments to be done. Also, if a trait is a good fit in one crop, that doesn't mean it is a good idea in all crops. Volunteer management must be thought out beforehand.

Biotech traits have had an overall negative effect on conventional breeding programs. We need to work to preserve germplasm that may otherwise be lost.

Growers commonly choose the cheapest effective alternative when making weed management choices. They need to see that the cheapest alternative this year may not be the best long-term decision. There are various avenues to educate growers, whether they listen to consultants, University representatives, or popular press. If the people that growers listen to understand the long-term impact of weed management decisions, growers are more likely to make better decisions.

Growers do not want to pay extra for unwanted traits. However, stacking traits can be costly. This limits how much stacking traits can be done economically. If growers are provided with choices, they will decide what works for them and what doesn't.

William McCloskey was elected to serve as chair for Project 5 in 2012.

Attendees:

Kevin Kelley	AgraServ, Inc.	kevin@agraserv.com
Dallas Peterson	KSU	dpeterso@ksu.edu
Rick Cole	Monsanto	rmcole@monsanto.com
David Saunders	Dupont	david.w.saunders@usa.dupont.com
Darren Unland	Bayer	darren.unland@bayercropscience.com
Steve Fennimore	UC Davis	safennimore@ucdavis.edu
Curtis Thompson	KSU	cthompso@ksu.edu
John Fenderson	Monsanto	john.m.fenderson@monsanto.com
Robert Rupp	Dupont	robert.n.rupp@usa.dupont.com
Thomas Peeper	OSU	peepert@okstate.edu
Mike Christoffers	NDSU	michael.christoffers@ndsu.edu
Stevan Knezevic	UNL	sknezevic2@unl.edu
Doug Grant	USDA-APHIS	douglas.w.grant@aphis.usda.gov
Siyuan Tan	BASF	siyuan.tan@basf.com
Mary Paulsgrove	Bayer	mary.paulsgrove@bayercropscience.com
Cheryl Wilen	UC Davis	cawilen@ucdavis.edu
Carol Mallory Smith	OSU	carol.mallory-smith@oregonstate.edu
Pamela Hutchinson	U of ID	phutch@uidaho.edu
Andrew Kniss	U of WY	akniss@uwyo.edu
Jill Schroder	NMSU	jischroe@nmsu.edu

Chair 2011:
Kevin Kelley
kevin@agraserv.com
Research Scientist
AgraServ, Inc.
American Falls, ID
(208) 226-2602

Chair 2012:
William McCloskey
wmcclosk@ag.arizona.edu
Weed Science Specialist
University of Arizona
Tuscon, AZ
(520) 621-7613

Western Society of Weed Science Financial Report
April 1, 2009 through March 31, 2010
Annual Meeting Report

CAPITAL

2008-2009 Balance Forward	$272,302.51
Current Income (loss) for 2009-2010	22,955.06
	$295,257.57

DISTRIBUTION OF CAPITAL

RBC Dain Rauscher Funds	$192,190.86
Money Market (Bank of the West)	49,004.59
Checking (Bank of the West)	10,299.79
Certificate of Deposit (Bank of the West)	43,762.33
	$295,257.57

WSWS Financial Report – April 1, 2009 through March 31, 2010

INCOME

Registration & Membership Dues (includes Proceeding and Research Progress Report income and sponsorships)	$ 72,717.61
Noxious Weed Control Short Course	1,151.00
Weeds of the West	48,798.34
Bio Control of Invasive Weeds book	108.38
California Weeds Books	715.00
Bank interest & Investment income	27,430.90
2009 Sustaining Membership Dues	6,996.00
Invasive Plants Book	150.00
Student Travel Account	0.00
UGA Press	241.80
Misc. Income	10.00
	$ 157,891.01

EXPENSES

Annual Meeting Expenses (includes cost of Proceedings, Research Progress Report, & programs printing and mailing)	55,569.93
Website (Host fees & service)	360.00
Domain name renewal	159.50
Tax Accountant	392.15
Liability Insurance	504.00
CAST Membership Dues (2008)	1,500.00
CAST Representative Travel	0.00
WSSA Director of Science Policy	15,000.00
Service Contract for business management	19,500.00
Noxious Weed Control Short Course	11,290.99
Newsletters (printing and postage)	612.40
Invasive Plants Books	257.14
Travel (Summer Board plus annual meeting)	9,968.14
Website transaction fee (Web Editor)	2346.00
Book handling charges	705.00
Merchant credit card fee	3149.63
Weeds of the West	428.02
California Weeds Book fee	348.50
UGA Press	109.43
WSSA Rep Travel	755.46
Student Travel Account	4544.89
Proceedings Scan Project	1489.88
Research Progress Report Scan Project	705.11
Misc. Expenses	153.12
	$ 129,421.27

2010 WSWS Fellow – Richard Arnold

Richard "Rick" Arnold obtained B.S. and M.S. degrees from New Mexico State University and served as the Assistant Technical Director of the Navajo Agricultural Products Industry from 1976 to 1979. After a short stint as a private consultant, he joined New Mexico State University at the Agricultural Science Center at Farmington where he holds a 100% research appointment. He has progressed up the academic ranks from Instructor to Professor. When Rick assumed his position at the Agricultural Science Center, he had limited resources and no existing research program. He successfully developed a weed-pest management program of value and relevance within his geographic area of responsibility as well as gaining recognition from university and industry scientists outside of New Mexico. This is no small accomplishment considering the relative isolation of his field research station. Current responsibilities include weed control in cropland and non-cropland, insect control in agronomic and horticultural crops, and revegetation of disturbed lands using coal bed methane produced water to help establish native and introduced grasses in the oil and gas producing basin of northwest New Mexico. He is the principle investigator for weed and insect control in northwest New Mexico and has conducted an extensive number of trials evaluating the efficacy and selectivity of herbicides for major crops grown in the Four-Corners Region of New Mexico, Colorado, Utah, and Arizona.

Rick has been a faithful and active member of the WSWS since 1986. He has served the Society in numerous capacities including member of the Student Contest, Finance, and Weed Management Short Course Committees; Chair of the Sustaining Membership Committee, Chair of the Horticultural Crops and Agronomic Crops Section's, and Chair of the Education and Regulatory Section; and as Member-at-Large on the Board of Directors. He is also a member of the Weed Science Society of America and is active in the New Mexico Academy of Science, having served as Vice-President and President of that organization. He's also served his profession as an Associate Editor of the Crop Plant Section of the Plant Management Network, affiliated with the Crop Science Society of America.

Rick has received numerous previous awards and recognitions including the New Mexico State University Staff Appreciation Award in 2004, for outstanding team work with the oil/gas industry, cattle producers, Bureau of Land Management and the United States Forest Service for the amelioration of rangelands. In 2006, he was named the WSWS Outstanding Weed Scientist from the Public Sector.

2010 WSWS Fellow – Dr. Tracy M. Sterling

Dr. Tracey M. Sterling, Department Head and Professor for the Land Resources and Environmental Sciences Department (LRES) at Montana State University (MSU), Bozeman, Montana was selected as a fellow of the Western Society of Weed Science (WSWS) at their 63rd annual meeting of the WSWS, which was held at the Waikoloa Beach Marriott, Waikoloa, Hawaii in March of 2010.

Tracy was originally a hard pavement girl from St. Paul, Minnesota, who during her undergraduate career at the University of Minnesota, fell in love with agriculture. She received a BS in Agronomy and Horticulture from the University of Minnesota in 1983, her MS in Horticulture from Michigan State University in 1985 and her PhD in Agronomy/Botany in 1988 from the University of Wisconsin.

Her professional career began in 1989 at the New Mexico State University (NMSU) as an assistant professor in the Entomology, Plant Pathology and Weed Science Department. In 1995, Dr. Sterling was promoted to associate professor at NMSU and in 2001, she was promoted to full professor. In 2009 Dr. Sterling accepted the position of department head and full professor at MSU.

During her academic career, Dr. Sterling has been the author or co-author of 39 refereed scientific journal articles, four book chapters and 128 proceeding abstracts. She has also been very active in the national weed science organization, the Weed Science Society of America (WSSA) and has held a number of committee positions in that organization, as well being a reviewer for *Weed Science* and *Weed Technology*. She has served as a co-editor several sections on the *WSSA Herbicide Handbook*.

The fellow award has two basic components: Demonstrated proficiency in weed science and service to the WSWS organization. Dr. Sterling's contributions to the WSW include, but certainly are not limited to, serving on at least eight different committees within WSWS and being chair person of five of those committees; many of the committee assignments within the WSWS were multiple year assignments and she often served on more than one committee at any given time. She has contributed to the society in a multitude of other ways also.

Dr. Tracy Sterling is an outstanding weed scientist and a valuable and committed contributor to the Western Society of Weed Science.

Tracy M. Sterling

Richard Arnold

2010 Honorary Membership Award -- Harry Cline

Harry's 45-year journalism career covers both daily newspapers and agricultural magazines. He was Western Farm Press' first editor and has more than 35 years of experience covering all aspects of high value, irrigated Western agriculture.

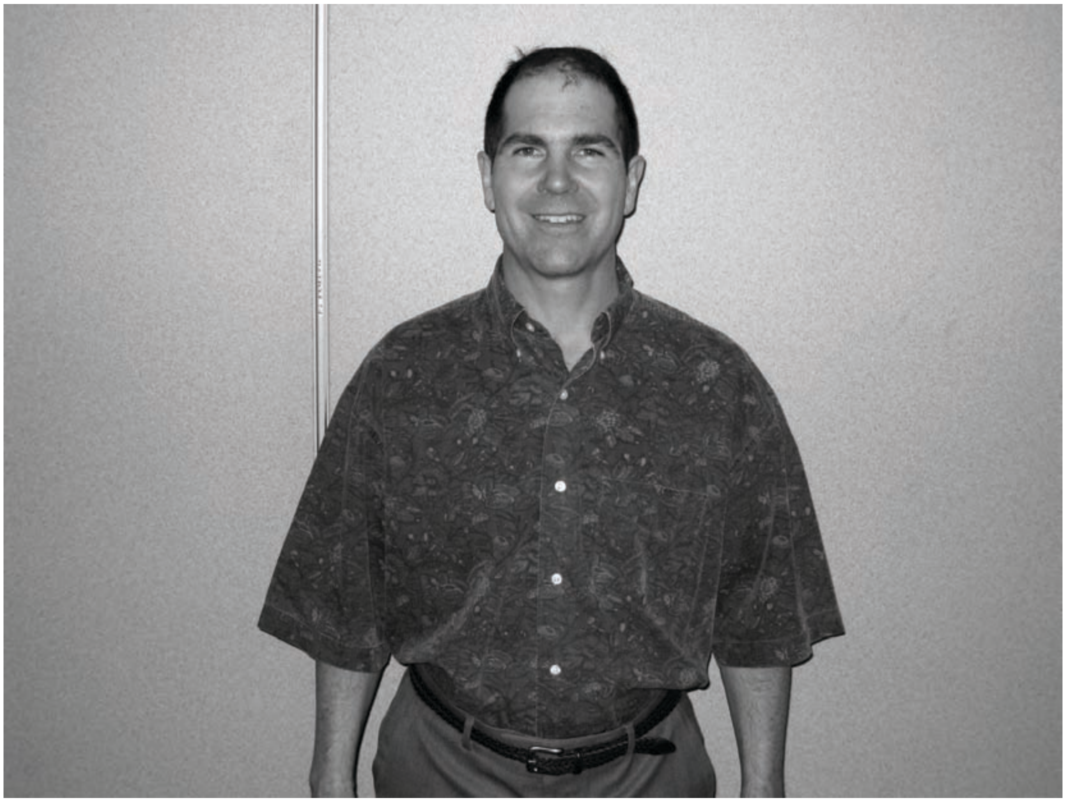
He is a former member of the California Chapter of the American Society of Agronomy executive council and recipient of the 1993 California Agricultural Production Consultants Association's Outstanding Contribution to California Agriculture. Born in Jacksonville, Florida and raised in Texas where he attended the University of Texas. He worked for newspapers in Texas and Arizona before moving to California in 1975 to begin his career as a Western agricultural journalist. Harry lives in Fresno with his wife Georgann; has 2 children and five grandchildren. He has covered a wide array of subjects as an ag journalist. His commentaries in recent years have focused on some of the major issues facing agriculture, including California's growing water crisis and other environmental issues. Perhaps his most impassioned opinions have focused on the issue of biotechnology. He has been an unabashed defender of this remarkable technology and the benefits it offers for not only production agriculture, but its impact on the challenges of feeding the world. Harry often cites the words of the late Nobel laureate Norman Borlaug, father of the Green Revolution, who said that agricultural biotechnology offers far greater advances in feeding mankind than his work. Today's extreme environmental activist groups often are the target of Harry's commentaries. His editorials have incurred their wrath on many occasions. Harry says American agriculture's story is a remarkable one; one he will cherish and relay at every opportunity in his career as an agricultural journalist.

