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2011

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PREFACE

The Proceedings contain the written abstracts of the papers and posters presented at the 2011 Western Society of Weed Science Annual Meeting plus summaries of the research discussion sections for each Project. The number located in parenthesizes the end of each abstract title corresponds to the paper/poster number in the WSWS Meeting Program. Authors and keywords are indexed separately. Index entries are published as received from the authors with minor formatting editing.

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The Minutes of the Board of Directors meetings and the Business Meeting are available at the WSWS website.

Proceedings Editor: Bill McCloskey, University of Arizona

POSTER SESSION

Project 1. Weeds of Range and Natural Areas

WEED CONTROL IN SWITCHGRASS (*PANICUM VIRGATUM* L.) USED FOR BIOFUEL PRODUCTION. Cassandra Setter*, Rodney G. Lym; North Dakota State University, Fargo, ND (001)

Switchgrass (*Panicum virgatum* L.), a perennial native grass, may be 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 stand at the Central Grassland Research Extension Station near Streeter, ND. Herbicides were applied at common and maximum use rates either on May 21 or June 25 in 2009, and grasses were harvested in August 2009 and 2010. In 2009, quackgrass was reduced more than 90% by propoxycarbazone, sulfometuron, and sulfosulfuron when applied in May. Smooth brome was reduced 100% with aminocyclopyrachlor, pyroxsulam, or sulfosulfuron. However, switchgrass yields were similar to the control regardless of treatment. Treatments applied in June were not effective. One year after treatment with aminocyclopyrachlor and sulfometuron, switchgrass production increased by 2X to 3X, respectively, but smooth brome and quackgrass also rapidly reestablished. Despite increased switchgrass yield, no herbicide provided satisfactory long-term weed control.

DISTRIBUTION AND FREQUENCY OF WEEDS ALONG ROADS AND TRAILS IN NORTHERN UTAH FORESTS. Heather Elwood*[1], Corey V. Ransom1, Kimberly Edvarchuk[1], Michael Duncan[2]; [1]Utah State University, Logan, UT, [2]USDA-Forest Service, Ogden, UT (002)

Early detection and rapid response (EDRR) to new species, as well as containment and/or reduction of established species are critical for effective weed management. In an effort to monitor and inventory weed species, the Wasatch-Cache National Forest (WCNF) in cooperation with Utah State University (USU) conducted weed mapping from 2006 to 2010 on key portions of Forest System lands in northern Utah. Mapped areas included select trails and roads as well as fires in the Logan, Ogden, Salt Lake, Spanish Fork, Pleasant Grove, Heber-Kamas, and Evanston-Mountain View Districts. From 2006 to 2010 over 74,000 acres of land were mapped. Of these mapped acres, 8,749 were infested with one or more species. Targeted species included state and county noxious weeds, known invasive weeds, and selected potential invaders. All weed infestation data were recorded as polygons on Juniper System’s Archer GPS units with a minimum detection target size of 0.001 acres. The most abundant species mapped, in terms of total number and size of infestations, are houndstongue, Canada thistle, lesser burdock, dyers woad, musk thistle, and dalmatian toadflax. However, it is important to note that these species were not all uniformly distributed across districts. Mapping was also vital in identifying new invaders such as Russian and spotted knapweed, tree of heaven, perennial pepperweed, oxeye daisy and scentless chamomile on high value recreation areas. Knowing the location and distribution of weed species enables land managers to efficiently allocate time and funds in creating and implementing an effective weed management plan.

A RE-INVENTORY OF INVASIVE PLANTS IN DINOSAUR NATIONAL MONUMENT TO ASSESS EFFECTIVENESS OF WEED MANAGEMENT EFFORTS. Katie Stoker*, Corey V. Ransom, Kimberly Edvarchuk; Utah State University, Logan, UT (003)

In the summer of 2002 an initial inventory of noxious and invasive weeds was conducted in Dinosaur National Park. Weed mapping crews used GPS units to record the species, location, area, and density of infestations. Priority was given to areas that were known to have been previously inhabited, historical sites, and disturbed areas. Approximately 3,200 acres in two different areas of the park were inventoried and of those acres 15 percent of the land was infested with invasive weeds. Almost 100 acres were treated from 2006-2010 with aminopyralid at 1.5 oz ai/A for Russian knapweed and Canada thistle. In 2007 and 2008 goats were used to graze infestations followed by aminopyralid treatment. Treatments focused on containment of infested areas and shrinking infestation perimeters. Russian olive and saltcedar were treated by cut stump applications of triclopyr. In 2010 weed mapping crews re-mapped the areas mapped in 2002 to determine management success. Data showed a decrease of Russian knapweed in treated areas by 79 percent from 2002 to 2010. Saltcedar also decreased by 74 percent, Canada thistle by 55 percent, and Russian olive by 89 percent. Other non-target invasive species also decreased in treated area. The untreated area of the park showed an increase in population and/or canopy cover in Russian knapweed and saltcedar as well as an increase in other non-target invasive species. Overall, the areas that were treated showed a 76 percent decrease in infestation from 2002 to 2010.

INVASIVE PLANT SPECIES MANAGEMENT WITH GEOSPATIAL TECHNOLOGIES AND COMPUTATIONAL SCIENCE. Stephen L. Young*[1], Qingfeng (Gene) Guan[2], Sunil Narumalani[3]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]Univeristy of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Lincoln, NE (004)

The occurrence of invasive plant species (IPS) are a threat to important ecosystem functions, such as hydrological cycles, disturbance patterns and sustainability. The management of invaded areas requires an objective-based approach that combines integrated techniques with technology for geospatial analysis. A field study with computer-based applications will be conducted at the University of Nebraska-Lincoln and the West Central Research and Extension Center to develop a rapid and robust method for identifying and mapping invasive plant species that have received management treatments and modeling the resulting spatio-temporal dynamics. Further, models will be used to develop a web-based intelligent decision support system (DSS) for addressing current and devising new invasive species management strategies. Finally, a web-based educational tool will be developed to provide interactive educational materials for clientele involved in invasive plant species management (e.g, students, stakeholders, researchers). The field portion of the study will take place in west central Nebraska along the North Platte River targeting the invasive plant species, common reed (Phragmites australis (Cav.) Trin. Ex Steud.).

Management treatments, including spraying, burning, mowing and cultivation will be applied during the 2-year project. Field data will be collected on site attributes, including soil type, slope, existing vegetation and distance from the river. For the computer-based portion, analyses of digital images taken previously will be analyzed in year 1 to identify common reed and calibrate equipment for analyzing the effects from field treatments at the end of years 1 and 2. Predictive models will be generated at the end of year 2 to simulate management scenarios that incorporate the use of treatments administered singly and in combination. Educational tools will be developed simultaneously with existing and new data from the project and used in courses taught at UNL.

NATIVE SPECIES ESTABLISHMENT ON RUSSIAN KNAPWEED INFESTED RANGELAND FOLLOWING PRE-PLANT HERBICIDES APPLICATIONS. James R. Sebastian*[1], K. George Beck[2], Scott Nissen[3], Derek Sebastian[4], Sam Rodgers[5]; [1]CSU, Loveland, CO, [2]Colorado State University, Ft. Collins, CO, [3]Colorado State University, Fort Collins, CO, [4]Creighton University, Omaha, CO, [5]University of Colorado, Boulder, CO (005)

Russian knapweed (*Acroptilon repens,* ACRRE) is a long-lived, creeping perennial weed that reproduces primarily from adventitious root buds. ACRRE rapidly colonizes and forms dense monocultures on pasture, rangelands, roadsides, and disturbed areas. ACRRE is highly competitive due to its vigorous creeping root system, dense canopy, and allelopathic properties. Currently, the best management strategy for long term ACRRE control includes the combination of mechanical, cultural, and chemical control. Single control strategies such as mowing, re-vegetation, or herbicides applied alone are usually insufficient. Rangeland that is dominated by ACRRE is often devoid of desirable plants. Herbicides may be only a temporary fix to prevent ACRRE re-invasion if there are no competitive plants to occupy bare ground once occupied by ACRRE. This study was designed to investigate re-establishment and competitiveness of native grass, shrub, and forb species and their response to herbicides. The allelopathic affects ACRRE has on seedling establishment was also investigated. Aminocyclopyrachlor (MAT at 0.5, 1, or 2 oz ai/A) and aminopyralid (1.8 oz ai/A) treatments were sprayed on May 14, 2009 and seeded on April 2010 to provide 12 months of herbicide decomposition before native seedling emergence. Metsulfuron was added to herbicide treatments to control hoary cress (*Cardaria draba*; CARDR). Handpull plots were sprayed twice in 2009 with glyphosate to decrease the number of handpulling events. These plots were handpulled three times during the 2010 growing season. Forb and shrub species were drilled in separate blocks from grass to ease in plot maintenance. The study was a split-split plot design with 4 replications. Native forb and shrub density, establishment rate, richness, and grass biomass tended to increase with the increase in ACRRE control. Forb and shrub density counts was conducted in two drill rows that were 10 feet long in August 2010 and data were converted to plants/m^2. ACRRE control increased with increasing MAT rates. Establishment ratings derived from density counts were used to evaluate success or failure of drilled species (0% establishment or 0 plants/m^2 = failure; 100% or >11 plants/m^2 = excellent establishment). With the exception of yarrow (*Achillea millefolium*) and gayfeather (*Liatris Punctata*), all forbs and shrubs in checks failed to establish (0% and 0 plants/m^2). Virtually no native forbs or shrubs established in untreated check plots. This illustrates how highly competitive ACRRE is with seedling plant establishment and the negative effects ACRRE allelopathy may have on germination of other plant species. MAT (2 oz ai/A) treatments had fair to excellent forb and shrub establishment (50 to 100%, 2 to >11 plants/m^2). Species richness (number of species present per unit area) increased with increasing ACRRE control. There were

10 forbs, 4 shrubs and 2 grass species that were seeded (16 species total). Total species richness in checks was three of which two were grass species. In contrast, species richness with aminopyralid or MAT (2 oz ai/A) was 11 or 15 species, respectively. MAT (2 oz ai/A) provided excellent establishment for 5 of the 10 forb, 2 of 4 shrub, and both grass species. Slender wheatgrass (*Elymus trachycaulus*, ELYTR) and Western wheatgrass (*Pascopyrum smithii*, PASSM) density and frequency counts were determined along 1 meter long quadrats when grass seedlings first emerged in May 2010. Grass biomass was harvested in August 2010. Forbs were not harvested in 2010 to prevent injury and disruption of flower and seed production. There were no differences between grass densities in sprayed vs. check plots when seedlings first emerged in May 2010; however, grass was almost non-existent in check plots by the August 2010 harvest. Grass biomass in checks was 0 to 27 lb/A and 565 to 3,329 lb/A in herbicide treatment plots in August 2010. ACRRE biomass and control was consistently higher in PASSM plots verses similar ELYTR treated plots. This resulted in slightly higher ELYTR biomass and establishment than PASSM from similar treatments. ACRRE control in forb plots tended to be lower than in similar treated grass plots. ELYTR and PASSM biomass increased with increasing MAT rates and the subsequent increase in ACRRE control. Forbs, shrubs, and both grass species established well where ACRRE was controlled and failed where ACRRE was not controlled. Although handpull plots were kept relatively weed free during the 2010 growing season there was significantly less grass biomass than all but MAT at 0.5 oz ai/A. This treatment had poor ACRRE control (26 to 37%). This was evident in a similar study conducted by CSU where grass established poorly where ACRRE roots were not controlled in handpulled plots. This study has also shown that tillage or intense cultivating likely *is not* necessary to establish drilled forb, shrub, and grass in previous dense stands of ACRRE. This particular study site had sandy loam soils. Seedling establishment may be more difficult in heavy soils with dry climate where herbicides and ACRRE allelochemicals potentially break down slower. Cultivation and delayed planting dates may be necessary at these sites. Evaluations in this study will continue in 2011.

THE CHALLENGES OF PREDICTING LEAFY SPURGE DISPERSAL WITH PLANT COMMUNITY SUSCEPTIBILITY IN AREAS OF HIGH HUMAN ACTIVITY. Larry W. Lass*, Timothy Prather; University of Idaho, Moscow, ID (006)

Predicting the wildland's susceptibility to leafy spurge invasion is ground in ecological theory where plant occurrence is related to plant community productivity and climate factors. The idea for predicting landscape susceptibility to leafy spurge was first explored by Hamilton, Lachowski and Campbell in 2006 and later refined by E. Raymond Hunt, Jr. Their work used a Weed Invasion Susceptibility Prediction (WISP) developed by Gillham et al in 2004. These occurrence models indicate the extent of the expected invasion and in the case of leafy spurge may indicated 35 to 40% of a county is highly susceptible. Past experience shows the best site for leafy spurge growth may not be the site receiving the seed. Over 50% of known infestations in southeastern Idaho are within 500 m (1600 ft) of a highway or 100 m (320 ft) of a road (streets, local and farm roads). For streams and rivers 30% of the infestations known in southeastern Idaho are within 200 m (640 ft) of water. If the buffer area around the water feature is expanded to 500 m (1600 ft) then 43% of the infestation is found. Combining both roads and water with 200 m (640 ft) buffer yields 69% of the known leafy spurge infestations and 75% when combined feature includes a 500 m (1600 ft) water feature buffer. The high occurrence within a few meters of transportation routes and water suggest seed or roots transport is important for determining the occurrence of leafy spurge.

CONTROL OF LEAFY SPURGE WITH IMAZAPIC AND SAFLUFENACIL APPLIED IN SPRING. Stevan Knezevic[1], Avishek Datta[1], Ryan Rapp[1], Jon Scott[1], Brian Mealor[2], Rodney Lym[3], George Beck[4], Leo Charvat*[5], Joseph Zawierucha[6]; [1]University of Nebraska, Concord, NE, [2]University of Wyoming, Laramie, WY, [3]North Dakota State University, Fargo, ND, [4]Colorado State University, Ft. Collins, CO, [5]BASF Corporation, Lincoln, NE, [6]BASF Corporation, RTP, NC (007)

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. Previous studies conducted during springs of 2007 and 2008 in NE determined the best tank-mix ratio of the two herbicides for leafy spurge control at about 25 g/ha of saflufenacil and 105 g/ha of imazapic. Similar rates of the two herbicides were selected for a regional study across five locations, including NE (two locations), CO, ND, and WY in 2010. The treatments included two saflufenacil (25 and 50 g/ha) and two imazapic (70 and 105 g/ha) rates applied alone, or in combination with each other. Results of the regional study confirmed our previous results, indicating that saflufenacil rate of about 25 g/ha tank-mixed with either 70 or 105 g/ha of imazapic applied in spring provided 90% control of leafy spurge for at least 90 DAT. Additional efficacy evaluation is needed (e.g., 365 DAT) to confirm the long-term synergy.

TIMING OF LOW RATES OF GLYPHOSATE FOR CONTROL OF MEDUSAHEAD IN SAGEBRUSH SCRUB. Guy B. Kyser*[1], J. Earl Creech[2], Joseph M. DiTomaso[1]; [1]University of California, Davis, CA; [2]Utah State University, Logan, UT (008)

Although glyphosate is usually used nonselectively, some researchers report that low rates can be applied over the top of established perennial plants for control of seedling annuals in the understory. In 2008-2009 and 2009-2010 we evaluated the effects of low rates of glyphosate for medusahead (*Taeniatherum caput-medusae*) control and safety on sagebrush in two trials in northern California sagebrush scrub (12 km south of Alturas, Modoc County, 1410 m elevation). We applied a rate series of 0, 79, 158 … 709 g a.e. ha^{-1} glyphosate at three timings in each trial: mid-March (medusahead in early seedling stage), late April to early May (tillering), and late May to early June (boot to early head). Plots were 3 m by 9 m in randomized complete blocks with four replications for each rate and timing. In early July before medusahead senescence, we made estimates of vegetative cover for all dominant species in three 1-m^2 quadrats per plot, and took biomass samples in three 0.1-m^2 quadrats per plot. Medusahead cover declined with increasing rates of glyphosate, and the mid-season application was found to be most effective. In rate series regression models, we achieved 95% control of medusahead with 160 g a.e. ha^{-1} glyphosate in mid-season 2009, compared with 463 g a.e. ha^{-1} in early season and 203 g a.e. ha^{-1} in late season. In 2010, we achieved 95% control with 348 g a.e. ha^{-1} in mid-season, compared with >709 g a.e. ha^{-1} in early season. Medusahead seed production reflected changes in cover, although plants tended to compensate at low densities. We attribute reduced control early in the season, and poorer control in 2010 overall, to greater tolerance to glyphosate at lower temperatures. Sagebrush appeared tolerant to these treatments. With the right timing, overspraying with low

rates of glyphosate may be an effective and relatively inexpensive technique for controlling medusahead in sagebrush ecosystems.

EFFICACY OF IMAZAPIC AND GLYPHOSATE FOR PRE- AND POST-EMERGENCE CONTROL OF BUFFELGRASS. Travis M. Bean*, William B. McCloskey, Grant Casady; University of Arizona, Tucson, AZ (009)

Buffelgrass (*Pennisetum ciliare*) is a perennial African bunchgrass that aggressively outcompetes native Sonoran Desert species for water and nutrients and initiates a grass-fire cycle that results in ecosystem replacement. Various herbicides have been tested for efficacy on buffelgrass but only glyphosate has been able to kill mature plants in a single application. However, glyphosate has no soil activity and repeated treatments in successive years are required to reduce the buffelgrass soil seed bank and achieve lasting control. Our objectives are to determine if imazapic can reduce the need to repeat herbicide treatments by providing preemergence control of buffelgrass and if imazapic-glyphosate mixtures can improve the postemergence control of buffelgrass. We will use a full-factorial experimental design to evaluate mortality of buffelgrass plants sprayed with imazapic, glyphosate or combinations of the herbicides and to evaluate buffelgrass seedling densities following treatment.

IMAZAPIC: A PROCESS-BASED TOOL FOR POST-FIRE RESTORATION OF *BROMUS TECTORUM* INFESTED PLANT COMMUNITIES**.** Marques D. Munis*, Cynthia S. Brown, Roy Roath, Michael Coughenour, Mark Paschke; Colorado State University, Fort Collins, CO (010)

Bromus tectorum (cheatgrass) is one of the most widespread invasive species in the western United States. In sagebrush steppe rangeland it alters fire frequency, soil moisture, and nutrient dynamics, decreasing value of rangeland for wildlife and livestock and increasing costs associated with wildfire and habitat restoration. Research indicates cheatgrass invasion can alter ecosystem processes promoting a persistently infested, post invasion state. We ask whether an imazapic herbicide can be used to restore ecosystem processes and promote desirable plant communities resistant to reinvasion by cheatgrass. In July of 2008 research plots were established on eight burned and seven paired unburned sites in southeast Wyoming. Half of the sites burned within three years of plot establishment (NB) and half burned between three and twelve years of plot establishment (OB). Following baseline data collection, plots received either a treatment of 5oz/ac (148ml/0.4ha) imazapic or no treatment (controls). In 2009, plant functional group biomass was reassessed as was vegetation carbon and nitrogen content and soil nitrate and ammonium mineralization rates. Cheatgrass biomass was reduced by imazapic treatment in NB and OB treatment plots, but no reduction was observed in NB and OB control plots. Plant available ammonium was similar amongst treatments; while levels of plant available nitrate were elevated in imazapic treated burned and unburned plots of all ages. No reduction in cheatgrass biomass between NB and OB controls suggests limited recovery through natural processes. Although reduced cheatgrass biomass was achieved in treated plots, elevated available nitrate in these plots is cause for concern. If nitrate remains high beyond the time imazapic is active in the soil, it can become an ecological driver for reinvasion by cheatgrass. High levels of nitrate have been observed beneath cheatgrass communities relative to native communities and identified as a potential explanation for cheatgrass persistence. Mechanistically, annuals sacrifice environmental stress tolerance for fast growth through rapid nitrogen uptake. When resources are reduced the competitive advantage may shift toward perennial species. Further work will be conducted to determine whether perennials reduced nitrogen levels before the expected loss of imazapic activity.

FIVE YEARS ANNUAL GRASS EFFICACY EVALUATIONS USING RIMSULFURON AND SULFOMETURON-METHYL PLUS CHLORSULFURON IN THE INTERMOUNTAIN AREA. Jim T. Daniel*[1], K. George Beck[2], James R. Sebastian[3], John D. Cantlon[4], Ronnie G. Turner[5]; [1]Self, Keenesburg, CO, [2]Colorado State University, Ft. Collins, CO, [3]CSU, Loveland, CO, [4]DuPont Land management, Lakewood, CO, [5]DuPont Land Management, Lakewood, CO (011)

Annual grass control with rimsulfuron and sulfometuron methyl premixed with chlorsulfuron in established perennial grasses was evaluated in 16 trials conducted across Colorado and Wyoming. Most of the evaluations were on downy brome (Bromus tectorum L.). Control of feral rye (Secale cereale L.) and annual wheatgrass (Eremopyrum triticeum (Gaertn) Nevski) was also evaluated. All trials were applied with a standard small plot sprayer equipped with flat fan tips. Seven of the evaluations were replicated, randomized complete block trials and nine were nonreplicated demonstration trials containing three treatments and located across both states. Both rimsulfuron (formulated as MATRIX®) and sulfometuron methyl premixed with chlorsulfuron (formulated as LANDMARK®) provided excellent control of downy brome across all trials. In these trials, both fall and spring applications were effective in controlling downy brome. Both products were also effective in controlling annual wheatgrass. Rimsulfuron gave good initial control of feral rye when applied either late summer or early spring. Feral rye evaluations dropped to the mid 70% range of control by late July. Late spring applications were not effective for feral rye control. Perennial grasses in general were not harmed in most trials. There was some stunting especially from higher rates but the perennial grasses did recover from the stunting usually by the end of the growing season.

EFFECTS OF NATIVE COVER CROP, INTRODUCED WEEVIL HERBIVORY, AND SOIL NUTRIENTS ON CANADA THISTLE (*CIRSIUM ARVENSE* L.). Erin E. Burns*, Greta Gramig, Deirdre A. Prischmann-Voldseth; North Dakota State University, Fargo, ND (012)

Our objective was to determine the effects of integrating Hadroplontus litura Fabricius (a stem-mining weevil) and a native cover crop (Helianthus annuus L., common sunflower) on Canada thistle (Cirsium arvense L.) height, basal stem diameter, flower number, leaf number, and final biomass (root and shoot). Previous research has shown that H. litura provides poor to moderate control when used alone; however, integrating additional tactics may enhance its efficacy. During 2010, outdoor microcosms (19-L containers of field soil) were established with factorial combinations of weevil and cover presence/absence and high vs. low soil nutrient levels. Plant characteristics were measured weekly and final shoot and root biomass was harvested. From 7/7 to 8/4 weevil absence was associated with greater thistle height. From 7/15 to 9/8, cover absence was associated with greater thistle height. From 6/24 to 8/4, increased soil nutrients were associated with increased stem diameter. From 7/7 to 9/8, cover absence was associated with greater stem diameter. From 7/15 to 9/8, cover absence, weevil absence, and increased soil nutrients were associated with greater leaf number. From 8/4 to 9/8 weevil absence (except 8/19) and cover absence was associated with greater flower number. From 7/29 to 9/8, cover absence was associated with increased shoot production. From 8/13 to 9/8, high soil nutrients were associated with increased shoot production only in weevil absence. Cover presence reduced both final root and shoot biomass. Increased soil nutrients increased final shoot, but not root, biomass. Results suggest transient weevil effects but more persistent plant competition effects.

CONTROL OF TALL LARKSPUR (*DELPHINIUM OCCIDENTALE*) WITH AMINOCYCLOPYRACHLOR. Brandon J. Greet*, Brian Mealor, Andrew R. Kniss; University of Wyoming, Laramie, WY (013)

Tall larkspur is an important perennial weed on high elevation rangelands in the western United States where cattle are grazed because of significant livestock losses from toxic alkaloids in the plant. A new synthetic auxin herbicide, aminocyclopyrachlor, was evaluated for tall larkspur control alone and in combination with chlorsulfuron at multiple rates (17.5, 35, 70, 140 and 315 g ai/ha of aminocyclopyrachlor) at a high elevation infestation in the Big Horn Mountains of Wyoming. Aminocyclopyrachlor-containing treatments were compared with picloram at 1120 g ai/ha and metsulfuron-methyl at 63 g ai/ha. Treatments were replicated four times in 3 m x 12.2 m plots set in a randomized complete block design. Herbicides were applied at 187 liters per hectare with a CO_2-powered sprayer and 3 m boom with six 8002 nozzles on June 18, 2010. All treatments contained a non-ionic surfactant at 0.25% v/v. Sixty days after spraying, percent control (visual estimate) and mortality of tall larkspur, and percent injury (visual estimate) of grasses were recorded. A four parameter log-logistic model was used to evaluate tall larkspur control and grass injury in response to rates of aminocyclopyrachlor. Aminocyclopyrachlor alone and aminocyclopyrachlor + chlorsulfuron provided maximum tall larkspur control of 88% and 85%, respectively; which did not differ statistically. Metsulfuron methyl and picloram provided 92% and 27% control, respectively. These results suggest that aminocyclopyrachlor alone may provide satisfactory control of tall larkspur, but it will be necessary to reevaluate this site 1 year after treatment to determine if the control is lasting.