Outstanding Weed Scientist – Drew Lyon

Dr. Drew Lyon is the Dryland Cropping Systems Specialist at the Panhandle Research and Extension Center, University of Nebraska – Scottsbluff. His position is 50% research and 50% extension, and his responsibilities include the investigation and development of resource efficient cropping systems for dryland crops. Drew grew up in Mt. Prospect, IL and attended the University of Illinois graduating in 1980 with a Bachelor of Science in Agronomy with an emphasis in crop protection. For three years after graduation, he was the Assistant Extension County Advisor in Kane County Illinois. In 1983, Drew began his graduate program at the University of Nebraska receiving his M.S. and PhD in Weed Science. Drew accepted a position with American Cyanamid in 1989 as a Technical Services Representative in Michigan. In 1990, Drew returned to the PREC-Scottsbluff, University of Nebraska as the Dryland Cropping Systems Specialist. In this tenure, he has published 58 refereed journal articles, five book chapters, two refereed proceedings, and 72 Extension publications. Drew was named a Fellow of the American Society of Agronomy in 2005 and named Fenster Professor of Dryland Agriculture in 2008.
Drew's greatest contribution to weed science was the development of crop rotations to control winter annual grasses in winter wheat. His research contributed to the management of these weeds utilizing the rotation of summer annual crops which has become a widely adapted practice within the winter wheat cropping system.
Drew is a grass roots weed scientist providing long term management solutions to the producer while making significant contributions to the field of weed science. Drew provides practical approach as weed science problem solver.

Outstanding Young Weed Scientist – Ian Burke

Dr. Ian Burke is an Assistant Professor in the Department of Crop and Soil Sciences at Washington State University. He began his split appointment of teaching and research at WSU in July of 2006. Ian grew up as member of an Air Force family and travelled the world, however he claimed Louisiana as his home. He attended Old Dominion University and received his Bachelor of Science in Biology in 1997. He received his MS and PhD. in Weed Science from North Carolina State U. and was named the WSSA Outstanding Graduate Student in 2004. From there he began a Post Doctoral position with the USDA-ARS at the Southern Weed Science Research Unit before his current position at WSU. In his brief career he has published 24 refereed journal articles and 29 abstracts and reports. Ian has served or is serving as major advisor for 3 graduate students and has served on the graduate committees of 5 other students. He teaches graduate level courses in Laboratory Methods in Weed Science and Ecology and Management of Weeds.
His current areas of research include: Sustainable dryland organic farming systems of the Pacific Northwest; Development of Artemisinin compounds from *Artemisia annua* for cancer treatment; and characterizing prickly lettuce latex quality for use in rubber and plastic. His primary accomplishment at WSU has been the characterization of growth regulator herbicide resistance in prickly lettuce.

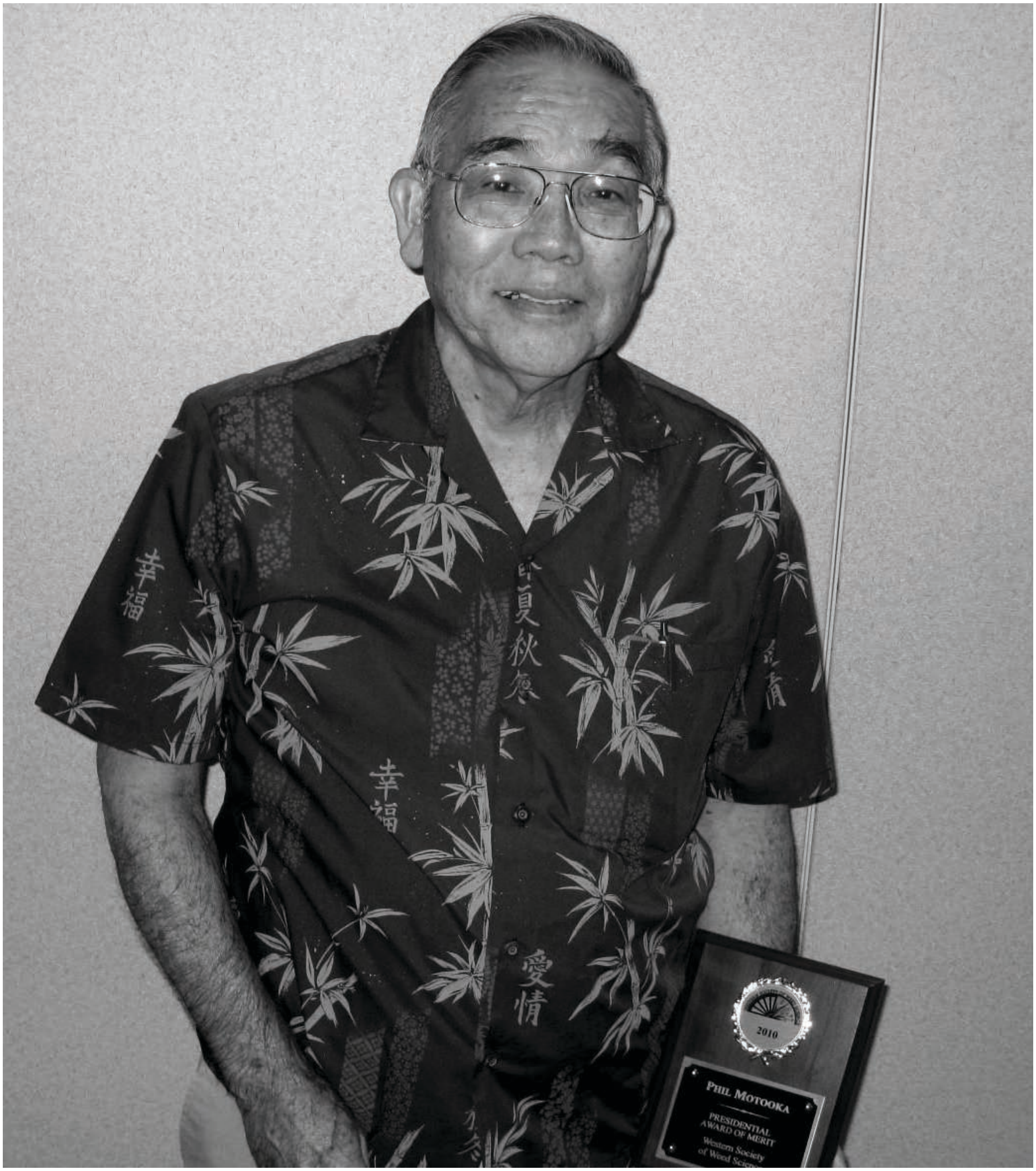


Outstanding Weed Scientist – Drew Lyon

Outstanding Early Career Weed Scientist – Ian Burke

Professional Staff Award – Cheryl Fiore

Cheryl Fiore has been active in weed science since 1996, beginning when she received the WSSA Undergraduate Research Award. She earned a B.S. in Agronomy and Horticulture in 1997 and a M.S. in Weed Science in 2004, both from New Mexico State University. Cheryl has published one journal article, one Experiment Station Report, 21 abstracts, and 12 annual weed science progress reports. She continues to be active in the discipline, both in her job as a Research Specialist in Weed Science and as a member of WSWS since 1997. As a Research Specialist at NMSU, Cheryl is responsible for managing the field research program in Weed Science. She is a contentious and talented researcher, excelling at developing methods and troubleshooting problems that could affect that outcome of the projects. As supervisor, Cheryl looks for ways to allow the students to develop their skills and learn on the job. She has worked with undergraduates on special research projects, both the research and the development of poster presentations, which they have subsequently presented at WSWS meetings. She also works with graduate students to help them achieve their research goals and graduate. Other researchers (faculty, staff, and students) in the college, as well as local consultants, rely on her expertise to help with weed identification, sprayer calibration, herbicide label interpretation, and other issues related to weed control in their programs. She is very generous with her time and talents. Cheryl has attended every WSWS annual meeting since 1997 and has presented a poster on research conducted in our program at all but one meeting. She began to actively participate in the organization a few years later and has served on the poster committee and currently as Newsletter editor. She regularly helps at the registration desk and with poster session set up and take down at many annual meetings – even though she is no longer on the committee!

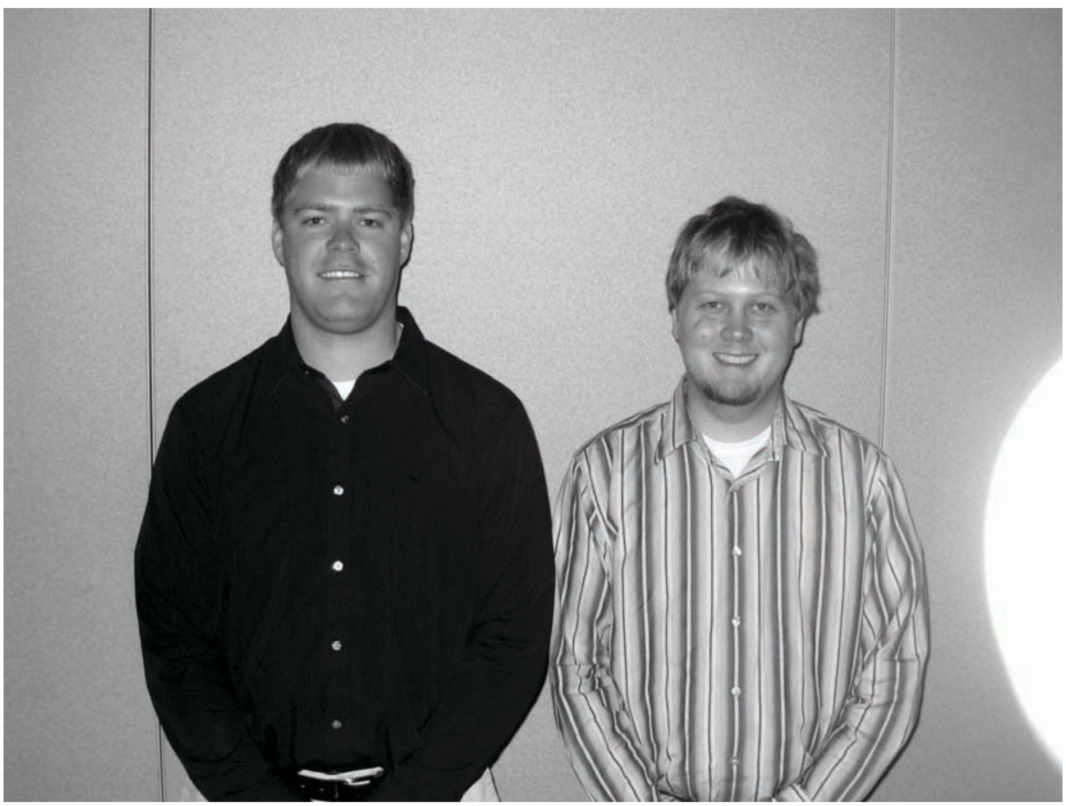


Philip Motooka – Presidential Award

Student Scholarship Awards
Mary Joi Abit (left), Wilson Avila-Garcia, Jeremiah Mann (right)