RUSSIAN KNAPWEED RESPONSE TO GOAT GRAZING AND AMINOPYRALID. Clarke G. Alder*, Corey V. Ransom; Utah State University, Logan, UT (014)

Russian knapweed *(Acroptilon repens)* has become an invasive pest species of non-crop and agricultural lands in the western United States and many parts of Canada. It displaces desirable vegetation and forms monocultures which effectively reduce forage quality, increase soil erosion and causes a decline in native species diversity. The objective of this study was to determine the effects of a single early-season targeted grazing treatment combined with a late fall application of aminopyralid to Russian knapweed in an abandoned pasture setting. Research trials were initiated in 2009 at Dinosaur National Monument, UT and repeated in 2010. Using goats from a local rancher, grazing was performed during early spring for about two weeks until maximum utilization was achieved. Aminopyralid was applied in late fall at 0, 0.75, 1.0, 1.25 and 1.5 oz ae/A. Preliminary analyses of the data show no interaction between grazing and herbicide treatment. Aminopyralid effectively reduced Russian knapweed density and cover regardless of rate. Effects of grazing at 10 months after treatment (MAT) remained undetected as aminopyralid was very effective at all rates. Desirable grass density was not affected by aminopyralid, however grass cover increased over all aminopyralid rates as Russian knapweed cover decreased. In visual evaluations 10 MAT, grazing alone appeared to provide some suppression of Russian knapweed in grazed plots compared to ungrazed controls. Preliminary results show that aminopyralid is effective at several different rates for control of Russian knapweed.

SEEDLING RESPONSE OF 27 NATIVE SPECIES AND 2 EXOTIC WEEDS TO AMINOCYCLOPYRACHLOR. Holden J. Hergert*, Brian Mealor, Rachel D. Mealor, Andrew R. Kniss; University of Wyoming, Laramie, WY (015)

Aminocyclopyrachlor, a synthetic auxin, has recently been registered for non-crop applications. One potential future use of aminocyclopyrachlor is invasive weed management in reclamation and restoration situations. A greenhouse study was conducted in 2010 at the University of Wyoming to investigate the seedling response of 27 species accessions or cultivars and 2 exotic weeds to aminocyclopyrachlor. Aminocyclopyrachlor was applied at rates of 20, 40, 80, 160, 320, and 640 g/ha 30 days after planting when grasses reached the 3 to 5 leaf stage and forbs and shrubs were less than 5 cm in height. There were 7 replicates and all treatments included a nonionic surfactant at 0.25% v/v. Herbicide treatments were applied in a spray chamber delivering 187 l/ha at 276 kPa. A four parameter log-logistic model was used to estimate the dry weight reduction in response to aminocyclopyrachlor rate. Russian thistle biomass was reduced 99% at 180 g/ha. At the same rate, reduction in grass biomass ranged from 11 to 49%. Variation in growth reduction by aminocyclopyrachlor was observed among genera and species, and even among germplasm within a species. At 180 g/ha, growth of all flax and sagebrush species was reduced ≥81%. If aminocyclopyrachlor were used in a reclamation or restoration situation for postemergence control of Russian thistle, most of the grasses in this experiment appear to be fairly tolerant; whereas the selected sagebrush and flax species were highly susceptible at this early growth stage even at low rates.

DEVELOPMENT OF NOVEL CHLOROPLAST MARKERS FOR YELLOW TOADFLAX (*LINARIA VULGARIS*) AND DALMATIAN TOADFLAX (*LINARIA DALMATICA*). Andrew S. Boswell*[1], Sarah M. Ward[2]; [1]Colorado State University, Greeley, CO, [2]Colorado State University, Fort Collins, CO (016)

Recent research at Colorado State University has confirmed hybridization in the field between invasive populations of yellow toadflax (YT) and Dalmatian toadflax (DT). Hybrid toadflax populations could pose a greater threat than either parent species if the hybrids occupy different niches or have a greater adaptive ability than the parents. Earlier results from controlled interspecific crosses showed greater seed set and seedling viability seed from YT x DT crosses than DT x YT. This suggests asymmetric gene flow in naturally hybridizing toadflax populations, with a greater likelihood of invasive YT populations acquiring DT genes via introgression than the reverse. In most angiosperms chloroplasts are maternally inherited, so species-diagnostic chloroplast DNA markers can determine the identity of a toadflax hybrid's maternal parent and direction of gene flow. We are screening published universal cpDNA primers to identify variable chloroplast DNA regions which could be used as a species diagnostic tool. After amplification and sequencing, we selected chloroplast regions trnT(GUC)/trnD(GGU), trnL, and rpL16 as likely candidates for chloroplast marker development. We have identified an AluI restriction site in region trnT/trnD, that distinguishes between YT and DT cpDNA, and we are using this to screen additional field-collected hybrids.

HYBRID TOADFLAX PERFORMANCE: PRELIMINARY RESULTS FROM A COMMON GARDEN EXPERIMENT. Marie F. Turner*[1], Sarah M. Ward[1], Sharlene E. Sing[2]; [1]Colorado State University, Fort Collins, CO, [2]United States Forest Service, Bozeman, MT (017)

The existence of natural hybrids between yellow and Dalmatian toadflax has now been affirmed by morphological and molecular analyses. The exact nature of these hybrids is of interest to land managers already confronting co-invading invasive parental populations. Replicated, multi-season common garden experiments in Colorado and Montana are underway to measure characters of both parent species and hybrids which may contribute to invasiveness. Preliminary results indicate that in general, hybrids produce more biomass, flowers, and seed pods, so may have potential to be more aggressive than either parental species population; but also that the performance of different hybrid genotypic classes may vary across environments.

THE ROLE OF RELATIVE SIZE AND NITROGEN AVAILABILITY IN COMPETITIVE INTERACTIONS BETWEEN CHEATGRASS (*BROMUS TECTORUM*) AND BLUEBUNCH WHEATGRASS (*PSEUDOROEGNERIA SPICATA*). Noelle Orloff*, Jane Mangold, Fabian Menalled, Zachariah J. Miller; Montana State University, Bozeman, MT (018)

Reestablishing native perennial grass species such as bluebunch wheatgrass (Pseudoroegneria spicata) is one management tool for restoring lands dominated by cheatgrass (Bromus tectorum), an exotic annual grass. Yet, reseeding perennial grasses is often unsuccessful due to cheatgrass' early emergence time and ability to preempt and quickly utilize resources. We conducted a greenhouse study investigating the role of relative size and nitrogen (N) availability in competitive interactions between cheatgrass and bluebunch wheatgrass, with the intent of improving rangeland revegetation practices. We hypothesized that cheatgrass growth is more responsive to increased N than bluebunch wheatgrass and that competitive ability of bluebunch wheatgrass seedlings increases with seedling size relative to cheatgrass. In an addition series experiment, we combined four densities of each species, three size cohorts of bluebunch wheatgrass (seeds, two-leaf, and four-leaf seedlings), and two N treatments (ambient and high) for a total of 96 experimental units replicated four times. For both species, we predicted individual average biomass as a function of densities of each species, bluebunch wheatgrass size cohort, and N treatment. Cheatgrass responded to added N by accumulating more biomass than bluebunch wheatgrass. As predicted, when the species were planted simultaneously cheatgrass suppressed bluebunch wheatgrass growth, but cheatgrass had little effect on larger bluebunch wheatgrass seedling biomass across both N treatments. Furthermore, the larger bluebunch wheatgrass seedlings suppressed cheatgrass growth. These results suggest that techniques that allow perennial grasses to achieve a size advantage over cheatgrass may increase the chance of reseeding success, even when resource availability is elevated.

SAGO PONDWEED CONTROL IN IRRIGATION CANALS USING ENDOTHALL AND CHELATED COPPER. Joseph D. Vassios*, Scott Nissen; Colorado State University, Fort Collins, CO (019)

Sago pondweed (Stuckinea pectinatus) is a native aquatic species that occurs across the US. In Colorado and many western states, irrigation and drainage canals provide excellent habit for this native species; however, when infestations are severe enough some control strategy is necessary to restore efficient delivery of water for irrigation, recreation, and industrial purposes. There are a number of aquatic herbicide that can control sago pondweed in lakes and ponds, but few are registered for flowing water. Chelated copper formulations are one option for sago pondweed control in irrigation canals and endothall was recently registered for the same purpose. Published research has reported endothall plus copper acted synergistically to improve sago pondweed control. The goal of this project was to evaluate sago pondweed control in simulated irrigation canals using endothall plus chelated copper treatments. Single tubers were planted in three-inch diameter pots and grown for 14 days prior to herbicide treatment. Herbicide treatments included endothall (1 and 2 ppm), ethanolamine chelated copper (Cutrine Ultra) (0.75 and 1 ppm), ethanolamine chelated copper (Clearigate) (0.5 and 1 ppm), and combination treatments. Four replications were included for each treatment. Plants were exposed to the various herbicide treatments for 4, 8, and 12 hours. Analysis of dry biomass following treatment indicated that treatment with 1 ppm endothall+0.5 ppm Clearigate resulted in the greatest control for all exposure times. While these initial results suggest endothall+copper treatments will control sago pondweed, further greenhouse and field trials are needed to optimize treatment rate and exposure time.

USE OF ENDOTHALL FOR CONTROL OF EURASIAN WATERMILFOIL IN IRRIGATION CANALS. Joseph D. Vassios[1], Scott Nissen*[1], Cody Gray[2]; [1]Colorado State University, Fort Collins, CO, [2]United Phosphorous, Inc., Peyton, CO (020)

Although Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) is commonly found in lakes and ponds, it can prove especially difficult to control in flowing water systems. Endothall is labeled for EWM control, and in 2010 two endothall formulations, dipotassium salt (DPSE) and the mono (N,N-dimethlalkylamine) salt (MSE), were approved for use in irrigation canals. While DPSE will only provide control of aquatic weeds, MSE can also provide algae control. While these herbicides have been shown to provide good control of sago pondweed (*Stuckenia pectinata*) in flowing water systems, little work has been done to examine EWM efficacy in these situations. During summer 2010, two field-scale demonstration studies were conducted. The first site was the Leggett Canal near Boulder, CO, which contained EWM, sago pondweed, and elodea (*Elodea canadensis*). The second site was the Minnequa Canal that originates outside of Florence, CO, which contained only EWM. Herbicides combinations were to the Leggett Canal (2.75 ppm DPSE + 0.25 ppm MSE for 8 hours) and the Minnequa Canal (1.8 ppm DPSE + 0.2 ppm MSE for 12 hours). Water samples were taken during treatment to confirm application rates. Following herbicide applications, both canals were monitored with visual ratings and photographs over 28 DAT. EWM control was >80% at both sites and nearly 100% control of sago pondweed and elodea was observed at the Leggett Canal. Both sites will continue to be monitored during 2011 to evaluate residual control.

A BRIEF HISTORY OF THE BIOLOGICAL CONTROL OF WEEDS IN WYOMING. John L. Baker*; Fremont County Weed and Pest, Lander, WY (021)

No abstract submitted.

PARTNERSHIP FOR INVASIVE SPECIES MANAGEMENT, PROFESSIONAL OUTREACH AND LAND RESTORATION. Tim J. Damato*; Larimer County Weed District, Fort Collins, CO (022)

The Western United States has seen booming population growth resulting in great changes in the landscape and agriculture practices. Changes include transformation of rangeland and farms to houses, or to 'ranchettes,' and an influx of newcomers either from out of the area or land owners without a rural background, often lacking knowledge of local vegetation management practices. Introduction of invasive weeds often comes with disturbances from new roads and home construction, and from inadvertent seed deposition from livestock, bedding straw and machinery brought in from other parts of the country. This introduction of invasive plants creates an education and outreach challenge for resource specialists striving to disseminate most current information on plant identification and management recommendations. When facing the issue of a changing landscape and degrading forces such as invasive plant species, land managers need time sensitive and cost effective solutions to these problems. Field research results do not often reach target audiences due to decreasing state extension budgets. This economic shortfall has meant that training and educating land managers and extension personnel has suffered and the sharing of those ideas is often lost in scientific journals.

A proposal has been submitted to the Western Society of Weed Science to create a subgroup or committee within the society to address these issues. The discussion will take place at the Range and Natural Areas symposium under the title "*Extend invasive weed management with novel technologies and collaborative applied research networks*".

The proposal includes the following goals:

· Create a venue that bridges the gap between researchers, extension specialists and land managers by structuring a program that encourages cooperation and collaboration with a focus on invasive weed species management and restoration techniques in natural areas, rangeland and pasture.

· Identify and prioritize most important issues confronting land managers, and apply research necessary to address such issues by establishing locations for research & demonstration sites with private landowners, open space agencies and on local, state and federal lands.

· Conduct research that focuses on range and pasture restoration techniques and judicious use of herbicides and alternative weed management methods.

· Disseminate results of research and demonstration sites through tours, publications and a website.

· In short, help to fill the gap left by declining state extension budgets and activities, and encourage land managers to actively participate with researchers in establishing best management practices relating to invasive plant management and restoration techniques.

ARROWWEED (PLUCHEA SERICEA) MANAGEMENT IN ARIZONA IRRIGATION DISTRICTS. William B. McCloskey*[1], Vanelle F. Peterson[2]; [1]University of Arizona, Tucson, AZ, [2]Dow AgroSciences, Mulino, OR (022A)

Arrowweed (*Pluchea sericea*) is a C3, perennial woody shrub native to southwestern deserts that can grow up to 10 feet in height and is found in low-lying areas where water is intermittently available. It is particularly invasive in irrigation systems in central and western Arizona where it can destroy concrete-lined irrigation ditches. In earthen canals, arrowweed growth can greatly restrict water flow and tremendous costs are incurred by irrigation districts for mechanical control and restructuring of canals. Arrowweed has periods of active growth in the spring and early summer when it flowers and in the fall. It grows very slowly in the summer during the hottest months and in the winter. Two studies were conducted to test the efficacy of aminopyralid, triclopyr, glyphosate and dicamba on arrowweed in Sacaton, AZ (central Arizona) and near Poston, AZ (Parker Valley in western Arizona). In Sacaton, the herbicides were applied on October 12, 2007 using a backpack sprayer and a 10-ft, 6 nozzle boom with a carrier volume of 23 GPA. An organosilicone surfactant was used and plants along a concrete lined irrigation ditch were sprayed. Because of the size of the plants it was not possible to spray over the top of the arrowweed at Sacaton. In Posten, a utility vehicle with a spray system and boomless nozzle mounted 6 ft above the ground were used to apply the herbicides with a methylated seed oil in 18 or 21 GPA (depending on treatment) on December 5, 2008. Since the plants were a little smaller in Posten and the spray swath was 16 feet, plants closest to the vehicle were sprayed over-the-top. Herbicide symptoms developed slowly over several months; aminopyralid had little effect on arrowweed with the greatest efficacy achieved being 10% at 5 months after treatment (MAT). The best treatments were tryclopyr at 2 to 3 lb ae/A and glyphosate at 2.5 to 3.7 lb ae/A at 5 MAT at 70% control. Plants exhibited regrowth in early summer following fall-winter treatments suggesting that multiple or regular treatments will be required to suppress arrowweed and reduce irrigation system maintenance costs.

Project 2. Weeds of Horticultural Crops

SPURGE MANAGEMENT IN NURSERY CONTAINERS. Kelly M. Young*; University of Arizona, Phoenix, AZ (023)

Weedy spurges (*Euphorbia hyssopifolia, E. maculata, E. nutans* and *E. prostrata)* are among the most difficult to control weeds in nursery containers in the desert southwest. Nursery managers complain that available granular herbicides are ineffective. Dithiopyr, trifluralin + isoxaben and trifluralin + isoxaben + oxyfluorfen were topdressed into one gallon nursery containers without a crop on 07 September 2010 at 150 and 200 lbs granular product./A; dimethanamid + pendimethalin was applied on the same date at 150 lbs. granular product/A only. Chemical treatments were compared to an untreated control (UTC). Spurge control was compared in containers with a regular planting medium composed of 2 parts fine mulch, 2 parts volcanic cinder and one part coarse mulch to containers with regular planting medium plus a two inch coarse mulch topdress. Weekly spurge germinations were counted and percent of the container covered by spurge mat was calculated at 30 days after treatment (DAT) and 60 DAT. Data was analyzed using JMP 8.0.2. There was no improvement in spurge control applying the higher rate of dithiopyr, trifluralin + isoxaben or trifluralin + isoxaben + oxyfluorfen. The addition of the coarse mulch topdress improved spurge control in trifluralin + isoxaben and trifluralin + isoxaben + oxyfluorfen. At 60 DAT, greatest control was achieved using dimethanamid + pendimethalin, although trifluralin + isoxaben + oxyfluorfen and dithopyr performed better than the UTC.

WEED CONTROL AND CROP SAFETY FOLLOWING SULFENTRAZONE USE IN MELONS AND TOMATOES. Wayne T. Lanini*; University of California, Davis, Davis, CA (024)

Weeds, including lambsquarters, nightshades, and field bindweed remain a problem in tomatoes and melons. Sulfentrazone is currently labeled for use in cabbage, beans, and several other crops, and initial studies indicated that tomato and melon crops might be tolerant. Sulfentrazone was compared with standard treatments in transplanted processing tomato in 2007, and 2010, and in cantaloupe, honeydew and watermelon, in 2007 to 2010. In spite of injury from sulfentrazone applied preemergence at 112 g/ha, tomato yields were the highest, and broadleaf weed control was equal or better than the standard treatment of rimsulfuron. Melon injury exceeded 50% when sulfentrazone was applied at 168 g/ha, but was less than 20% at 112 g/ha. Watermelon was more tolerant of sulfentrazone than honeydew melon, and cantaloupe was the least tolerant. Broadleaf weed control was near 100% for the entire season, when sulfentrazone was applied postplant, preemergence, and incorporated by irrigation. Broadleaf weed control in melons declined to near 80% at eight weeks after planting when sulfentrazone was mechanically incorporated. Control of grasses and established field bindweed was poor. Melon yields were equal or better than standard treatments when the 112 g/ha rate of sulfentrazone was used.

EFFECT OF TIMING AND RATE ON EFFICACY OF FLAZASULFURON AND OTHER DORMANT SEASON HERBICIDES IN VINEYARDS. R. E. Peachey*; Oregon State University, Corvallis, OR (025)

Experiments were located at the Oregon State University Woodhall Vineyard near Alpine in Chardonnay grapes in 2009 and 2010 to measure efficacy of flazasulfuron and other herbicides used in vineyards. The primary grasses present at the two sites were tall fescue (*Festuca arundinacea)* and bentgrass (*Agrostis* spp.); the primary broadleaf species present were bristly hawksbeard (*Crepis setosa***)**, spotted catsear (*Hypochaeris radicata),* and dandelion (*Taraxacum officinale*), with a small amount of clover, willow weed (*Epilobium* spp.), geranium present. Soil tests indicated a pH of 5.7, OM of 5.08 % (loss on ignition) and CEC of 12.1 meq/100 g of soil. The experimental design was a randomized complete block with 4 replications. All herbicides were applied with a backpack CO_2 sprayer with an XR-8003 nozzle delivering 20 GPA. The nozzle was held 10 inches from the vine row and approx 20-24 inches above the ground to create a 2 ft. spray width on each side of the row. There were 3 vines per 21 ft. long plot. In 2009, flazasulfuron was applied alone or as a tankmix with other PRE herbicides on April 2. In 2010, glyphosate at 1.375 lbs ae/A was applied first to all plots except the untreated check plot on April 7. Preemergence treatments of flazasulfuron, flumioxazin, oxyfluorfen, oryzalin, rimsulfuron were applied 2 and 6 weeks after the glyphosate.

In 2009, flazasulfuron alone on April 2 provided exceptional control of the grasses and clover. Control of bristly hawksbeard and spotted catsear was less than for the grasses. Tankmixing flazasulfuron with pendimethalin and s-metolachlor did not improve control of bristly hawksbeard; tankmixing with flumioxazin increased control of hawksbeard from 83 to 93%. In 2010, flazasulfuron following glyphosate provided very good control of all species except willow weed at 7 WAT. Willow weed control improved slightly with flazasulfuron applied at 0.045 lbs ai/A compared to 0.033 lbs ai/A. Most of the other preemergence herbicide treatments improved glyphosate efficacy, but a late application of oryzalin did not improve weed control compared to glyphosate alone. Control of willow weed dropped when flazasulfuron and flumioxazin were applied on May 24 rather than April 22, but increased when oxyfluorfen, oryzalin, and rimsulfuron were applied on May 24 rather than April 22. No effect of herbicides on vines was noted in either year.

INDAZIFLAM FOR PRE-EMERGENT WEED CONTROL IN ALMONDS. Ryan Allen*; Bayer CropScience, Sacramento, CA (026)

Field efficacy studies conducted between 2004-2010 in California almond orchards have demonstrated that Indaziflam effectively controls a wide spectrum of important broadleaf and grass weed species when applied preemergence. Indaziflam has been evaluated throughout the almond growing region of California by University, private, and Bayer CropScience researchers at various rates and timings, as well as in tank mixes with many common adjuvants and other herbicides. The results of these studies demonstrate that an application of Indaziflam at 73 g ai/ha (5 fl oz/A) can effectively control a broad spectrum of grass and broadleaf weeds for up to 6 months, although control of 10 months or more has been observed in some cases. Indaziflam will be marketed as Alion™ upon registration, which is anticipated in 2011.

CROP SAFETY OF INDAZIFLAM ON PERENNIAL HORTICULTURAL CROPS. Hank J. Mager*, Darren Unland; Bayer CropScience, Fountain Hills, AZ (027)

Indaziflam is a new preemergence herbicide Bayer CropScience has developed for use in perennial tree nut, fruit, and vine crops. Indaziflam is a new active ingredient and will be marketed by Bayer CropScience under the trade name Alion. Registration is currently under review and pending approval by EPA. Excellent crop tolerance was observed in more than 400 field trials conducted by Bayer CropScience and university researchers across the United States in the major fruit and tree nut production areas. No crop response has been observed when indaziflam was applied in a manner consistent with the proposed label. Many different parameters have been measured in these trials including: root and shoot growth, vigor, trunk diameter, and yield.

IMPROVING CONTROL OF FIELD BINDWEED (*CONVOLVULUS ARVENSIS*) IN WILLAMETTE VALLEY CANEBERRIES. Jessica M. Green*, R. E. Peachey; Oregon State University, Corvallis, OR (028)

Persistent, perennial weeds such as field bindweed (*Convolvulus arvensis*) typically require an integrated approach for successful management. Quinclorac has been shown to effectively reduce field bindweed by up to 85% in small fruit systems, with minimal risk of crop injury. Another strategy for field bindweed management is the use of biological control agents. There are currently two arthropods registered for use in the U.S., a defoliating moth and a gall-forming mite. The mite, *Aceria malherbae*, has proven to be particularly effective in dryland states such as Texas, Oklahoma, and Western Colorado. However, successful recovery of the mite in the Pacific Northwest has been limited. This study evaluated the efficacy of *A.malherbae* both alone and in conjunction with quinclorac applied at varying rates. Experiments were placed at two different sites; established blueberries in Lebanon, OR., and first year blackberries near Dayton, OR. Plots were designed as completely randomized blocks, with 4 replications each. Application method of the mites was the first experimental factor; herbicide rate was the second factor. Plants were evaluated using 6 visual parameters to estimate presence of the mite and herbicide effectiveness. In blueberries, percent control averaged 77% and did not differ between 0.42kg ai/ha and 0.84kg ai/ha rates. Quinclorac reduced flowering by 40% in first year blackberries and control averaged 38%. Interactions between *Aceria* and quinclorac varied between sites.

THE USE OF MEADOWFOAM SEED MEAL AS A SOIL AMENDMENT TO SUPPRESS SEED GERMINATION. Suphannika Intanon*, Andrew G. Hulting, Carol Mallory-Smith, Fred Stevens, Jennifer Kling, Ralph Reed; Oregon State University, Corvallis, OR (029)

Meadowfoam (*Limnanthus alba* Hartw. ex Benth.) seed meal, a by-product of meadowfoam oil extraction, has characteristics that suggest its potential utility in agriculture as a soil amendment to enhance plant growth and possibly suppress soil pests. The presence of glucosinolate degradation products which are produced by the enzyme myrosinase are thought to be directly or indirectly responsible for the weed suppression induced by meadowfoam seed meal. Greenhouse and laboratory studies were conducted to evaluate the effect of three different forms of meadowfoam seed meal: seed meal, activated seed meal, and seed meal pellets on the suppression of lettuce emergence and growth. The three formulations had different effects in regards to seedling emergence and growth, time course of activity, and consistency in the concentrations of active compound in the soil. Meadowfoam seed meal in the pellet form produced highly variable concentrations of glucosinolate and its breakdown products in soil samples. The soil amended with activated meadowfoam seed meal provided the best results for suppression of lettuce emergence and growth. The effect lasted less than 6 days after seed meal application; therefore, it may be possible to use meadowfoam seed meal preplanting for weed control. Research is needed to determine the activity of meadowfoam seed meal under field conditions.