Graduate Student Poster Presentation Award Winners
Roberto Luciano, 1st (L), Stephanie Christensen, 2nd, Cassandra Setter, 3rd (R)

Graduate Oral Paper Contest Winners (Section A)
Jared Bell, 1st (L) and Jeremiah Mann, 2nd



Graduate Oral Paper Contest Winners (Section B)
Michael Ostlie, 1st (L) and Jonathan Mikkelson, 2nd

Undergraduate Poster Contest Winner
Holden Hergert

Passing the gavel. Jesse Richardson to Joe DiTomaso

NECROLOGY

Keith E. Wallace died May 18, 2009 at his home in Spokane, WA. He was born June 21, 1923 to Norman Wallace and Cornelia Greeno Wallace on the home farm at Britton.He attended Britton Public Schools, graduating from Britton High School in May 1940. He started college at South Dakota State College in September 1940. This education was interrupted for World War II in the spring of 1942. During World War II he farmed with his father and when it was feasible to leave the farming to his father alone, he joined the Merchant Marines, where he became a Radio Operator on the WILLIAM BLOUNT LIBERTY SHIP, following education at USMS Radio School at Gallops Island, Boston, MA. At the end of the war Keith returned to College, graduating with a Bachelor of Science Degree in 1949. He taught Vocational Education for one year at Barnard High School, Barnard. He then became a teacher for the "Veterans on the Farm Training" Program at Groton. Keith attended graduate school at South Dakota State College, earning a Master of Science Degree in Agronomy in 1954. He married Marilyn Elizabeth Page during his graduate school days (August 1, 1953. After receiving his Graduate Degree he became Extension Weed Specialist for South Dakota State College in 1954. They moved to Spokane, WA in 1961 becoming Weed Specialist for Washington State University. Keith took Sabbatical from WSU in 1976 and traveled and studied in American Samoa, New Zealand, Australia, Japan, Hong Kong and Taiwan. He accepted a position with WSU in "Farming Systems Research" in Lesotho, Southern Africa, serving from January 1982 to August 1985.

John “Jack” May, 79, passed away peaceably on Friday, February 26, 2010. He was born and raised on a cattle ranch near Steamboat Springs, CO. He was the youngest of five siblings born to Fred and Anna May. Starting in a one-room school called Fly Gulch, Jack continued his education in Steamboat Springs where he was elected class president five times. He graduated (as student body president) in 1949 from Steamboat High School. He went on to earn an AS from Mesa College, where he was V.P. of the Student Body and met his future wife, Alma Jean Tourney. Jack and Alma were married at Col Poly, San Dimas, CA in 1952 and returned to Steamboat Springs to ranch on the Elk River for eight years. While ranching, Jack was very active in the Colorado Cattleman’s Association. Jack returned to college, Colorado State University, in 1960. He earned his PhD in Plant Physiology and was an assistant professor at CSU until he graduated in 1968.After completing his PhD, Jack and family moved to St.Louis, MO, where he worked for eight years in R&D covering the mid-western states with Shell Development Company. He did technical support for Shell in several states before moving to Shell’s Biological Research Center in Modesto, CA as the coordinator for new herbicide development. Jack played a major role in the development of many products, including Bladex, Planavin, Endavin/Matavin, and Cinch as well as several insecticides. In 1986, Shell sold their agricultural business to DuPont, so Jack and Alma moved to Maryland where he was the herbicide development manager. They returned to CA where he managed a research facility in Fresno. After retiring from DuPont in 1990 he worked as a consultant for Western Farm Service for 14 years, retiring again in 2004. Jack was a member of both WSWS and WSSA. He will be remembered by his peers as “Cowboy” because he wore western clothes, boots, and hat throughout his professional career.

MARY JOY ABIT
KANSAS STATE UNIVERSITY
3723 THROCKMORTON
MANHATTAN, KS 66506
joieabs@k-state.edu

CRAIG ALFORD
DUPONT CROP PROTECTION
390 UNION BLVD, SUITE 500
DENVER, CO 80228
craig.alford@usa.dupont.com

KASSIM AL-KHATIB
KSU DEPT OF AGRONOMY
2004 THROCKMORTON HALL
MANHATTAN, KS 66506-5501
khatib@ksu.edu

JULIE ALLEN
CARBON COUNTY WEED & PEST
PO BOX 1126
RAWLINS, WY 82301
jewelyjoe@hotmail.com

JILL ALMS
SOUTH DAKOTA STATE UNIVERSITY
235 AG HALL
BROOKINGS, SD 57007
jill.alms@sdstate.edu

KIM ANDERSEN-EDVARCHUK
UTAH STATE UNIVERSITY
4820 OLD MAIN HILL
LOGAN, UT 84322-4800
kim.edvarchuk@aggiemail.usu.edu

MONTE ANDERSON
BAYER CROPSCIENCE
16304 SOUTH YANCEY LANE
SPANGLE, WA 99031-9563
monte.anderson@bayercropscience.com

RANDY ANDERSON
USDA-ARS
2923 MEDARY AVE
BROOKINGS, SD 57006
randerson@ngirl.ars.usda.gov

MIKE ANSOLABEHERE
VALENT USA CORPORATION
1170 W. SHAW
FRESNO, CA 93711
manso@valent.com

RICK ARNOLD
NMSU AGRICULTURAL SCI CENTER
PO BOX 1018
FARMINGTON, NM 87499
riarnold@nmsu.edu

SCOTT ASHER
BASF CORPORATION
3210 CR 7610
LUBBOCK, TX 79423
bsasher@sbcglobal.net

JAMSHID ASHIGH
NEW MEXICO STATE UNIV
PO BOX 30003-MSC 3AE
LAS CRUCES, NM 88003
jashigh@nmsu.edu

CHAD ASMUS
BASF CORPORATION
2301 BRISTOL LANE
NEWTON, KS 67114
chad.asmus@basf.com

WILSON AVILA
OREGON STATE UNIVERSITY
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331
avilagar2000@hotmail.com

BILL BAGLEY
WILBUR-ELLIS CO
4396 E EVANS RD
SAN ANTONIO, TX 78259
bbagley@wilburellis.com

JOHN (LARS) BAKER
FREMONT CO WEED & PEST
450 N 2ND ST ROOM 325
LANDER, WY 82520
larsbaker@wyoming.com

ORVILLE BALDOS
UNIVERSITY OF HAWAII AT MANOA
3190 MAILE WAY
HONOLULU, HI 96822
obaldos@hawaii.edu

DAN BALL
OSU COLUMBIA BASIN AG. RES
PO BOX 370
PENDLETON, OR 97801
daniel.ball@oregonstate.edu

PHIL BANKS
MARATHON AG CONSULTING
205 W BOUTZ BLDG 4 STE 5
LAS CRUCES, NM 88005
marathonag@zianet.com

GERARDO BANUELOS
UNIV OF CALIF COOP EXT
4437 SOUTH LASPINA ST SUITE B
TULARE, CA 93274
gbanuelos@ucdavis.edu

THOMAS BAUMAN
PURDUE UNIVERSITY
5104 FLOWERMOUND DR
WEST LAFAYETTE, IN 47906-9051
tbauman@purdue.edu

PAUL BAUMANN
TEXAS A&M UNIVERSITY
DEPT SOIL & CROP SCIENCE
COLLEGE STATION, TX 77843-2474
p-baumann@tamu.edu

ROBERT BAUMGARTNER
UNIVERSITY OF WYOMING
3779 RD 40
YODER, WY 82244
baumgart@uwyo.edu

JARED BELL
WASHINGTON STATE UNIV
PO BOX 646420
PULLMAN, WA 99164-6420
bellja@wsu.edu

DAVID BELLES
SYNGENTA CROP PROTECTION
4037 EAST KARSTEN DRIVE
CHANDLER, AZ 85249
david.belles@syngenta.com

LARRY BENNETT
OREGON STATE UNIVERSITY
PO BOX 370
PENDLETON, OR 97801
larry.bennett@oregonstate.edu

BOB BLACKSHAW
AGRIC & AGRI-FOOD CANADA
BOX 3000
LETHBRIDGE AB, CANADA
T1J 4B1
robert.blackshaw@agr.gc.ca

LISA BLECKER
UNIV. OF NEVADA COOP EXT.
111 SHECKLER ROAD
FALLON, NV 89406
bleckerl@unce.unr.edu

CALLIE BOLTON
WSU
3251 BIZ POINT ROAD
ANACORTES, WA 98221
calliebolton@yahoo.com

C. RYAN BOND
BASF CORPORATION
PO BOX 13528
RESEARCH TRIANGLE PARK, NC
27709
ryan.bond@basf.com

RICK BOYDSTON
USDA-ARS
24106 N BUNN ROAD
PROSSER, WA 99350
rick.boydston@ars.usda.gov

JOHN BROCK
REST. & INVASIVE PLANT MGMT
PO BOX 25939
TEMPE, AZ 85285
john.brock@asu.edu

TODD BURKDOLL
BASF CORPORATION
PO BOX 6654
VISALIA, CA 93290-6654
james.burkdoll@basf.com

IAN BURKE
WASHINGTON STATE UNIVERSITY
201 JOHNSON HALL
PULLMAN, WA 99164
icburke@wsu.edu

MARVIN BUTLER
OREGON STATE UNIVERSITY-COARC
850 NW DOGWOOD LANE
MADRAS, OR 97741
marvin.butler@oregonstate.edu

DAN CAMPBELL
NATIONAL PARK SERVICE
600 E PARK AVENUE
PORT ANGELES, WA 98362
dan_campbell@nps.gov

JOAN CAMPBELL
UNIVERSITY OF IDAHO
PSES DEPT BOX 442339
MOSCOW, ID 83844-2339
jcampbel@uidaho.edu

DAVID CARRUTH
NORTH DAKOTA STATE UNIVERSITY
1717 40TH ST. SW APT. 334
FARGO, ND 58103
david.carruth@ndsu.edu

LEO CHARVAT
BASF CORPORATION
6211 SADDLE CREEK TRAIL
LINCOLN, NE 68523-9227
leo.charvat@basf.com

STEPHANIE CHRISTENSEN
UTAH STATE UNIVERSITY
4820 OLD MAIN HILL
LOGAN , UT 84322
steph.durf@aggiemail.usu.edu