HERBICIDE COMBINATIONS FOR WEED CONTROL IN ORNAMENTAL BULBS. Carl R. Libbey*, Timothy W. Miller; Washington State University, Mount Vernon, WA (030)

Herbicide combinations were evaluated for weed control in ornamental bulbs at Mount Vernon and Puyallup, Washington in 2008 through 2010. Tulip (cv. ‘Ile de France’), daffodil (cv. ‘Dutch Master’), and iris (cv. ‘Blue Diamond’) bulbs were planted in October, 2008 and 2009 and dormant-season herbicides were applied in early winter prior to emergence of bulb foliage. Tested herbicides at the Mount Vernon were napropamide, oryzalin, mesotrione, s-metolachlor, and pendimethalin applied alone at two rates each or in several two-way combinations. Herbicides tested at Puyallup were napropamide and oryzalin at two rates each. Weed control and crop injury were evaluated through the growing season. Flower number and stem length were recorded at full bloom for each species. At the end of the growing season, bulbs were harvested, cleaned, sized, counted, and weighed. Weed control at Mount Vernon during March and April generally exceeded 90% for most treatments in 2009 and 2010. By late April, 2009, weed control was diminished with mesotrione, napropamide, and pendimethalin applied alone. Combination treatments continued to provide > 90% weed control through April, 2009. In 2010, all treatments except for the low rate of pendimethalin provided > 90% weed control in late April. By May, only oryzalin alone or in combination was still providing > 90% weed control. Weed control at Puyallup during 2009 and 2010 exceeded 88% for all treatments in early March. However, by late March, 2009 weed control with napropamide treatments was significantly poorer than with oryzalin. By early May, 2010 only the highest rate of oryzalin exceeded 87% weed control. No treatment caused visible foliar or floral injury to any bulb species at either location in either year. There were no significant differences in yield parameters due to herbicide in any of the three bulb species at either location in either year.

THE USE OF TOPRAMEZONE AND TRICLOPYR FOR THE MANAGEMENT OF PERENNIAL GRASS INFESTATIONS IN COOL SEASON TURFGRASS. Joseph Zawierucha*[1], Larry Newsom[2], Clete Youmans[2]; [1]BASF Corp, Research Triangle Park, NC, [2]BASF Corporation, Research Triangle Park, NC (031)

Topramezone is under development by BASF for weed control in cool season turfgrasses. Topramezone is a HPPD inhibiting herbicide that controls weeds by inhibiting carotenoid biosynthesis. Topramezone provides broad spectrum control of both broadleaf and grass weeds. Extensive field testing has shown that major cool season turfgrass species exhibit excellent tolerance including: Kentucky bluegrass, fine and tall fescue, and perennial ryegrass. Tolerance levels in most warm season turfgrass species has been shown to be poor with the exception of centipedegrass, which exhibits a high level of tolerance. Field studies conducted in cool season turfgrass with topramezone have demonstrated effective control of key weed species such as white clover, Veronica spp, crabgrass and goosegrass. Additional research has demonstrated that topramezone also offers selective control of key perennial grasses such as bermudagrass when mixed with triclopyr. Effective control of perennial grasses was shown to require a multiple application approach for best results. Control of bermudagrass with topramezone plus triclopyr applied in sequential programs provided superior control to that observed with either herbicide used alone. In addition, the visual bleaching effect of topramezone on bermudagrass was substantially reduced when applied in mixtures with triclopyr. The mixture's aesthetic benefit of reduced bleaching combined with the enhanced control of weedy bermudagrass should be a valuable tool for cool-season turfgrass managers.

WEED MANAGEMENT IN PEPPERMINT GROWN FOR OIL EFFICACY AND CROP SAFETY OF EXPERIMENTAL HERBICIDES. Barbara J. Hinds-Cook*, Daniel W. Curtis, Carol Mallory-Smith, Andrew G. Hulting; Oregon State University, Corvallis, OR (032)

Weeds are a significant pest management problem in peppermint grown for oil production across Oregon and the use of herbicides to control these weeds is the primary weed management tool utilized by peppermint growers. Experiments were conducted from 2008-2011 in growers' fields throughout the Willamette Valley and at Hyslop Research Farm in Corvallis, Oregon to evaluate the tolerance of peppermint grown for oil to herbicides that are not currently registered for this use pattern. The herbicides evaluated included pyroxasulfone, ethofumesate, saflufenacil and carfentrazone. Pyroxasulfone was initially evaluated for efficacy in a noncrop experiment at 0.0224 and 0.045 kg ai/ha. Pyroxasulfone at 0.103 and 0.206 kg ai/ha were evaluated on dormant, 5% and 10% emerged, 0.6, 2.5, 5.1, 7.6, and 45.7 cm peppermint and in a post harvest situation in double cut peppermint. Ethofumesate was evaluated in dormant, 5.1, 12.7, 15.2, and 25.4 cm peppermint and in a post harvest situation in double cut peppermint with rates of 0.56, 1.12 and1.68 kg ai/ha. Saflufenacil was evaluated in dormant peppermint at rates of 0.018, 0.0247 and 0.038 kg ai/ha and 0.0493 kg ai/ha was evaluated in a post harvest situation in double cut peppermint. Carfentrazone at 0.0168 kg ai/ha was evaluated on 20.3 and 50.8 cm peppermint and in a post harvest situation in double cut peppermint. The experimental design of all experiments was a randomized complete block with 3 or 4 replications. Visual evaluations of crop injury and weed control were taken when crop or weeds were present and fresh weight and oil yields were taken on the studies that were conducted in crop situations. Crop tolerance of peppermint grown for oil from all preemergent and postemergent applications of ethofumesate in 2008, 2009 and 2010 and saflufenacil in 2009 and 2010 was excellent. Peppermint was injured (30%) in 2008 with the highest rate of pyroxasulfone evaluated (0.206 kg ai/ha) when applied to dormant and 0.6 cm peppermint. Carfentrazone did injure the peppermint in 2010 when applied to 20.3 cm or taller peppermint; however, the peppermint did recover from the injury. Pyroxasulfone applied at 0.103 kg ai/ha preemergence to weeds and incorporated with water provides good control of redroot pigweed (*Amaranthus retroflexus)*, annual sowthistle (*Sonchus oleraceus)*, common groundsel (*Senecio vulgaris)*, and prickly lettuce (*Lactuca serriola)* with crop safety. Ethofumesate applied at 1.68 kg ai/ha on moist ground to actively growing peppermint and preemergence to pigweed provides crop safety and weed control. Saflufenacil, while safe on the crop, has not provided weed control in the situations it has been evaluated. The high rate (0.0493 kg ai/ha) applied post harvest in a double cut field may be the best fit for saflufenacil. A timing study with carfentrazone is needed to determine the safest application timing. Registration of pyroxasulfone, ethofumesate and carfentrazone would provide expanded control of many weeds in peppermint.

WEED SPECIES RESPONSE TO FOUR PROTEIN MEALS. Don W. Morishita, Donald L. Shouse*, J. Daniel Henningsen, Jialin Yu; University of Idaho, Twin Falls, ID (033)

Corn gluten meal and mustard seed meal have been shown to have the ability to control weeds when applied pre-emergence. Other protein meals such as blood and poultry meal are used as organic nitrogen sources and as growth promoters among organic gardeners and farmers. These products, like corn gluten meal, are high protein meals typically used as animal feed supplements. A greenhouse study was conducted to: 1) determine whether animal protein meals had herbicidal activity; 2) understand what rates of protein meals would kill weeds; and 3) determine if there is a weed species response to these meals. This screening trial examined four protein meal sources: blood meal, poultry meal, feather meal, and sardine meal; applied at three rates: 2,240, 4,480 and 6,720 kg/ha. The experimental design was a three by four factorial randomized complete block design with four replications. An untreated control was included to compare the protein meal treatments. Weed species evaluated were common lambsquarters (CHEAL), kochia (KCHSC), redroot pigweed (AMARE), hairy nightshade (SOLSA), annual sowthistle (SONOL), Russian thistle (SASKR), green foxtail (SETVI) and barnyardgrass (ECHCG). A soil mixture consisting of a 4:1 ratio of field soil and potting mix was used for growing the weeds. Two kg of soil mix was added to 25.4 by 50.8 cm plastic trays in preparation for planting. Eight grooves evenly spaced across each tray were made for planting the seed. Each required amount of protein meal was mixed with 680 gm soil mix and carefully placed over the weed seed. Weed seedling emergence and weed control were evaluated 21 days after planting (DAP) and 28 DAP. In addition, weed seedlings were harvested 28 DAP and dry weights recorded. All data are presented as a percent of the control. KCHSC was not controlled very well by any of the protein meals and there was no difference in KCHSC dry weight between protein meals or rates. The meal dry weights pooled across protein meals and application rate averaged 91% of the control. AMARE dry weights pooled across application rate averaged 35% of the control, with no difference among protein meals. In response to application rate pooled across protein meal, AMARE dry weights were 60, 20 and 7% of the control at 2,240, 4,480 and 6,720 kg/ha, respectively. There was a significant protein meal by application rate interaction for CHEAL dry weight. CHEAL dry weight was reduced more by the 2,240 kg/ha rate of blood meal than any other protein meal applied at 2,240 kg/ha rate. At 6,720 kg/ha, CHEAL dry weight was reduced to 4, 8, and 8% of the control with poultry, blood, and sardine meal, respectively. However, with feather meal, CHEAL dry weight was reduced to only 40% of the control with feather meal. SETVI dry weight was reduced most by feather meal and poultry meal, averaging 5 and 14% of the control, respectively. Averaged across application rate, sardine and blood meal reduced SETVI dry weight to 25 and 33% of the control. There was a significant protein meal by application rate interaction for SASKR dry weight. SASKR dry weight was most affected by sardine meal and least affected by poultry and blood meal at the 2,240 kg/ha rate. Dry weight of SASKR was not statistically different at the 4,480 and 6,720 kg/ha rates of all four protein meals and averaged 21% of the control. ECHCG dry weight appeared to be the least affected weed by the protein meals. ECHCG was least affected by feather meal, with a dry weight that was 128% of the control. ECHCG dry weight from the poultry, blood and sardine meal treatments were not statistically different and averaged 80% of the control. ECHCG dry weight in response to application rate pooled across the protein meals was 130% of the control at 2,240 kg/ha. There was no difference in dry weight between the 4,480 and 6,720 kg/ha application rates pooled across meals and averaged 73%. SOLSA was not affected more by one protein meal than another. However, SOLSA dry weight in response to application rate pooled across protein meals was 55, 10 and 11% of the control when applied at 2000, 4000 and 6000 lb/A, respectively. SONOL appeared to be the most sensitive of the eight weed species evaluated. Average SONOL dry weight pooled across protein meal and pooled across application rate was only 2% of the control. KCHSC appeared to be the most tolerant of all weed species evaluated while SONOL was the most susceptible to the protein meals.

Project 3. Weeds of Agronomic Crops

COMPARISON OF PYROXSULAM FORMULATIONS FOR GRASS AND BROADLEAF WEED CONTROL IN THE WESTERN U.S. Joe Yenish*[1], Harvey Yoshida[2], Daniel C. Cummings[3], Kevin D. Johnson[4], Roger Gast[5]; [1]Dow AgroSciences, Pullman, WA, [2]Dow AgroSciences, Richland, WA, [3]Dow AgroSciences, Perry, OK, [4]Dow AgroSciences, Barnesville, MN, [5]Dow AgroSciences, Indianapolis, IN (034)

Pyroxsulam is the active ingredient in Dow AgroSciences' PowerFlex® herbicide. PowerFlex is labeled for use in winter wheat. The currently available PowerFlex formulation contains 7.5% of active ingredient in a water dispersible granule. A potential new formulation being evaluated contains 13.1% pyroxsulam. The studies described herein were designed to compare crop tolerance and weed control of the two formulations. Crop tolerance studies were conducted at 6 and 7 locations in 2009 and 2010, respectively. Each formulation was applied at 18.4 g (1X) and 36.8 g (2X) pyroxsulam/ha with nonionic surfactant and ammonium sulfate. In each year, only 1 location showed differences between formulations for crop tolerance. In both cases, formulation differences occurred only with the 2X rate of pyroxsulam. In 2009, the differences persisted throughout the growing season, while in 2010 differences were transitional and were not observed in ratings made later than 3 days after application. Generally, injury ratings did not exceed 10% although there were a few exceptions. Separate grass weed control studies were conducted at 13 locations in each year. Pyroxsulam rates for the formulation comparison were 13.8 and 18.4 g ai/ha applied with nonionic surfactant and ammonium sulfate. Targeted grasses were Italian ryegrass and downy brome. Differences in grass control between formulations only occurred in 6 of the 26 locations. Moreover, there was not a consistent pattern in which formulation provided better control nor were there consistent differences within or between rates. Thus, in summary both formulations performed equally well for weed control and crop tolerance.

DOWNY BROME CONTROL WITH PYROXSULAM IN WINTER WHEAT. Robert K. Higgins*[1], Drew Lyon[2]; [1]University of Nebraska Panhandle Research & Ext. Center, Sidney, NE, [2]University of Nebraska-Lincoln, Scottsbluff, NE (035)

Field studies were conducted at the University of Nebraska High Plains Agricultural Lab near Sidney, NE from 2008 through 2010 to evaluate downy brome control with pyroxsulam (PowerFlex™) in winter wheat. Studies were located on an Alliance silt loam (2.3% organic matter) during both growing seasons. One standard rate (18.4 g ai/ha) of pyroxsulam was applied to downy brome in early fall and spring. For comparison purposes, sulfosulfuron (Maverick®) was applied at the standard rate of 35 g ai/ha at the same application times. All treatments were applied POST. Plots were evaluated for crop injury and weed control. No crop injury was observed. Within an application timing, no treatment differences existed. Downy brome control was best with fall-applied treatments, averaging 92 and 75% in 2009 and 2010, respectively. Downy brome control with spring-applied applications averaged 59 and 29% in 2009 and 2010, respectively. In 2009, grain yield averaged 2910, 2320, and 1910 kg/ha for fall-applied, spring-applied, and the nontreated check treatments, respectively. In 2010, grain yield averaged 2750, 1180, and 692 kg/ha for fall-applied, spring-applied, and the nontreated check treatments, respectively. Pyroxsulam provides downy brome control that is similar to sulfosulfuron. With both products, fall applications are superior to spring applications.

SPRING PEA OR MUSTARD IN WINTER WHEAT ROTATION. Joan Campbell*, Donn Thill; University of Idaho, Moscow, ID (036)

Oriental mustard and dry pea insect pest interactions with wild oat were evaluated in 2006 and 2007. Treatments were insecticide seed treatment (+ and -), foliar insecticides (+ and -), and post-emergence grass herbicide (+ and -). Wild oat was seeded before seeding crops to obtain a uniform weed population. Insect pests and feeding damage were measured throughout the growing season. Crops were harvested at maturity and winter wheat was planted in the fall. Wheat grain was harvested the following year to determine rotational effects on yield. Flea beetle damage on mustard was lower with foliar insecticide than no foliar insecticide in 2006 and 2007. In 2006, flea beetle damage was lower with herbicide treatment when mustard seed was treated, but herbicide had no effect when seed was not treated with insecticide. In 2007, flea beetle damage was affected by an interaction of seed treatment, foliar insecticide and herbicide. Flea beetle damage was always lower with treated seed compared to nontreated seed. However, within treated seed, damage was higher when neither foliar insecticide nor herbicide were applied. Herbicide had no effect on flea beetle when seed was not treated. Mustard yield was not affected by seed treatment in 2006, but yield was higher with foliar insecticide compared to no foliar insecticide. Within no foliar insecticide treatments, yield was greater when herbicide was applied compared to no herbicide treatment. In 2007, mustard yield was higher when herbicide was applied compared to no herbicide treatment. Pea aphid was affected by a seed treatment, foliar insecticide, herbicide interaction. Aphids were not affected by herbicide when insecticide was applied as seed treatment or to the foliage. Aphid feeding was lower when herbicide was applied to mustard that received no seed or foliar insecticide treatment compared to no herbicide application. Pea seed yield in 2006 was higher with herbicide treatment and foliar insecticide regardless of seed treatment. Herbicide and insecticide treated and untreated yields were 1425 and 678 lb/a and 1300 and 802 lb/a, respectively. This was a function of high wild oat population. Harvested pea seed had 9% and 45% wild oat contamination in herbicide and no herbicide treatments, respectively. Seed treatment did not affect pea yield. In 2007, pea seed yield was 663 and 447 lb/a and wild oat seed contaminations was 10 and 38% with herbicide treatments and nontreatments, respectively. Wheat grain yield following the 2006 experiment was lower with nonherbicide treated mustard (98 bu/a) compared to herbicide treated mustard (118 bu/a) or pea treated with or without herbicide (116 and 118 bu/a, respectively). Wheat grain yield, test weight and wild oat seed contamination following the 2007 experiment was 1507 and 1108 lb/a, 60 and 55 lb/bu, and 2 and 4% following pea and mustard, respectively. Test weight was 58 and 57 lb/bu from herbicide and nonherbicide treatments averaged over all other factors.

BROADLEAF WEED CONTROL STUDIES IN WHEAT. Steve Wright*, Gerardo Banuelos; UCCE, Tulare, CA (037)

The objective of this study was to evaluate the effectiveness of Tribenuron and Carfentrazone alone and in tank mix combinations including Dicamba, MPCA, and 2,4-D at different rates to control different broadleaf weeds and how it affected the injury to common hard red spring wheat. The study was conducted at three different locations; Ducor, Porterville, and Visalia in Tulare County, California. The treatments were applied with a CO_2 backpack at a speed of 4 mph. The nozzles were 8002vs flat fans with a spray pressure of 40 psi and a volume of 15 GPA. The plot sizes for all three locations were 8 feet by 30 feet with four replications.

The Visalia location was sprayed on January 10, 2011 with a temperature of 45°F and a wind speed of 0 to 2 MPH. The wheat was 5 to 12 inches tall and at the 5 to 7 leaf stage. The weeds present at the time of the application were burning nettle (*Urtica dioica*) which was 0.5 to 1" dia, common chickweed (Stellaria media) which was 0.5 to 1" dia. The Ducor location was sprayed on January 28, 2011 with a temperature of 48°F and a wind speed of 0 to 3 MPH. The wheat was 3 to 8 inches tall and at the 4 to 6 leaf stage. The weeds present at the time of the application were burning nettle (*Urtica dioica*) which was 0.25 to 1" diameter (dia) (0 to 0.25 plants/sq. ft.,), common chickweed (Stellaria media) which was 1 to 1.5" dia. (0 to 3 plants/sq. ft.), shepherd's purse (Capsella bursa-pastoris) which was at 0.25 to 0.5" dia. (18 to 20 plants/sq. ft.), fiddleneck (Amsinckia spp.) which as at 0.5 to 2.5" dia. (5 to 10 plants/sq. ft.), filaree (Erodium spp.) which was at 0.25 to 3" dia. (4 to 6 plants/sq. ft.), malva (Malva parviflora) which was at 0.5 to 2.5" dia. (0.25 to 1 plants/sq. ft.), and wild oats (*Avena fatua)* which was 1 to 2.5" tall (5 to 8 plants/sq.ft.). The Porterville location was sprayed on February 8, 2011 with a temperature of 55°F and a wind speed of 0 to 4 mph. The wheat was 4 to 6 inches tall and was at a 3 to 5 leaf stage. The weeds present at the time of the first application were burning nettle (*Urtica dioica*), common chickweed (Stellaria media), and fiddleneck (Amsinckia spp.).

The results of this study demonstrated some variation between weeds, treatments, and location. For the Ducor locations the treatments showed moderate control (60-70) over fiddleneck, chickweed, shepherd's purse, common groundsel, filaree, and malva 14 days after treatment. At the Porterville location Carfentrazone alone treatments showed excellent control of burning nettle 7 days after treatment. The treatment combinations with Tribenuron and Carfentrazone showed excellent control over burning nettle as well, except for the treatment with the low rate of Tribenuron and high rate of Carfentrazone which only gave moderate control over burning nettle 7 days after treatment. All of the treatments gave fair control over common chickweed 7 days after treatment, except for the high rate of Tribenuron and the high rate of Carfentrazone which gave excellent control over common chickweed. The treatments with Carfentrazone alone gave excellent control of fiddleneck 7 days after treatment. All of the treatments with the Tribenuron and Carfentrazone combinations showed excellent control of fiddleneck 7 days after treatment. The injury levels were low among all of the treatments 7 days after treatment. At the Visalia location all of the treatments gave excellent control of burning nettle and chickweed by 28 days after treatment. The treatments with Tribenuron alone showed extremely low levels of injury 28 days after treatment. The treatments with the Carfentrazone alone and Tribenuron and Carfentrazone combinations demonstrated the highest levels of injury, however, injury was not significant and disappeared after 30 days. The treatments with combination of Tribenuron and dicamba, Tribenuron and 2,4-D showed low levels of wheat injury and the treatment with Tribenuron and MCPA showed no levels of injury.

EVALUATION OF WINTER WHEAT VARIETIES FOR TOLERANCE TO METRIBUZIN. J. Connor Ferguson*, Jon-Joseph Armstrong; Oklahoma State University, Stillwater, OK (038)

There is an increasing interest in finding alternative options to improve control of herbicide-resistant weeds in winter wheat. The herbicide metribuzin has been successful in controlling problem weeds in small grains, but is not widely used because of potential crop injury concerns. During the spring and fall of 2010 two greenhouse trials at the Oklahoma State University Agronomy Farm were completed to evaluate sixteen wheat varieties commonly grown in Oklahoma and their response to the herbicide metribuzin. Metribuzin was applied at a rate of 105 g ai/ha to the wheat at the 2-3 leaf growth stage. The 16 varieties were compared to a known tolerant wheat variety and a known susceptible variety to the herbicide metribuzin. The varieties were then harvested a week after being sprayed and their fresh mass was taken. The fresh weight of the treated plants were compared to the untreated check to calculate an overall percentage reduction in fresh weight. Oklahoma’s most popular wheat variety, Endurance, had a tolerance level that dropped nearly 50% with a change in soil type between the two trials. Conversely, Oklahoma’s second most popular variety, Jagger, had almost no change between the two trials. The results also found over half of the newer varieties had a markedly improved metribuzin tolerance as compared to the previously identified most tolerant variety.

DETECTING THE IMI1 GENE IN IMAZAMOX RESISTANT WHEAT BY JOINTED GOATGRASS HYBRIDS WITHIN COMMERCIAL WHEAT FIELDS. Bianca A. Martins*, Carol Mallory-Smith; Oregon State University, Corvallis, OR (039)

Clearfield® wheat varieties carry the Imi1 gene, which is responsible for conferring resistance to the imidazolinone herbicide imazamox. This trait allows the selective control of jointed goatgrass (Aegilops cylindrica), a difficult to control annual grass weed in winter wheat. However, there is a close genetic relationship between jointed goatgrass (JGG) and wheat, which enables the species to hybridize, backcross, and produce seed under natural field conditions. Thus, Imi1 gene flow between Clearfield wheat and JGG may occur via hybridization and backcross events. Hybrids between Clearfield wheat and JGG were identified in 2008 in a commercial wheat field in Eastern Oregon. In 2009 and 2010, surveys were conducted in commercial wheat production fields in Eastern Oregon in order to understand how widespread the imazamox-resistant hybrids were. Fields with Clearfield wheat history were sampled, as well as non-cropping areas such as roadsides, road construction, field borders and Crop Reserve Program areas. Hybrid tissue and spikes were collected. PCR-based allele specific assays were performed in order to detect the presence of the mutant gene (Imi1) in the hybrids. We also determined seed set in the F_1 plants to access average fertility per spike. A total of 128 sites were surveyed in the two years. Seventy-three of those sites had at least one hybrid. We have completed analysis of hybrids from 27 sites, at least one imazamox-resistant hybrid was detected in 26 of the 27 sites. In 2009, there was an average F_1 seed set of 1.8%. The Imi1 gene was detected in some plants, which did not have the characteristic hybrid morphology and had higher seed numbers, typically found in backcross generations. Our results demonstrate that the Imi1 gene is moving from Clearfield wheat to F_1 plants and potentially to backcross generations in commercial wheat production fields in Eastern Oregon.