DEAN CHRISTIE
BAYER CROPSCIENCE
4402 SOUTH GLENDORA LANE
SPOKANE, WA 99223
dean.christie@bayercropscience.com

PAT CLAY
VALENT USA
37860 W. SMITH-ENKE ROAD
MARICOPA, AZ 85239
Pat.Clay@valent.com

CHRIS CLEMENS
SYNGENTA CROP PROTECTION
2631 STONECREEK
RICHLAND, WA 99352
christopher.clemens@syngenta.com

BILL COBB
COBB CONSULTING SERVICES
815 SO KELLOGG
KENNEWICK, WA 99336-9369
wtcobb42@aol.com

RICK COLE
MONSANTO
800 LINDBERGH BLVD-NC3G
ST. LOUIS, MO 63167
rmcole@monsanto.com

D. CHAD CUMMINGS
DOW AGROSCIENCES
25600 CR 110
PERRY, OK 73077
dccummings@dow.com

GREG DAHL
WINFIELD SOLUTIONS LLC
PO BOX 64281
ST PAUL, MN 55164-0089
gkdahl@landolakes.com

TREVOR DALE
VALENT USA CORPORATION
4305 SOUTH LOUISE AVE
SIOUX FALLS, SD 57106
tdale@valent.com

ED DAVIS
MONTANA STATE UNIVERSITY
334 JOHNSON HALL
BOZEMAN, MT 59717-3120
edavis@montana.edu

NATHAN DEAL
PACIFIC AG RESEARCH
1840 BIDDLE RANCH ROAD
SAN LUIS OBISPO, CA 93401
nathan@pacificaggroup.com

JOSEPH DEFRANK
UNIVERSITY OF HAWAII
3190 MAILES WAY, ROOM 102
HONOLULU, HI 96822
defrenk@hawaii.edu

DARRELL DENEKE
SOUTH DAKOTA STATE UNIVERSITY
AG HALL 239
BROOKINGS, SD 57007
deneke.darrell@ces.sdstate.edu

JOE DITOMASO
UNIVERSITY OF CALIFORNIA
DEPT OF PLANT SCI, MAIL STOP 4
DAVIS, CA 95616
jmditomaso@ucdavis.edu

DON DRADER
SYNGENTA CROP PROTECTION
7080 DUNE LAKE RD SE
MOSES LAKE, WA 98837-0167
donald.drader@syngenta.com

CELESTINE DUNCAN
WEED MGMT SERVICES
PO BOX 1385
HELENA, MT 59624-1385
weeds1@wildblue.net

KEITH DUNCAN
NEW MEXICO STATE UNIVERSITY
67 EAST FOUR DINKUS RD
ARTESIA, NM 88210
kduncan@nmsu.edu

BOB ECCLES
WILBUR ELLIS
PO BOX Y
FILER, ID 83328
beccles@wilburellis.com

JOHN EDSTROM
UNIV CALIF COOP EXT
PO BOX 180
COLUSA, CA 95932
jpedstrom@ucdavis.edu

RYAN EDWARDS
COLORADO STATE UNIVERSITY
4470 S. LEMAY AVE APT 1203
FT. COLLINS, CO 80525
redwards155@hotmail.com

CHAD EFFERTZ
ARYSTA LIFESCIENCE
4551 HWY 41N
VELVA, ND 58790
chad.effertz@arystalifescience.com

GREGORY ENDRES
NORTH DAKOTA STATE UNIVERSITY
RES EXT CENTER BOX 219
CARRINGTON, ND 58421-0219
gregory.endres@ndsu.edu

ERIC ERIKSMOEN
NDSU
PO BOX 1377
HETTINGER, ND 58639-1377
eric.eriksmoen@ndsu.edu

LUKE ETHEREDGE
MONSANTO
3911 CHAINHURST DR
RICHARDSON, TX 75082
luke.m.etheredge@monsanto.com

STEVE EVANS
COLORADO STATE UNIVERSITY
PO BOX 4607
HILO, HI 96720
tiana@rams.colostate.edu

JEANNE FALK
KANSAS STATE UNIVERSITY
PO BOX 786
COLBY, KS 67701
jfalk@k-state.edu

JANAN FARR
UNIVERSITY OF IDAHO
1693 SOUTH 2700 WEST
ABERDEEN, ID 83210
janan@uidaho.edu

DARYNE FEGLER
FREMONT COUNTY WEED & PEST
450 N 2ND ST ROOM 325
LANDER, WY 82520
feglerfarms@wyoming.com

JOEL FELIX
OREGON STATE UNIVERSITY
595 ONION AVENUE
ONTARIO, OR 97914
joel.felix@oregonstate.edu

JOHN FENDERSON
MONSANTO COMPANY
PO BOX 47
KIOWA, KS 67070-1025
john.m.fenderson@monsanto.com

STEVE FENNIMORE
UNIVERSITY OF CALIFORNIA
1636 E ALISAL STREET
SALINAS, CA 93905
safennimore@ucdavis.edu

MARK FERRELL
UNIVERSITY OF WYOMING
1000 UNIVERSITY BOX 3354
LARAMIE, WY 82071-3354
ferrell@uwyo.edu

ROBERT FINLEY
FREMONT CO WEED & PEST
PO BOX 1171
DUBOIS, WY 82513
rfinley@dteworld.com

CHERYL FIORE
NEW MEXICO STATE UNIVERSITY
6635 RIO DORADO
LA MESA, NM 88044
cfiore@nmsu.edu

SCOTT FITTERER
AGRO-TECH INC.
PO BOX 63
VELVA, ND 58790
scottfitterer@srt.com

PETER FORSTER
SYNGENTA CROP PROTECTION
35492 WCR 43
EATON, CO 80615-9205
pete.forster@syngenta.com

ROGER GAST
DOW AGROSCIENCES
9330 ZIONSVILLE RD
INDIANAPOLIS, IN 46268
regast@dow.com

SETH GERSDORF
BAYER CROPSCIENCE
12694 KINGS VALLEY HIGHWAY
MONMOUTH, OR 97361
seth.gersdorf@bayercropscience.com

AMAR GODAR
KANSAS STATE UNIVERSITY
1540 INTERNATIONAL COURT I-11
MANHATTAN, KS 66502
godarws@ksu.edu

BOBBY GOEMAN
LARIMER COUNTY WEED DISTRICT
PO BOX 1190
FT. COLLINS, CO 80522
GoemanB@co.larimer.co.us

DOUG GRANT
USDA APHIS BRS
2150 CENTRE AVE
FT. COLLINS, CO 80526
douglas.w.grant@aphis.usda.gov

CODY GRAY
UNITED PHOSPHORUS, INC.
11417 CRANSTON DRIVE
PEYTON, CO 80831
cody.gray@uniphos.com

ALYSIA GRECO
OREGON STATE UNIVERSITY
4017 AG & LIFE SCIENCE BUILDING
CORVALLIS, OR 97331-7304
alysiacgreco@yahoo.com

JESSICA GREEN
OREGON STATE UNIVERSITY
PO BOX 913
CORVALLIS, OR 97339
greenje@hort.oregonstate.edu

MELVIN GROVE
ISK BIOSCIENCES
3714 ASH GLEN DRIVE
SPRING, TX 77388
grovem@iskbc.com

AMBER GROVES
MARATHON AG CONSULTING
205 W. BOUTZ, BLDG. 4, STE 5
LAS CRUCES, NM 88005
amber.groves@marathonag.com

MARY HALSTVEDT
DOW AGROSCIENCES
3311 HORTON SMITH LN
BILLINGS, MT 59106
mbhalstvedt@dow.com

JASON HANLEY
USFWS
66-590 KAMEHAMEHA HWY
HALEIWA, HI 96712
jason_hanley@fws.gov

BRAD HANSON
UNIVERSITY OF CALIFORNIA, DAVIS
ONE SHIELDS AVE
DAVIS, CA 95616
bhanson@ucdavis.edu

JIM HARBOUR
DUPONT CROP PROTECTION
429 NW 23RD ST
LINCOLN, NE 68528
james.d.harbour@usa.dupont.com

DEWAYNE HARPER
WILBUR ELLIS COMPANY
PO BOX 764
PASCO, WA 99301
dharper@wilburellis.com

TIMOTHY HARRINGTON
USDA FOREST SERVICE
3625 93RD AVE SW
OLYMPIA, WA 98512
tharrington@fs.fed.us

ALAN HELM
COLORADO STATE UNIV EXT SERV
315 CEDAR SUITE 100
JULESBURG, CO 80737
alan.helm@colostate.edu

DAN HENNINGSEN
UNIVERSITY OF IDAHO
PO BOX 2317
TWIN FALLS, ID 83301
hennings@uidaho.edu

HOLDEN HERGERT
UNIVERSITY OF WYOMING
570 1/2 N 10TH ST
LARAMIE, WY 82071
hhergert@uwyo.edu

CHARLIE HICKS
BAYER CROPSCIENCE
3008 SHORE ROAD
FT. COLLINS, CO 80524
charlie.hicks@bayercropscience.com

JORDAN HOEFING
NORTH DAKOTA STATE UNIV
5400 HWY 83 SOUTH
MINOT, ND 58701
jordan.hoefing@ndsu.edu

RICK HOLM
PLANT SCIENCES UNIV OF SASK
51 CAMPUS DRIVE
SASKATOON SK, CANADA S7N 5A8
rick.holm@usask.ca

JODIE HOLT
UNIVERSITY OF CALIFORNIA
BOTANY & PLANT SCIENCES
RIVERSIDE, CA 92521-0124
jodie.holt@ucr.edu

ROBERT HOOTEN
FMC CORPORATION
4615 NW 86TH PLACE
KANSAS CITY, MO 64154
ROBERT. HOOTEN@FMC.COM

KIRK HOWATT
NORTH DAKOTA STATE UNIV
NDSU DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
kirk.howatt@ndsu.edu

LORI HOWLETT
U OF NEB PANHANDLE RES & EXT CTR
4502 AVENUE I
SCOTTSBLUFF, NE 69361
lhowlett1@unl.edu

MIKE HUBBARD
KOOTENAI VALLEY RESEARCH
4181 DISTRICT 5 ROAD
BONNERS FERRY, ID 83805
hubbard@wildblue.net

ANDREW HULTING
OREGON STATE UNIVERSITY
109 CROP SCIENCE BUILDING
CORVALLIS, OR 97331-3002
andrew.hulting@oregonstate.edu

PAM HUTCHINSON
U OF IDAHO ABERDEEN R & E CENTER
1693 S. 2700 W.
ABERDEEN, ID 83210
phutch@uidaho.edu

ROGER HYBNER
USDA-NRCS BRIDGER PLANT MAT.
98 S. RIVER RD
BRIDGER, MT 59014-9514
roger.hybner@mt.usda.gov

SCOTT INMAN
NOVOZYMES BIOLOGICALS
3280 WESTERDOLL AVE
LOVELAND, CO 80538
scin@novozymes.com

TRAVIS JANAK
TEXAS A&M UNIVERSITY
SOIL & CROP SCIENCES 2474 TAMU
COLLEGE STATION, TX 77843-2474
Tjanak@ag.tamu.edu

BRIAN JENKS
NORTH DAKOTA STATE UNIV
5400 HWY 83 SOUTH
MINOT, ND 58701
brian.jenks@ndsu.edu

ERIC JOHNSON
AGRIC & AGRI-FOOD CANADA
BOX 10
SCOTT SK, CANADA S0M 0E0
johnsone@agr.gc.ca

MICHAEL JOHNSON
SYNGENTA CROP PROTECTION
410 S SWING RD
GREENSBORO, NC 27409
mike.johnson@syngenta.com

KYLE KELLER
BASF CORPORATION
6315 GUESS ROAD
ROUGEMONT, NC 27572
kyle.keller@basf.com

KEVIN KELLEY
AGRASERV
2565 FREEDOM LANE
AMERICAN FALLS, ID 83211
kevin@agraserv.com

RAJ KHOSLA
COLORADO STATE UNIVERSITY
CO13 PLANT SCIENCES BUILDING-1170
FORT COLLINS, CO 80523-1170
raj.khosla@colostate.edu

MICHAEL KILLEN
UNIVERSITY OF WYOMING
747 RD 9
POWELL, WY 82435
mkillen@uwyo.edu

STEVEN KING
BAYER CROPSCIENCE
1321 FLORIAN AVE
HUNTLEY, MT 59037
steven.king@bayercropscience.com

DON KIRBY
NORTH DAKOTA STATE UNIVERSITY
SOILS/RANGE SCIENCE WALSTER 103
FARGO, ND 58105
donald.kirby@ndsu.edu

ROBERT KLEIN
UNIVERSITY OF NEBRASKA
402 WEST STATE FARM ROAD
NORTH PLATTE, NE 69101-7751
rklein1@unl.edu

STEVAN KNEZEVIC
UNIVERSITY OF NEBRASKA
1009 SHERMAN
WAYNE, NE 68787
sknezevic2@unl.edu

ANDREW KNISS
UNIVERSITY OF WYOMING
DEPT 3354 1000 E UNIVERSITY
LARAMIE, WY 82071
akniss@uwyo.edu

BILL KRAL
DUPONT CROP PROTECTION
1739 JULIE LANE
TWIN FALLS, ID 83301
c-william.kral@usa.dupont.com

TIM KSANDER
CHEMINOVA, INC
1695 GREENWOOD WAY
YUBA CITY, CA 95993
tim.ksander@cheminova.com

GUY KYSER
UNIVERSITY OF CALIFORNIA
1 SHIELDS AVENUE
DAVIS, CA 95616
gbkyser@ucdavis.edu

CRYSTAL LA PIERRE
WILBUR ELLIS
7101 WEST HOOD PLACE
KENNEWICK, WA 99336
clapierre@wilburellis.com

TIANA LACKEY
COLORADO STATE UNIVERSITY
PO BOX 4607
HILO, HI 96720
tiana@rams.colostate.edu

TOM LANINI
UNIVERSITY OF CALIFORNIA
278 ROBBINS HALL
DAVIS, CA 95616
wtlanini@ucdavis.edu

LARRY LASS
UNIVERSITY OF IDAHO
3663 HWY 8
TROY, ID 83871
llass@uidaho.edu

NEVIN LAWRENCE
UNIVERSITY OF WYOMING
DEPT. 3354 1000 E. UNIVERSITY AVE
LARAMIE, WY 82071
nevinlaw@uwyo.edu

MICHELLE LE STRANGE
UNIVERSITY OF CALIFORNIA COOP EXT
4437-B S. LASPINA ST.
TULARE, CA 93274
mlestrange@ucdavis.edu

LELAND LEARNED
FMC CORPORATION
1126 OLD PEACHY CANYON RD
PASO ROBLES, CA 93446
leland.learned@fmc.com

JAMES LEARY
UNIV. HAWAII AT MANOA
PO BOX 269
KULA, HI 96790
leary@hawaii.edu

GILLES LEROUX
LAVAL UNIVERSITY
3245 E. UNIVERSITY #904
LAS CRUCES, NM 88011
Gilles.Leroux@fsaa.ulaval.ca

GLENN LETENDRE
SYNGENTA CROP PROTECTION
11852 W ONEIDA DR
BOISE, ID 83709-3882
glenn.letendre@syngenta.com

CARL LIBBEY
WSU - MOUNT VERNON NWREC
16650 SR 536
MT VERNON, WA 98273-4768
libbey@wsu.edu

BRAD LINDENMAYER
COLORADO STATE UNIVERSITY
1177 CAMPUS DELIVERY
FORT COLLINS, CO 80523-1177
blindenm@rams.colostate.edu

ROBERTO LUCIANO
NORTH DAKOTA STATE UNIV
2901 8TH ST. N APT. 7
FARGO, ND 58102
roberto.luciano@ndsu.edu

SCOTT LUKAS
UNIVERSITY OF HAWAII
3190 MAILE WAY
HONOLULU, HI 96822
slukas@hawaii.edu

ROD LYM
NORTH DAKOTA STATE UNIV
NDSU DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
rod.lym@ndsu.edu

DREW LYON
UNIVERSITY OF NEBRASKA
PHREC 4502 AVENUE I
SCOTTSBLUFF, NE 69361
dlyon1@unl.edu

LARRY MADDUX
KANSAS STATE UNIVERSITY
9748 NW 66TH STREET
SILVER LAKE, KS 66539
lmaddux@ksu.edu

HANK MAGER
BAYER CROPSCIENCE
14422 N PRICKLY PEAR CT
FOUNTAIN HILLS, AZ 85268
hank.mager@bayercropscience.com

CAROL MALLORY-SMITH
OREGON ST UNIV-CROP SOIL SCI
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331-3002
carol.mallory-smith@oregonstate.edu

JANE MANGOLD
MONTANA STATE UNIVERSITY
PO BOX 173120
BOZEMAN, MT 59717
jane.mangold@montana.edu

JEREMIAH MANN
UNIVERSITY OF CALIFORNIA
4224 ARLINGTON AVE
SACRAMENTO, CA 95820
jjmann@ucdavis.edu

KENT MARTIN
KANSAS STATE UNIVERSITY
4500 E. MARY ST.
GARDEN CITY, KS 67846
kentlm@ksu.edu

DEAN MARUSKA
BAYER CROPSCIENCE
408 E. JOHNSON AVE
WARREN, MN 56762
dean.maruska@bayercropscience.com

MARK MATOCHA
TEXAS AGRILIFE EXT SERVICE
115 AGRONOMY FIELD LAB
COLLEGE STATION, TX 77843
mmatocha@ag.tamu.edu

MATTHEW MATOCHA
TEXAS A&M UNIVERSITY
SOIL & CROP SCIENCES
2474 TAMU
COLLEGE STATION, TX 77843-2474
MEMatoch@ag.tamu.edu

TODD MAYHEW
VALENT USA CORPORATION
1143 N. ABILENE DRIVE
GILBERT, AZ 85233
tmayh@valent.com

BILL McCLOSKEY
UNIVERSITY OF ARIZONA
PLANT SCIENCE FORBES 303
TUCSON, AZ 85721-0036
wmcclosk@ag.arizona.edu

KIRK McDANIEL
NEW MEXICO STATE UNIVERSITY
DEPT. ANIMAL & RANGE, BOX 31
LAS CRUCES, NM 88003
kmcdanie@nmsu.edu

SANDRA McDONALD
2960 SOUTHMOOR DRIVE
FT COLLINS, CO 80525
sandrakmcdonald@gmail.com

BRIAN MEALOR
UNIVERSITY OF WYOMING
BOX 3354, 1000 E. UNIV. AVE.
LARAMIE, WY 82071
bamealor@uwyo.edu

GARY MELCHIOR
GOWAN COMPANY
625 ABBOTT RD
WALLA WALLA, WA 99362
gmelchior@gowanco.com

FABIAN MENALLED
MONTANA STATE UNIVERSITY
719 LEON JOHNSON HALL
BOZEMAN, MT 59717-3120
menalled@montana.edu

ABDEL MESBAH
UNIVERSITY OF WYOMING
747 ROAD 9
POWELL, WY 82435
sabah@uwyo.edu

JONATHAN MIKKELSON
NORTH DAKOTA STATE UNIV
NDSU DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
Jonathan.Mikkelson@ndsu.edu

TIM MILLER
WASHINGTON STATE UNIV
16650 STATE ROUTE 536
MT VERNON, WA 98273-9761
twmiller@wsu.edu

MIKE MOECHNIG
SOUTH DAKOTA STATE UNIV
229 AG HALL BOX 2207A
BROOKINGS, SD 57007
michael.moechnig@sdstate.edu

THOMAS MONACO
USDA AGRICUTURAL RESEARCH
700 N. 100 E.
LOGAN, UT 84322-6300
tom.monaco@ars.usda.gov

DON MORISHITA
UNIVERSITY OF IDAHO
PO BOX 1827
TWIN FALLS, ID 83303-1827
don@uidaho.edu

PHIL MOTOOKA
75-452 HOENE ST
KAILUA-KONA, HI 96740-1966
motookap001@hawaii.rr.com

TINA MUDD
NEVADA DEPT. OF AGRIC
405 SOUTH 21ST STREET
SPARKS, NV 89431
tmudd@agri.state.nv.us

PHIL MUNGER
BASF CORPORATION
27448 ROAD 140, K
VISALIA, CA 93292
philip.munger@basf.com

JERRY NACHTMAN
UNIVERSITY OF WYOMING
2753 STATE HIGHWAY 157
LINGLE , WY 82223
nachtman@uwyo.edu

GEORGE NEWBERRY
GOWAN COMPANY
1411 SOUTH ARCADIA STREET
BOISE, ID 83705
gnewberry@gowanco.com

GLENN NICE
PURDUE UNIVERSITY
915 W. STATE STREET, LILLY HALL
WEST LAFAYETTE, IN 47907
gnice@purdue.edu

SCOTT NISSEN
COLORADO STATE UNIVERSITY
115 WEED RESEARCH LAB
FT COLLINS, CO 80523-1177
snissen@lamar.colostate.edu

RUTENDO NYAMUSAMBA
SOUTH DAKOTA STATE UNIV
BOX 2207A
BROOKINGS, SD 57007
Rutendo.Nyamusamba@sdstate.edu

TIM OBRIGAWITCH
DUPONT
52 BELMONT DRIVE
HOCKESSIN, DE 19707
timothy.t.obrigawitch@usa.dupont.com

DENNIS ODERO
UNIVERSITY OF WYOMING
2126 BINFORD ST. APT. 302
LARAMIE, WY 82072
odero@uwyo.edu

BRETT OEMICHEN
DOW AGROSCIENCES
32 PAR 4 COURT
PORT LUDLOW, WA 98365
bmoemichen@dow.com

CHRIS OLSEN
BAYER ES
22978 CATT RD
WILDOMAR, CA 92595
chris.olsen@bayercropscience.com

BRIAN OLSON
KANSAS STATE UNIVERSITY
PO BOX 786
COLBY, KS 67701
bolson@oznet.ksu.edu

EMMANUEL OMONDI
UNIVERSITY OF WYOMING
918 REYNOLDS STREET
LARAMIE, WY 82072
eomondi@uwyo.edu

SCOTT ONETO
UNIV OF CALIFORNIA COOP EXT
2 SOUTH GREEN STREET
SONORA, CA 95370
sroneto@ucdavis.edu

MARK OOSTLANDER
BASF CORPORATION
109 LYNX PLACE
LETHBRIDGE AB, CANADA T1H 6V9
mark.oostlander@basf.com

STEVE ORLOFF
UNIV OF CALIF COOP EXT
1655 S MAIN ST
YREKA, CA 96097
sborloff@ucdavis.edu