MANAGEMENT OF DIFFICULT TO CONTROL GRASS SPECIES WITH MESOSULFURON-METHYL PLUS PROPOXYCARBAZONE IN WHEAT. Dean W. Maruska*[1], Kevin B. Thorsness[2], Steven R. King[3], Mary D. Paulsgrove[4], Mike C. Smith[2], Thomas W. Kleven[5], George S. Simkins[6], Bradley E. Ruden[7], Mark A. Wrucke[8]; [1]Bayer CropScience, Warren, MN, [2]Bayer CropScience, Fargo, ND, [3]Bayer CropScience, Huntley, MT, [4]Bayer CropScience, Raleigh, NC, [5]Bayer CropScience, Sabin, MN, [6]Bayer CropScience, Vadnais Heights, MN, [7]Bayer CropScience, Bruce, SD, [8]Bayer CropScience, Farmington, MN (040)

Rimfire Max was commercially introduced in the spring of 2010. It 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 with ALS-inhibiting compounds mesosulfuron-methyl and propoxycarbazone sodium plus a safener, mefenpyr-diethyl. 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 adjuvant systems. Adjuvant 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. Results from research trials have shown that a methylated seed oil additive is the most effective adjuvant system to maximize weed control. Rimfire Max is generally tankmixed with a broadleaf herbicide such as Huskie (containing pyrasulfotole and bromoxynil) to provide broad spectrum weed control in wheat. Between 2009 and 2010, 114 trials were conducted in ND, SD, MT and MN to evaluate control of difficult to control grass weed species such as downy brome, Japanese brome, Persian darnel and ACC-ase resistant and susceptible wild oat. Rimfire Max at 13.97 g ai/ha plus Huskie at 206 g ai/ha with 1.75 l/ha methylated seed oil (MSO) applied prior to tillering of downy brome resulted in 66% control averaged across 9 trials. Wild Oat control averaged 89 to 93 percent 30 to 60 DAT with various dicot tankmkix partners. Persian darnel control was best with Rimfire Max + Huskie combined with MSO (91%) compared to Rimfire Max + Huskie combined with a basic blend adjuvant (87%). Japanese brome was controlled 89 to 94 percent when Rimfire Max was combined with various dicot tankmix partners. Control of common lambsquarters, common sunflower, wild buckwheat, kochia, Russian thistle, and wild mustard averaged greater than 96 percent.

DOWNY BROME (*BROMUS TECTORUM*) INCREASES WINTER WHEAT (*TRITICUM AESTIVUM*) OVER-WINTER MORTALITY DUE TO SNOW MOLD. Zachariah J. Miller*, Fabian Menalled, Mary Borrows; Montana State University, Bozeman, MT (041)

While weeds can reduce crop yields through resource competition, they can also impact yields by acting as a reservoir for pathogens and facilitating disease spread. Cheatgrass (*Bromus tectorm*) can reduce winter wheat yields via both mechanisms as it is highly competitive and is known to be an alternate host for *Fusarium spp*. However, effects of Cheatgrass on winterkill in winter wheat caused by *Microdochium nivale* (pink snow mold) have not been reported. Observations made in spring of 2010 of an ongoing experiment designed to investigate the impact of pathogens on crop-weed interactions strongly suggest that Cheatgrass infestation increases crop mortality due to this pathogen. First, 26 of the 160 plots planted with winter wheat exhibited high levels of winterkill and *M. nivale* was isolated from dead and dying wheat plants. Among these high winter kill plots, 92.3 percent were plots where Cheatgrass had been planted, more than expected by chance. We also compared wheat overwinter survival across weed treatments of Wild Oat, Cheatgrass, and Weed Free treatments, winter wheat survival in B. tectorum plots averaged 39%, significantly lower than in the other two treatments. In addition, increasing Cheatgrass fall seedling densities were significantly correlated with estimates of crop over-winter mortality, suggesting that more abundant weeds in the fall lead to increased spread and impact of snow mold. Overall, these observations suggest that the impact of *M. nivale* on rates of winterkill in winter wheat appears to be facilitated by increasing densities of Cheatgrass seedlings. These observations are consistent with the limited dispersal ability of snow mold pathogens that would require susceptible weed plants between rows for the pathogen to spread and cause large patches of winterkilled plants. Consequently, reducing Cheatgrass and other known reservoir species (*Bromus japonicus*, *B. secalinus*, *Dactylis glomerata*, and *Lolium perenne*) seedling densities in the fall may be an effective way to control the spread and impact of pink snow mold.

RESPECT THE ROTATION: A COMPREHENSIVE PARTNERSHIP TO PRESERVE HERBICIDE AND TRAIT TECHNOLOGY. Monte Anderson*, Charlie Hicks, James Rutledge; Bayer CropScience, RTP, NC (042)

Good stewardship practices enable growers to prevent, manage or delay the spread of weed resistance and protect all useful technologies. It is the right thing for crop production agriculture to preserve the utility of glyphosate and properly steward other technologies.

Respect the Rotation is a proposed partnership among all sectors of the agricultural industry to establish a comprehensive initiative to drive industry-wide support for weed management stewardship to preserve trait and herbicide technology.

Working together, the weed science, grower, consultant, government, and commodity communities can better steward weed management technology, preserve conservation tillage opportunities and promote sustainable and profitable row crop production.

GLYPHOSATE EFFICACY ON CANADA THISTLE (*CIRSIUM ARVENSE*) GROWN IN FIELD AND GREENHOUSE SOIL. Taylor M. Close*, Andrew R. Kniss; University of Wyoming, Laramie, WY (043)

Previous greenhouse studies have shown that common lambsquarters and giant ragweed plants grown in an unsterile soil were more severely damaged by glyphosate than those grown in a sterile medium. The objective of this study was to determine whether soil type had an effect on the efficacy of glyphosate on Canada thistle (*Cirsium arvense* L.) grown from rhizomes. Rhizomes were collected from a field near the University of Wyoming greenhouse in September, 2010. Rhizomes approximately 4 mm in diameter were cut to 2 cm and planted in 10 cm pots in either greenhouse or field soil. The field soil was collected from the same field as the rhizomes. Emerged plants were sorted by size and treated with glyphosate at rates from 0 to 3.4 kg ae/ha.

Visual injury ratings were taken 2 weeks after glyphosate application. Plants were harvested 3 weeks after glyphosate application and dried for 48 hours at 60°C. Data were analyzed using analysis of variance. Soil type did not have a significant impact on glyphosate efficacy based on visual injury symptoms or dry weight. The difference in these results compared to previous studies may be attributed to the fact that plants were grown from rhizomes that may have already contained soil pathogens, rather than clean seed. In the future, more studies will be necessary to determine whether there would be a different result if the Canada thistle plants were grown from seed. Other possibilities for further study include sterilizing the rhizomes prior to planting.

EFFECT OF VOLUNTEER CORN DENSITY ON GLYPHOSATE RESISTANT SUGARBEET YIELD. Jared C. Unverzagt*[1], Andrew R. Kniss[1], Robert G. Wilson[2], Gustavo M. Sbatella[2], David A. Claypool[1], Ramesh Sivanpillai[1]; [1]University of Wyoming, Laramie, WY, [2]University of Nebraska-Lincoln, Scottsbluff, NE (044)

A field study was conducted in 2010 to quantify the effect of volunteer corn density on sugarbeet yield loss. The objective of this study was to determine whether remote sensing or light measurements taken mid-season were correlated to sugarbeet yield loss. Volunteer corn was planted into the sugarbeet row at 0, 0.3, 0.5, 0.8, 1.2 and 1.6 plants/m². Plots were 3 m wide by 9 m long and arranged in a randomized complete block design with four replications. Glyphosate was applied as needed to remove weeds other than volunteer corn. Light transmittance (LT) and leaf area index (LAI) measurements were taken above and below the sugarbeet canopy within each plot on July 14. Remote sensing imagery was taken via AEROCam on August 13 in red, green, and near infrared (NIR) bands with a spatial resolution of 0.25 m². Spectral values were calculated for similar locations as LT and LAI measurements, and analyzed in ERDAS IMAGINE software. Sugarbeet root yield, percent sucrose content and recoverable sucrose were measured at harvest on October 5. Measured LAI above the sugarbeet canopy was strongly correlated with root yield and recoverable sucrose (r=-0.8319, P=0.0001 and r=-0.8039, P=0.0001 respectively). LT at the top of the sugarbeet canopy was also correlated with root yield and recoverable sucrose (r=0.9392, P=0.0001 and r=0.9184, P=0.0001 respectively). The NIR spectral values significantly correlated with root yield and recoverable sucrose (r=0.5405, P=0.0064 and r=0.5728, P=0.0043 respectively) but the relationship was not as strong when compared to either LAI or LT.

SMALL BURNET RESPONSE TO HERBICIDES APPLIED POSTEMERGENCE. Ryan L. Nelson*[1], Corey V. Ransom[1], Michael D. Peel[2]; [1]Utah State University, Logan, UT, [2]USDA-ARS Forage and Range Research Lab, Logan, UT (045)

Small burnet (Sanguisorba minor scop) is a perennial, evergreen forb in the rosacaceae family. It is a hardy, relatively long lived forb that does well in most of North America. There is interest in its use to extend grazing of pastures and rangelands into late fall and winter. Two small burnet genotypes were arranged in a randomized complete block design with a split plot arrangement where herbicide treatment was the whole-plot and small burnet genotypes were the sub-plots. Twelve treatments, untreated, clopyralid, imazamox, 2,4DB, metribuzin, aminopyralid, pendimethalin, dimethenamid-P, bromoxynil, dicamba, quinclorac, and clethodim were applied June 4, and November 11, 2009 of the establishment year. Plots were given a visual rating of 1 to 10. 1 = complete mortality and 10 = no injury. Seed was hand harvested and weighed. The remaining biomass was harvested. The dry weight seed yield was added to the dry matter yield

(DMY). Fall treatments of aminopyralid and imazamox showed the most injury reducing seed yield by 95% and 84% and DMY by 48% and 42%. Aminopyralid caused the greatest visual injury of all the spring treatments with a rating of 5.5 compared to 9.0 for the untreated. Fall applications of dicamba caused significant injury with a rating of 5.1 compared to 9.5 for the untreated, and DMY was 7% less than the untreateds with seed yield showing a 14% increase. Data suggests that pendimethalin, dimethenamid-P clethodim, metribuzin, and quinclorac have potential for use in small burnet seed or forage production.

COMPARISON OF INDAZIFLAM PERFORMANCE BETWEEN FALL OR SPRING APPLICATIONS IN ORCHARDS ACROSS THE UNITED STATES. Seth Gersdorf*[1], Darren Unland[2], Monte Anderson[3]; [1]Bayer CropScience, Monmouth, OR, [2]Bayer CropScience, Fountain Hills, AZ, [3]Bayer CropScience, RTP, NC (046)

Indaziflam is a new cellulose biosynthesis inhibitor under development as a preemergence broadspectrum herbicide. This new active ingredient from Bayer CropScience is expected to be available for use in perennial tree fruit, nut, and vine crops as Alion. 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 (Rely 280).

In 2010, fifteen trials were conducted by university and Bayer CropScience researchers to compare fall and spring application timings of Alion. These trials were established in eleven states and included six different crops, 41 annual dicot weeds, nine annual monocot weeds, and 19 perennial weeds. Data was split by weed life cycle (annual versus perennial), weed type (dicot versus monocot), and evaluation date (4-6 months after fall application, 7-9 months after fall application, and 10-12 months after fall application).

Evaluations show that 73 g ai ha-1 indaziflam (5 fl oz Alion) plus a burndown product such as glufosinate (Rely 280) applied in the fall provided 90% or higher control of annual monocot and dicot weeds through the spring (4-6 months after application) and summer (7-9 months after application). The same fall applied treatments controlled the perennial weeds 90% 4-6 months after the fall application but declined by the later evaluations.

The same rate of Alion (73 g ai ha-1 indaziflam) applied in the spring also gave excellent residual control of annual weeds however this timing showed the importance of tankmixing an effective burndown product to control weeds already emerged at the time of application. Initial ratings of the spring applications of Alion showed 70-80% control of annual weeds however once the existing weeds were finally burned down excellent residual control (95%) of newly emerging weeds remained for the duration of the trials. Similar to the fall applications, the applications in the spring were less effective on perennial weeds than on annual weeds as Alion has little effect on existing plant tissue which contributes to an excellent safety profile in perennial crops.

In summary, Alion applied in fall is a viable treatment option in addition to the more common spring application timing. Alion provided excellent residual preemergence control of annual monocot and dicots, superior to most standards tested and demonstrated excellent crop safety.

DISSIPATION AND MOVEMENT OF SOIL-APPLIED HERBICIDE COMBINATIONS IN CORN, DRY BEAN AND SUNFLOWER. Dale L. Shaner*; USDA, Fort Collins, CO (047)

Pre-emergent herbicides are used to control weeds in most of our crops. Combinations of herbicides are applied to broaden the spectrum of weeds controlled. Although many studies have been done on the behavior of individual herbicides in the soil, there are few studies that examine the fate of multiple herbicides applied at the same time. In this study the fate of herbicide combinations (atrazine and metolachlor in corn, flumioxazin and metolachlor in dry beans and pendimethalin and sulfentrazone in sunflowers) in different crops was measured over two years. The herbicides varied in soil binding and in rates of dissipation. In sunflowers, pendimethalin remained in the top 7.5 cm of the soil column, whereas sulfentrazone moved rapidly down the profile with heavy irrigation or rainfall. Flumioxazin also remained in the top 7.5 cm along with metolachlor. However, flumioxazin rapidly dissipated compared to metolachlor. In corn, atrazine moved more readily in the soil with a heavy rainfall compared to metolachlor. Atrazine also rapidly dissipated after the soil temperature increased due to enhanced degradation. Metolachlor dissipated at similar rates in corn and dry beans. The fate of each of the herbicides did not appear to be affected by the presence of other herbicides in the same soil.