JOHN ORR
AMVAC
PO BOX 369
STAR, ID 83669
johno@amvac.net

MICHAEL OSTLIE
COLORADO STATE UNIVERSITY
1177 CAMPUS DELIVERY
FT COLLINS, CO 80523
mostlie@rams.colostate.edu

JULIA PARISH
COLORADO STATE UNIV
PO BOX 4607
HILO, HI 96720
tiana@rams.colostate.edu

BOB PARKER
WASHINGTON STATE UNIV
24106 N BUNN ROAD
PROSSER, WA 99350-0687
rparker@wsu.edu

JIM PAROCHETTI
CSREES-USDA
4th & INDEPENDENCE AVE SW MS 2220
WASHINGTON, DC 20250-2220
jparochetti@csrees.usda.gov

MARY PAULSGROVE
BAYER CROPSCIENCE
2 TW ALEXANDER DR
 - PO BOX 12014
RTP, NC 27709
Mary.Paulsgrove@bayercropscience.com

ED PEACHEY
OREGON STATE UNIVERSITY
HORT DEPT ALS4017
CORVALLIS, OR 97331
peacheye@hort.oregonstate.edu

JEREMY PEDERSON
NDSU EXTENSION SERVICE
5400 HWY 83 SOUTH
MINOT, ND 58701
jeremy.pederson@ndsu.edu

TOM PEEPER
OKLAHOMA STATE UNIV
PLANT & SOIL SCIENCE DEPT
STILLWATER, OK 74078
peepert@okstate.edu

DAVID PETER
USFS PACIFIC NW RES STATION
3625 93RD AVE SW
OLYMPIA, WA 98512
dpeter@fs.fed.us

DALLAS PETERSON
KANSAS STATE UNIVERSITY
2014 THROCKMORTON HALL
MANHATTAN, KS 66506-5504
dpeterso@ksu.edu

VANELLE PETERSON
DOW AGROSCIENCES
28884 S MARSHALL ROAD
MULINO, OR 97042-8709
vfpeterson@dow.com

JOHN PHILLIPS
US NAVY
1155 W LEXINGTON ST
NAS WHIDBEY ISLAND, WA 98277
john.r.phillips1@navy.mil

TIMOTHY PRATHER
UNIVERSITY OF IDAHO
1387 WALENTA
MOSCOW, ID 83843
tprather@uidaho.edu

CURTIS RAINBOLT
BASF
4763 N PACIFIC AVE
FRESNO , CA 93705
curtis.rainbolt@basf.com

COREY RANSOM
UTAH STATE UNIVERSITY
4820 OLD MAIN HILL
LOGAN, UT 84322-4820
corey.ransom@usu.edu

TRACI RAUCH
UNIVERSITY OF IDAHO
PO BOX 442339
MOSCOW, ID 83844-2339
trauch@uidaho.edu

CHUCK RICE
BASF CORPORATION
725 N CENTER PKWY
APT. R302
KENNEWICK, WA 99336
chuck.rice@basf.com

RUTH RICHARDS
BIG HORN COUNTY WEED & PEST DIST
PO BOX 567
GREYBULL, WY 82426-0567
bhcwp@tctwest.net

JESSE RICHARDSON
DOW AGROSCIENCES
9330 10TH AVENUE
HESPERIA, CA 92345
jmrichardson@dow.com

JERRY RIES
NDSU DEPT PLANT SCIENCE
NDSU DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
jerry.ries@ndsu.edu

JOHN RONCORONI
UCCE NAPA COUNTY
1710 SOSCAL AVE SUITE 4
NAPA, CA 94559-1315
jaroncoroni@ucdavis.edu

ROBERT RUPP
DUPONT CROP PROTECTION
5813 SANDSAGE DR.
EDMOND, OK 73034
robert.n.rkupp@usa.dupont.com

KEN SAPSFORD
UNIV OF SASKATCHEWAN
51 CAMPUS DRIVE
SASKATOON SK, CANADA
S7N 5A8
k.sapsford@usask.ca

DAVID SAUNDERS
DUPONT
24087 230TH ST.
DALLAS CENTER, IA 50063
david.w.saunders@usa.dupont.com

GUSTAVO SBATELLA
UNIVERSITY OF NEBRASKA
4502 AVENUE I
SCOTTSBLUFF, NE 69361
gsbatella2@unl.edu

ROLAND SCHIRMAN
WASHINGTON STATE UNIV
120 WEINHARD RD
DAYTON, WA 99328-9677
schirman@innw.net

ALAN SCHLEGER
KANSAS STATE UNIVERSITY
1470 STATE HWY 96
TRIBUNE, KS 67079
schleger@ksu.edu

JERRY SCHMIERER
UNIVERSITY OF CALIF
PO BOX 180 100 SUNRISE BLVD STE E
COLUSA, CA 95932
jlschmierer@ucdavis.edu

MARTY SCHRAER
SYNGENTA CROP PROT
152 E CASSIDY DRIVE
MERIDIAN, ID 83646
marty.schraer@syngenta.com

JILL SCHROEDER
NEW MEXICO STATE UNIVERSITY
BOX 30003 MSC 3BE
LAS CRUCES, NM 88009-0003
jischroe@nmsu.edu

CASSIE SETTER
NORTH DAKOTA STATE UNIV
NDSU DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
cassandra.setter@ndsu.edu

DALE SHANER
USDA-ARS
2150 CENTRE AVE BLDG D
FT COLLINS, CO 80526
dale.shaner@ars.usda.gov

DONALD SHOUSE
UNIV OF IDAHO
P.O. BOX 1827
TWIN FALLS, ID 83303
dshouse@uidaho.edu

BYRON SLEUGH
DOW AGROSCIENCES
6887 DAKOTA DRIVE
WEST DES MOINES, IA 50266
bbsleugh@dow.com

DANIEL SMEAL
NEW MEXICO STATE UNIV
PO BOX 1018
FARMINGTON, NM 87499
dsmeal@nmsu.edu

JAMIN SMITCHGER
WSU
720 NE REANEY WAY
PULLMAN, WA 99163
jsmitchger@wsu.edu

MONICA SORRIBAS
DOW AGROSCIENCES
1750 E. SHEPHERD AVE
FRESNO, CA 93706
msorribas@dow.com

PHIL STAHLMAN
KANSAS STATE UNIVERSITY
1232 240TH AVENUE
HAYS, KS 67601-9228
stahlman@ksu.edu

TRACY STERLING
MONTANA STATE UNIVERSITY
PO BOX 173120
BOZEMAN, MT 59717
tracy.sterling@montana.edu

SIYUAN TAN
BASF
1200 WHEELWRIGHT PL 207
CARY, NC 27519
siyuan.tan@basf.com

ERIN TAYLOR
UNIV OF ARIZONA COOP EXT
4341 E BROADWAY RD
PHOENIX, AZ 85040
etaylor@cals.arizona.edu

DONN THILL
UNIV OF IDAHO PSES DEPT
PO BOX 442339
MOSCOW, ID 83844-2339
dthill@uidaho.edu

CURTIS THOMPSON
KANSAS STATE UNIVERSITY
2014 THROCKMORTON HALL
MANHATTAN, KS 66506-5504
cthompso@ksu.edu

RONNIE TURNER
DUPONT CROP PROTECTION
88 McCALL DRIVE
COLLIERVILLE, TN 38017
ronnie.g.turner@usa.dupont.com

STUART A TURNER
TURNER & CO
5903 KILAWEA DRIVE
WEST RICHLAND, WA 99353
agforensic@aol.com

ROBERT ULLOM
WILBUR-ELLIS CO
PO BOX 31293
BILLINGS, MT 59107
BULLOM@WECON.COM

KAI UMEDA
UNIVERSITY OF ARIZONA
4341 EAST BROADWAY
PHOENIX, AZ 85040
kumeda@cals.arizona.edu

DARREN UNLAND
BAYER CROPSCIENCE
2 TW ALEXANDER DR
RTP, NC 27709
darren.unland@bayercropscience.com

JARED UNVERZAGT
UNIVERSITY OF WYOMING
1359 N 17TH ST
LARAMIE, WY 82072
jzagt@uwyo.edu

MAHESH UPADHYAYA
UNIV OF BRITISH COLUMBIA
FACULTY LAND & FOOD SYSTEMS
VANCOUVER, BC V6Y 3B7
upadh@interchange.ubc.ca

JIM VANDECOEVERING
BASF CORPORATION
104 E FAIRVIEW AVE #226
MERIDIAN, ID 83642
jim.vandecoevering@basf.com

LEE VANWYCHEN
WSSA-DSP
900 2ND ST NE STE 205
WASHINGTON, DC 20002
Lee.VanWychen@wssa.net

JOSEPH VASSIOS
COLORADO STATE UNIVERSITY
110 WEED RESEARCH LAB
FT COLLINS, CO 80523
jvassios@rams.colostate.edu

KURT VOLKER
TKI NOVASOURCE
7610 SCENIC DRIVE
YAKIMA, WA 98908
kvolker@tkinet.com

DAVID VOS
SOUTH DAKOTA STATE UNIV
414 8TH AVE S.
BROOKINGS, SD 57006
dave.vos@sdstate.edu

LEN WELCH
VALENT
PO BOX 300
HOOD RIVER, OR 97031
len.welch@valent.com

JERI WEST
ARYSTA LIFESCIENCE
23504 E 3RD AVE
LIBERTY LAKE, WA 99019
jeri.west@arystalifescience.com

ERIC WESTRA
CSU
401 N. SHERWOOD ST.
FORT COLLINS, CO 80521
epwestra@rams.colostate.edu

PHIL WESTRA
COLORADO STATE UNIV
112 WEED LAB
FT COLLINS, CO 80523
cows19@comcast.net

CHRIS WHARAM
BASF
1091 DEER TRAIL LANE NE
THOMPSON, ND 58278
chris.wharam@basf.com

TONY WHITE
MONSANTO
241 HUMMINGBIRD LANE
HANNIBAL, MO 63401
tony.d.white@monsanto.com

HANNAH WILBUR
COLORADO STATE UNIV
1177 CAMPUS DELIVERY
FORT COLLINS, CO 80523-1177
Hannah.Wilbur@colostate.edu

CHERYL WILEN
UC STATEWIDE IPM PROGRAM / UCCE
5555 OVERLAND AVE SUITE 4101
SAN DIEGO, CA 92123
cawilen@ucdavis.edu

SAM WILLINGHAM
BASF CORPORATION
6626 CHAPEL HILL BLVD #A304
PASCO, WA 99301
samuel.willingham@basf.com

GARY WILLOUGHBY
NORTH CENTRAL RES EXT CNTR
5400 HWY 83 SOUTH
MINOT, ND 58701
gary.willoughby@ndsu.edu

ROBERT WILSON
UNIVERSITY OF NEBRASKA
4502 AVENUE I
SCOTTSBLUFF, NE 69361
rwilson1@unl.edu

ROBERT WOLF
KANSAS STATE UNIVERSITY
145 SEATON HALL
MANHATTAN, KS 66506-2917
REWOF@KSU.EDU

STEVEN WRIGHT
UNIV OF CALIFORNIA COOP EXT
4437 S LASPINA ST
TULARE, CA 93274-9597
sdwright@ucdavis.edu

JOE YENISH
WASHINGTON STATE UNIV
PO BOX 646420
PULLMAN, WA 99164
yenish@wsu.edu

STEVE YOUNG
WASHINGTON STATE UNIVERSITY
24106 N BUNN ROAD
PROSSER, WA 99350
steve_young@wsu.edu

RICK ZOLLINGER
NORTH DAKOTA STATE UNIV
NDSU 7670
FARGO, ND 58108-6050
r.zollinger@ndsu.edu

AUTHOR INDEX

Abit, M.J. 71
Adrian, G. 49
Alba-Lynn, C. 93
Al-Khatib, K. 65,93,71,99
Almquist, T. 45
Alms, J. 5,20,24,25
Anderson, M. 15
Ansolabehere, MJ 72
Armstrong, J.Q. 82
Arnold, R.N. 79,82
Ashigh, J. 90
Avila, W.V. 63
Baker, J.L. 88
Baldos, O.C. 58,59
Ball, D. 13,23,91
Banuelos, G. 6,77
Barney, J.N. 54
Bauman, T. 18
Baumann, P.A. 48,66,55
Baumgartner, R. 27
Beck, K.G. 8,42,45,52
Becker, R.L. 48
Beckie, H.J. 33
Bell, J. 3,39,91
Belles, D.S. 98
Bennett, L. 16,23
Beutler, B. R. 20,59
Bisabri, B. 58
Blackshaw, R.G. 36,69,73,74
Blecker, L. 88
Bloomberg, J. 79
Bolton, C. 12
Booth, D.T. 53
Bosley, B. 36
Boydston, R.A. 15
Boyles, M.C. 82
Brewster, B. 70
Brock, J.H. 43
Brunk, G.R. 17
Bukun, B. 90
Burch, P.L. 45
Burke, I. 3,23,27,39,91,72
Bushong, J.A. 82
Butler, M.D. 2
Cabrera, A. 13
Campbell, J. 62
Cantlon, J.D. 5
Capps, S. 13
Carruth, D.J. 75
Casini, M. 90
Charvat, L.D. 7,7,31
Christensen, R. 20
Christensen, S.D. 37
Christoffers, M.J. 96
Chung, W. 2
Claus, J.S. 41,41
Clay, P. 74,83,106
Claypool, D. 21,25,27,28
Clewis, S. 626
Cole, R.M. 99
Cook, S. 2
Copeland, H. 53
Cox, S. 53
Creech, J.E. 88
Cummings, D. 8,24,43,45,84
Curtis, D. 70
Dahl, G. 75
Dale, T.M. 74,83
Daniel, J.T. 5
Datta, A. 7,7
Davis, E.S. 26,83
DeFrank, J. 58,59
Deneke, D. 5,24,25
Devine, W.D. 44
Dille, J.A. 35,95
DiTomaso, J.M. 4,50,54
Dixon, P. 35,67,68
Doohan, D. 60
Douglass, C. 42
Duncan, C.A. 45,51,51
Edvarchuk, K.A. 9,37
Edwards, R. 52
Effertz, C. 78
Ekken, M.R. 18
Ellis, J.M. 24,84
Endres, G. 80
Farr, J. 20,59
Fay, D. 106

Felix, J. 34,60
Fennimore, S. 94
Finn, G.A. 24,84
Fiore, C. 38
Fisher, M.L. 45,58
Forster, P.C. 62
Franzen, D.W. 80
Frost, S.M. 31
Gast, R.E. 24,26
Gednalske, J. 75
Geier, P.W. 24,31,71
Gerik, J.S. 13
Gersdorf, S.A. 15
Getsinger, K. 86
Giacamini, D. 93
Gill, K.S. 39
Godar, A.S. 32,99
Goeman, B. 8
Golus, J.A. 71
Gonsalves, D. 40
Gray, C.J. 49
Greco, A. 11
Green, J. 92
Haikal, P. 78
Halstvedt, M.B. 43,44,45,45,51
Hanson, B.D. 6,13
Harbour, J.D. 61,61
Harrington, T.B. 10,44,47
Heldreth, K. 90
Heerema, R. 90
Helm, A. 36
Hembree, K.J. 6,77
Henningsen, J.D. 33,34
Henry, J.M. 11
Hergert, H.J. 22
Hicks, C.P. 79,81,84
Hidalgo, E. 41
Higgins, R.K. 22
Hinds-Cook, B. 70
Hipkins, P.L. 45
Hirsch, M. 1
Hoefing, J.L. 29,65
Holliday, M.J. 41
Holm, F.A. 33,73
Holman, J.D. 71
Howatt, K.A. 24
Howlett, L.A. 76
Hudec, G.W. 81
Hufbauer, R.A. 93
Hulting, A. 70
Hutchinson, P. 20
Hybner, R. 50
Ishida, J. 60
Jacobs, J. 50,51
Janak, T.W. 48,66,55
Jenks, B.M. 4,29,65
Johnson, B. 18
Johnson, E.N. 33,73,74
Johnson, K.D. 61,61
Johnson, K.K. 88
Johnson, M.D. 97
Johnson, W.G. 67
Jordan, D.L. 35,67,68
Kazmierczak, A. 17
Kenny, D. 86
Khosla, R. 36
Killen, M.J. 31
King, S. 26,80,84
Klein, R.N. 85,71
Kline, W.N. 45
Knezevic, S.Z. 7,7
Kniss, A.R. 21,22,25,27,28,38,72,89
Krick, N. 52
Kunkel, T. 17
Kyser, G.B. 4,50,54
Langston, V.B. 8
Lanini, W.T. 13
Lass, L. 2
Lawrence, N.C. 38
LeStrange, M. 94,94
Libbey, C.R. 14,48
Lindenmayer, RB...............................17,90
Lombard, K. 72
Lucero, F. 48
Luciano, R. 24,76
Lukas, S. 59
Lym, R.G. 18,41,45,53,62
Lyon, D.J. 22,22,89
Mager, H. 56
Mallory-Smith, CA 63,70
Madani, H. 10
Mangold, J.M. 51,51

Mann, J. 54
Mann, R.K. 58
Marling, K.J. 2
Martin, K. 87
Maruska, D.W. 80,84
Masters, L. 19
Masters, R.A. 8
Matthews, J.L. 67
Matocha, M.E. 48,66,55
McCloskey, WB...................................19,30
McDaniel, K.C. 1
McDonald, S.K. 89
McGaughey, B. 106
McKinley, N.D. 61,61
Meadows, D.J. 64
Mealor, B.A. 53
Meredith, J.H. 41
Mesbah, A.O. 31,69
Mikkelson, J.R. 62
Miles, C 12
Miller, T.W. 12,14,48
Moechnig, M. 5,20,24,25,31
Mohseni-Moghadam, M. 90
Monaco, T.A. 1
Morishita, D.W. 33,34
Moulton, G. 12
Mueller, J.P. 58
Murray, L. 38
Myers, D.F. 57
Nachtman, J.J. 25
Neff, M. 91
Netherland, M.D. 49
Newberry, G. 17
Nice, G.R.W. 18
Nissen, S. 42,89,90
Norton, E. 19
O'Neill, M.K. 79,82
Odero, D.C. 28
Odle, B. 83
Oemichen, B. 26
Olmstead, B. 49
Olsen, H.C. 57
Olson, B. 87
Omondi, E. 72
Oneto, S.R. 50
Ostlie, M.H. 64
Owen, M.D.K. 35,67,68
Paulsgrove, M. 80,81,84
Pawlak, J. 14,74,83
Peachey, E. 11,92,60
Pederson, J.D. 80
Peeper, T.F. 24,82
Peter, D.H. 44,47
Peterson, D.E. 87
Peterson, V.F. 6,43,45,51
Philbook, B.D. 79
Pittman, D. 23
Pitts, J.R. 41
Porter, D.J. 62
Postman, B. 36
Prather, T. 2,3,46
Preston, C. 98
Price, W. 2
Radosevich, S. 2
Ramirez, H. 6
Ransom, C. 9,37
Rapp, R. 7,7
Rauch, T. 23,91
Refsell, D. 83
Riar, D.S. 16,39
Rice, P.M. 45,51
Richards, R. 44
Richardson, J. 40,58,103
Ries, J. 17
Roncoroni, J.A. 13
Rood, R. 23,28
Roozen, J. 12
Ruden, B.E. 80,84
Rupp, R.N. 64
Sakamoto, G. 58,59
Samuel, L. 45
Sanders, B.H. 82
Sapsford, K.L. 33,73
Saunders, D.W. 61,61,64
Sbatella, G.M. 54,67,68,72,100
Schilling, B. 78
Schirmacher, K. 62
Schlegel, A.J. 71
Schmidt, N. 38
Schmierer, J. 37
Schraer, S.M. 62
Schroeder, J. 38,86,90

Schumacher, W. 64
Schwarzlose, G. 81
Scocas, J. 90
Scott, J. 7,7
Sebastian, J.R. 8,42,52
Setter, C. 18,53
Shafii, B. 2
Shaner, D. 16,36,39,64,90,93
Shatley, D.G. 58
Shaw, D.R. 35,67,68
Shaw, S. 48
Shoup, D.E. 24,87
Shouse, D.L. 33,34
Shrestha, A. 6,77
Simkins, G.S. 80
Slade, J.G. 49
Sleugh, B.B. 43,45
Smeal, D. 82
Smeda, R.J. 45
Smitchger, J. 27,72
Smith, C. 40
Smith, M.C. 80
Smith, R.F. 90,94
Sorribas, M.M. 45,58
Spak, D.R. 57
Spandl, E. 75
Stahlman, P.W. 31,32,71,93,99
Staska, K. 78
Stopps, G. 10
Strachan, S.D. 90
Stromberger, M. 36
Taylor, E.L. 30
Thill, D.C. 23,62,91,97
Thompson, C.R. 87,71,95
Thorsness, K.B. 80,84
Torell, L.A. 1
Tourte, L. 94
Tuinstra, M. 65
Turner, R.G. 2,41,41
Umeda, K. 55
Unland, D. 15,15,56,56
Unverzagt, J. 21
Upadhyaya, M. 10
Van Wychen, L. 40,86
Vassios, J. 42,89
Venn, T. 2
Violett, R.D. 69
Vos, D.A. 5,20,24,25
Waldron, B.L. 96
Wallace, J.M. 45
Ward, S.M. 93,98
Watteyne, K.K. 81
Weimer, M. 24
Welch, L. 24,74,83
Weller, S.C. 35,67,68
Westra, E.P. 16,16,17,39,24
Westra, P. 31,39,64,90,93,98
Whitson, T.D. 44
Wilbur, H.D. 93
Wilen, C.A. 11
Williams, C.S. 41
Willoughby, G. 29
Wilson, R.G. ...31,35,43,67,68,93,54,72,100
Wolf, R.E. 76
Wright, S.D. 6,77
Wrucke, M. 80
Yenish, J.P. 16,23,27,28,39,91,72
Young, B.G. 35,67,68
Young, S.L. 54
Zawierucha, J. 7,7
Zollinger, R. 17,86,75

INDEX

Keyword	Page
2,4-D	76,82
2,4-DB	9,30
acetochlor	79
adjuvants	55, 75
AHAS inhibitors	30
alfalfa	14,19,62,72
almond	14,58,77
ALS inhibitors	30
ALS in-vivo assay	64
amaranth	76
amaranth, Palmer	87
Amaranthus retroflexis	15
Amaranthus retroflexus L.	73
aminocyclopyrachlor methyl ester	90
aminocyclopyrachlor	90
aminopyralid	9,44,45,62,90
Aphthona lacertosa	53
Aphthona nigriscutis	53
application timing	28
archangel, yellow	48
asparagus	14
Astragalus filipes	9
atrazine	24,36,79,93
Avena fatua	78
azoxystrobin	33
barley	69
barnyardgrass	33,34,65
beet, Roundup Ready sugar	34
beet, sugar	33,34
bermudagrass tolerance	48
bermudagrass	48,55
bermudagrass, Coastal	48
bermudagrass, Jiggs	48
bermudagrass, Tifton 85	48
Between	17
bindweed, field	77
bioassay	90
biofuel	18
biological control	53
biological control	92
blueberry	14
bluegrass, Kentucky	44
bluegrass, Sandberg's	1
bottlebrush, squirreltail	1
brome grass, Smooth	18
brome	84
brome, downy	1,2,14,24,26,52,83
bromoxynil	83
bromoxynil/MCPA	23
buckwheat	76
buckwheat, tame	17
buckwheat, wild	74
carfentrazone	15
celery	94
chickpea	28,65
chlorpyrifos	33
chlorsulfuron	93
Cicer arientum L.	73
Classic	66
Clearfield	89
clethodim	17
clopyralid	9,30
common groundsel	14,72
competition	10
corn	17,36,62,66,79,80
cotton	77
cover crops	12
crop injury	31
crop safety	84
crop tolerance	74
cropping systems	54,93
CRP	62
cucumber	14,60
cucurbits	60
cultivar	65
cultivation	94
cupgrass, southwestern	55
cycloate	34
cyprosulfamide	79
Dalea ornata	9
Dalea searlsiae	9
Dallisgrass	55
dandelion	44
darnel, Persian	84

deposition....76
Destiny HC....17
dicamba....30,55,90,93
dichondra....55
dimethenamid....34,79,94
Diplomat....17
disturbance....1,54
ditchbanks....77
dithiopyr....58
dominance....44
dose response....24
drift....76
droplet size....76
DropletScan....76
early detection....37,88
early detection/rapid response....88
economics....34
endothall....49
enhanced degradation....36
EPTC....19,34
esfenvalerate....33
ethanol....18
ethofumesate....33,34
Exchange....17
Express....66
fenoxaprop....55
fertilizer placement....69
fertilizer timing....69
fescue, tall....70
fiddleneck, coast....58
filaree redstem....36,69,74
fire break....8
flame....14
flax....17
flazasulfuron....55
fleabane....6,58,77
flixweed....83
flucarbazone-sodium....24,78
flumioxazin....14,24,28,30,65,72,83,94
fluroxypyr....30,93
fomesafen....60
forage grass....48
foramsulfuron....55
forb tolerance....45
formulation....55
foxtail, green....33,34,69
fumitory....83
gap measurement....11
geographic information system....37
geographic positioning system....37
GIS....37,88
glufosinate and glyphosate....6,77
glufosinate....14
glyphosate resistance....32
glyphosate....8,14,17,19,32,32,33,34,36,48,
....74,75, 79,80,83,87,93
glyphosate-resistant crops....36
glyphosate-resistant kochia....32
GPS....37
gain sorghum....65
granivory....92
grapes....12
grasses grown for seed....70
ground cover....48
group 2 resistance....62
guayule....30
Harmony....66
Hawaii....58
herbicide efficacy....74
herbicide resistance management....62,65,93
herbicide tolerance....9
herbicide-resistant crops....36
hevea rubber....30
highway right of way....59
horseweed....6,14,58,77
horseweed, sprawling....55
HSOC....17
hydro mulching....59
Imazamox....8,64,89
imazapic....1,8,9
imazethapyr....28
indaziflam....15
In-row cultivation....94
Insect herbivory....93
Invasive species....54
Invasive Weed....45
invasive....44
inventory....37
iodosulfuron....55
irrigation canal....49

irrigation weed control 49
isoxadifen-ethyl 79
isoxaflutole 79
Japanese brome 84
Johnsongrass 6,66
Journey, imazaic + glyphosate 2
kidney bean 90
KJM44 6
kochia 14,32,33,34,36,73,74,83,93
lambsquarters 33,34,36,79,83,94
Landmark, sulfometuron + chlorsulfuron 2
lentil 74
lettuce 94
lettuce, prickly 14,28,62
London rocket 58
machine-vision 94
mallow, round-leaved 36,69,74
mapping 37,88
Matrix, rimsulfuron 2
mayweed, chamomile 28
MCPA 89
meadow communities 44
medusahead, Taeniatherum caput-medusae. 2
Mentha piperita 15
Mentha spicata 15
mesosulfuron 23,26
mesosulfuron-methyl 84
mesotrione 66,70,79
methomyl 33
metribuzin 28
metsulfuron 10,48
milkvetch, Basalt 9
millet, foxtail 31
millet, wild proso 11,92
mint 14,15
morningglory, tall 77
mowing 52
MSMA 55
mullein,c 93
mustard, tansy 83
mustard, tumble 82,83
mustard, wild 69,74
native forbs 9
native grasses 9
native Hawaiian Plants 59
native plants 9
native range 45
native seed production 9
Natural systems 54
Nevada 88
nicosulfuron 48,65
nightshade, black 79
nightshade, hairy 34,60,94
nitrogen fertilizer 69
nitrogen 80
noncrop 6
Non-native species 44,93
nozzles 75
nutsedge, purple 19,77
oat, wild 17,69,84
Optimum GAT 66
Orchard floor management 58
organic 12
ornamental 48
oxadiazon 59
oxamyl 33
oxeye daisy 44
oxyfluorfen 30,58,70,94
Palmer amaranth 58,66,81
paraquat 14,76
Parthenium argentatum 30
Pea, Dry 65
pea, field 74
pea, green 14
Pecan 58
pendimethalin H20 82
pendimethalin 15,48,94
penoxsulam 58
pepper 94
peppermint 15
peppers, bell 94
percent ground cover 19
pesticide labeling 76
phosphorus fertilizer 69
picloram 62
pigweed, Redroot 15,33,34,36,74,79,92,94
pistacios 77
plant back 62
Plateau 52
Plateau, imazapic 2

Polygonum convolvulus L. 73
potato 14
PPO inhibitor 60
prairie clover, searls' 9
prairie 45
pre plant burndown 83
Preemergence 28,94
prescribed fire 8
preseed weed control 74
prevention practices 37
propoxycarbazone 26
propoxycarbazone-sodium 84
prostrate pigweed 79
prothioconazole 33
protoporphyrinogen oxidase 30
protox inhibitors 30
Pterostichus melanarius 11
pyraflufen 14
pyrasulfotole + bromoynil 70
pyrasulfotole 81,82,83
pyroxsulam 26,82
quackgrass 18
quinclorac 55
quinoa 17
rangeland restoration 2
rangeland seeding 1
rangeland 2
rapid response 88
residual control 74
residual weed control 83
Residual 15,78
resistance management 34
resistance 81,87
Resolve 66
restoration 9
rimsulfuron 6,8
riparian 117-c
roadside right of way 58
Rye, Feral 8,64,89
saflufenacil 15,31,73,74,79
sagebrush, big 1
sago pondweed 49
salinity 1
sandbur, field 48
Scotch broom 10
sharppoint fluvellin 70
shepherd's-purse 58
shrub tolerance 45
Sinapis arvensis L. 73
slender aster 55
s-metolachlor 34,79,94
soil drought 10
soil residue 62
soil texture 1
soils 17
sorghum 66
sorghum, grain 81
sowthistle, annual 62
sowthistle, spiny 28
soybean 62,90
spatial distribution 36
spearmint 15
sprangletop 6
sprangletop 77
spray coverage 76
spray drift 75
spray droplets 75
spray quality 76
spray volume 74,78
spurge, Leafy 53
squash, winter 60
stale seedbed 14
sulfentrazone 15,28,65,73
sulfometuron 9,10,18,26,55
Superb HC 17
switchgrass 18
synergism 89
tebuthiuron 8
tembotrione 79
Texas panicum 66
thiencarbazone methyl 55,79
thistle, Canada 44
thistle, Russian 14,79
Thlapsi arvense L. 73
timing 26
TNV 15
tolerance 65
tomato 94
Touchdown 66
translocation 64

tree nuts..58
triallate 17
tribenuron..70
triclopyr...................................5,43,44,48,50
trifluralin 58
Triticum aestivum......................................78
tumbleweed..93
turf..11,55
turfgrass...55
various...93
virginicus, Sporobolus 58,59
volatility 90
walnut...58
water sensitve paper...................................76
waterhemp, common..................................81
waterhemp, Tall 81
weed community.......................................36
weed competition.......................................69
weed control....................................14,19,55
weed diversity 36
weed prevention...37
weed seedbank 36,69
Western prairie clover..................................9
wheat...17,69,84
wheat, durum...84
wheat, winter.....................23,26,82,83,84,89
wheatgrass, crested 1
white clover..44
whole plant essay 24
wildfire...1,8
woody debris..10
zucchini 60

2010-2011 Western Society of Weed Science Standing and Ad Hoc Committees *(Board Contact)*

Awards *(President)*
Nelroy Jackson, Chair (2012)
Frank Young (2011)
Jill Schroeder (2013)

Fellows and Honorary Members *(Past President)*
Don Morishita, Chair (2012)
Bill Cobb (2011)
Celestine Duncan (2013)

Finance *(Member-at-Large Public)*
Drew Lyon, Chair (2012)
Leo Charvat (2011)
Luke Samuels (2013)

Herbicide Resistant Plants *(Member-at Large Private)*
Joel Felix, Chair (2011)
Ian Burke (2011)
Melissa Bridges (2012)
Andrew Kniss (2012)

Legislative *(WSSA Representative)*
Lisa Boggs, Chair (2012)
Pam Hutchinson (2011)
John Brock (2013)
Lee Van Wychen, *Ex-officio*

Local Arrangements *(President-Elect)*
Chuck Rice, Chair (2012)
Phil Motooka, (2011)
Tina Mudd, (2013)

Program *(President-Elect)*
Vanelle Peterson, Chair (2011)
Brad Hanson (2011)
Marvin Butler (2011)

Nominations *(Past President)*
Ralph Whitesides, Chair (2012)
Don Morishita (2011)
Dan Ball, (2013)
Jesse Richardson, *Past-President*

Poster *(President-Elect)*
Robert Finley, Chair (2012)
Carl Libbey (2011)
Roger Gast (2013)

Sustaining Membership *(Past President)*
Seth Gesdorf, Chair (2012)
Jeff Koscelny (2011)
Curtis Rainbolt (2013)

Public Relations *(Education and Reg. Section Chair)*
Erin Taylor, Chair
Brad Hanson
Brian Olson
Mark Ferrell
Bill Cobb
Rick Affeldt
Deb Shatley

Publications *(President-Elect)*
Vanelle Peterson, Chair
Joan Campbell, Proceedings
Traci Rauch, Research Prog. Report
Cheryl Fiore, Newsletter
Tony White, Web Site

Site Selection *(President)*
Steve Orloff, Chair (2012)
Steve Wright (2011)
John Fenderson (2013)

Necrology *(Secretary)*
Jim Vandecoevering, Chair (2012)
Corey Ransom (2011)
John Roncoroni (2013)

Student Paper Judging *(President-Elect)*
Roland Schirman, Chair (2012)
Andy Hulting (2011)
Jamshid Ashigh (2013)

Education-Distance *(Education and Reg. Section Chair)*
Kassim Al-Khatib, Chair
Carol Mallory-Smith
Scott Nissen
Bill Dyer
Tracy Sterling

Noxious Weed Shortcourse
Joe DiTomaso
Vanelle Peterson