COMPARISON OF WEED CONTROL IN CONVENTIONAL AND GLYPHOSATE TOLERANT SUGAR BEET PRODUCTION SYSTEMS. Joel Felix*[1], Don W. Morishita[2], Joey K. Ishida[1], J. Daniel Henningsen[3], Donald L. Shouse[3]; [1]Oregon State University, Ontario, OR, [2]University of Idaho, Moscow, ID, [3]University of Idaho, Twin Falls, ID (048)

Glyphosate resistant sugar beets were introduced for wide commercial production in the United States in the 2008 cropping season. The event will arguably be remembered as the most significant change in sugar beet production since the commercial introduction of monogerm sugar beet seed in 1956. The adoption by growers in sugar beet producing states was rapid, approaching 99% in 2009. However, questions about yield and weed control advantages over conventional hybrids have lingered among some growers. The objective of this study was to compare yield and weed control in conventional and glyphosate resistant hybrids treated with conventional herbicides or glyphosate for the later. Field studies were conducted in 2010 near Ontario, OR and Kimberly, ID. Experimental design at both studies was a randomized complete block with four replications. The soil type at Ontario was an Owyhee silt loam and Portneuf silt loam at Kimberly. Conventional hybrids ‘Syngenta 4773R’ and ‘Syngenta 1339R’ as well as glyphosate resistant ‘BTS 26RR14' and ‘an experimental line from Syngenta’ were planted on April 14 and 19 at Ontario and Kimberly, respectively in 56-cm rows. The crop was planted at a ‘plant-to-stand’ density of 155,555 seeds/ha at Ontario and at 140,900 seed/ha at Kimberly. All hybrids were treated with ethofumesate (1.12 kg ai/ha) PRE followed by a tank mixture of (Phenmedipham+desmedipham+ethofumesate) + Triflusulfuron + Clopyralid when sugar beet plants were at 2-, 4-, and 6-leaf stage. Another set of the same glyphosate resistant hybrids was treated with glyphosate at 0.84 kg ae/ha. The predominant weeds were common lambsquarters (Chenopodium album), Kochia (Kochia scoparia), redroot pigweed (Amaranthus retroflexus), hairy nightshade (Solanum physalifolim), barnyardgrass (Echinochloa crus-galli) and annual sowthistle (Sonchus oleraceus) at both sites. Kimberly also had green foxtail (Setaria viridis) and Russian thistle (Salsola kali). Early season common lambsquarters control at Ontario ranged from 97 to 100% with conventional treatments providing the lowest control. There was no difference among treatments for late season common lambsquarters control at Ontario. Common lambsquarters control at Kimberly ranged from 79 to 88% (early) and 81% (late) with glyphosate; 94 to 97% (early) and 91 to 95% (late) with conventional weed control. Redroot pigweed control at Ontario ranged from 95 to 100% (early) and 93 to 100% (late) with glyphosate; 91 to 98% (early) and 90 to 96% (late) with conventional weed control. At Kimberly, redroot pigweed control was 98 to 99% (early) and 94 to 96% (late) with glyphosate; with conventional treatments providing complete pigweed control early and 96 to 98% late. There was no significant difference among treatments for kochia and annual sowthistle control at either site. Root yield at Ontario was greatest (105 to 108 T/ha) with glyphosate resistant hybrids treated with glyphosate compared to 81 to 94 T/ha when glyphosate resistant and conventional hybrids treated with conventional herbicides. The corresponding root yield at Kimberly was 82 to 89 T/ha for glyphosate and 65 to 117 with conventional herbicides. The study will be repeated to confirm these results.

WEED REMOVAL TIMING BY NITROGEN FERTILITY IN GLYPHOSATE TOLERANT SUGAR BEETS. Abdel O. Mesbah[1], Kyrre E. Stroh*[2]; [1]University of Wyoming, Powell, WY, [2]University of Wyoming, Laramie, WY (049)

Field experiments were conducted in 2010 at the University of Wyoming Research and Extension Center near Powell, Wyoming to evaluate the effect of weed removal timing and nitrogen fertility on yield of glyphosate-resistant sugarbeet. Glyphosate treatments were used to remove weed competition at 1, 3, 4, 5, 8, 12, and 16 weeks after sugarbeet emergence. Glyphosate was applied at 840 g ae/ha^{-1} and repeated one to several times as needed following initial applications. Nitrogen was applied at a split rate (splitting the nitrogen rates between pre-plant and mid-season side dressing) of 0, 85, and 170 kg/ha^{-1}. ANOVA indicated that nitrogen rate and glyphosate application timing affected sugarbeet yield. When kept weed free all season long sugarbeet yields were 26600 kg/ha^{-1}, 36400 kg/ha^{-1} and 38000 kg/ha^{-1} at nitrogen rates of 0, 85 and 170 kg/ha^{-1} respectively. A significant increase in sugarbeet yield resulted when initial glyphosate applications were delayed 3 to 3.5 weeks after sugarbeet emergence at nitrogen rates of 85 and 170 kg/ha^{-1}, yielding 46500 kg/ha^{-1} and 52200 kg/ha^{-1}, respectively. There was not a significant increase in yield in the zero nitrogen treatment when initial glyphosate applications were delayed. Season long weed competition reduced sugarbeet yield by 100%.

COMPARISON OF GLYPHOSATE RESISTANT AND CONVENTIONAL ALFALFA CULTIVARS. Steve B. Orloff*[1], Daniel H. Putnam[2]; [1]University of California, Yreka, CA, [2]University of California, Davis, CA (050)

Glyphosate-resistant alfalfa was developed in late 1997 and became commercially available in the fall of 2005. Plantings were subsequently suspended in March of 2007 until a full Environmental Impact Statement (EIS) could be completed. In January of 2011, USDA again granted non-regulated status to glyphosate-resistant alfalfa. Growers and the alfalfa industry are interested in the performance of glyphosate-resistant alfalfa cultivars and conventional cultivars under their respective weed management systems. Twelve glyphosate-resistant alfalfa cultivars and twelve commercial cultivars plus a standard check cultivar (Vernal) were planted on June 7, 2005. The treatments were replicated four times. In the seedling year the conventional varieties were sprayed with imazamox at 0.04 lbs ai/A and the blocks of glyphosate-resistant varieties were treated with glyphosate at 1.0 lb ai/A or imazamox at the same rate used on the conventional varieties. In years 2, 3 and 4 the conventional alfalfa and a block of glyphosate-resistant cultivars were treated with a dormant-season application in mid-March of Velpar at 0.5 lbs ai/A plus paraquat at 1.0 lbs ai/A. In the last year of the stand, the herbicide treatment was changed to metribuzin at 0.5 lbs ai/A plus the paraquat treatment, a typical treatment for the last year of an alfalfa stand to avoid plant-back problems. The same rate of glyphosate was used each year. By spraying the glyphosate-resistant cultivars with glyphosate or conventional herbicides in different blocks it was possible to separate alfalfa cultivar performance from crop phytotoxicity. Weeds were completely controlled throughout the trial with all the herbicide treatments so weed biomass did not influence yield. The alfalfa was harvested with a Carter forage harvester two times in the seeding year (2005) and four times per year the following years (2006-2009). Averaged over all 12 glyphosate-tolerant cultivars, the first-year alfalfa yield was 0.30 tons per acre greater when the alfalfa was treated with glyphosate than when treated with imazamox. In the subsequent 4 years when the alfalfa was treated with winter-dormant herbicides, there was not a consistent difference in yield when the glyphosate-resistant cultivars were treated with glyphosate versus conventional herbicides. However, over the 5-year stand life, alfalfa yield was 0.48 tons greater when the glyphosate-tolerant alfalfa was treated with glyphosate compared with conventional herbicide treatments. Glyphosate-resistant cultivars and conventional cultivars yielded similarly. Over the 5 years, the yield of the glyphosate-resistant cultivars was 0.26 tons per acre less than the conventional varieties when treated with the conventional herbicide treatments. However, the glyphosate-resistant varieties yielded 0.22 tons higher than conventional varieties over the 5 years when treated with glyphosate. There were significant differences between individual cultivars and there were high yielding conventional and glyphosate-resistant cultivars. All cultivars yielded higher than Vernal, the check variety.

SUMMER ANNUAL WEED CONTROL IN ESTABLISHED ALFALFA IN CALIFORNIA. Andre Biscaro*[1], Steve B. Orloff[2], Rob Wilson[3]; [1]University of California, Lancaster, CA, [2]University of California, Yreka, CA, [3]University of California, Tulelake, CA (051)

As a perennial plant with a long growing season, alfalfa is susceptible to weed invasion by both winter and summer annual weeds. Summer annual weeds, particularly pigweed *(Amaranthus* spp.), green and yellow foxtail (*Setaria* spp.) and lambsquarters (*Chenopodium album*) appear to be an increasing problem in the Intermountain and High Desert areas of California. Two trials were conducted in the Intermountain region of northern California in 2007 and 2008 with the objective of full-season control of both winter and summer annual weeds with a single dormant-season herbicide application. The treatments consisted of the winter-dormant applied herbicides hexazinone, diuron (one study only), metribuzin, and paraquat applied with and without varying rates of pendimethalin. Any treatment with hexazinone completely controlled the winter weeds shepherd's purse (*Capsella bursa-pastoris*) or tansy mustard (*Descurainia pinnata*). Gramoxone applied alone or tank mixed with pendimethalin did not provide acceptable control of these mustard species. The winter dormant-applied herbicides alone did not adequately control the summer weed spectrum. However, when combined with pendimethalin, foxtail and lambsquarters were controlled. The higher rate of pendimethalin (3.8 lbs/A) was needed for pigweed control and for late-season foxtail control in one trial. In the High Desert of southern California, a single dormant-season application has not been sufficient to control pigweed in mid to late-season cuttings, especially where dairy manure is intensively applied. This area has a longer growing season (7 cuts compared with 3 or 4 in the Intermountain area). A trial was conducted in 2010 to evaluate nine pre-emergent treatments using different rates, combinations and split application of trifluralin, pendimethalin, flumioxazin and prodiamine applied on March 5th (before the first cut) and on June 2nd (after second cut), and six post-emergent treatments using different rates and combinations of imazomox, pendimethalin and imazethapyr applied on June 2nd. Pigweed control was evaluated three times: after third, fourth and fifth cuts. Overall, the pre-emergent treatments performed significantly better than the post-emergent. A single application of prodiamine applied before first cut provided the best control (averaged 99% for the three evaluations), followed by a split application of pendimethalin (86% control) and a split application of pendimethalin and flumioxazin (83% control). Among the post-emergent treatments, only the tank-mix of imazamox + imazethapyr approached commercially acceptable control at 77% pigweed control.

PENOXSULAM FOR WEED CONTROL IN CALIFORNIA TREE NUTS. Deb Shatley*[1], Richard K. Mann[2], Barat Bisabri[3], Marc Fisher[4], James Mueller[5], Jesse Richardson[6], Monica Sorribas[7]; [1]Dow AgroSciences, Lincoln, CA, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences LLC, Orinda, CA, [4]Dow AgroSciences LLC, Fresno, CA, [5]Dow AgroSciences LLC, Brentwood, CA, [6]Dow AgroSciences LLC, Hesperia, CA, [7]Dow AgroSciences LLC, Indianapolis, IN (052)

Penoxsulam (Tangent[TM)]) is a new broadspectrum tree nut herbicide to be launched in the United States for the control of many winter annual weeds in bearing and non-bearing almonds, walnuts, pistachios and pecans. Tangent is a 2.0 lb ai/gallon SC (Suspension Concentrate) formulation containing 240 g of penoxsulam per liter. Tangent provides pre-emergence and post-emergence control of glyphosate resistant and susceptible horseweedl (*Conyza canadensis*) and fleabane (*Conyza bonariensis*), as well as the control of many other winter annual weeds including annual sowthistle (*Sonchus oleraceus*), California burclover (*Medicago polymorpha),* coast fiddleneck **(***Amsinckia menziesii* var. intermedia), common chickweed (*Stellaria media*), purple cudweed (*Gamochaeta purpurea*), cutleaf evening-primose (*Oenothera laciniata*), henbit (*Lamium amplexicaule*), mustards (*Sinapis* and *Brassica* spp.), pineapple-weed (*Matricaria discoidea),* prickly lettuce (*Lactuca serriola*), redmaids (*Calandrinia ciliata*), shepherd's-purse (*Capsella bursa-pastoris*), and willowherb (*Epilobium* spp.).

Tangent can be used at 1.0 oz/acre (17.5 gr ai/ha) for short term residual control (2 to 3 months) up to 2.0 oz/acre (35 gr ai/ha) for long term residual control (4 to 6 months). Tangent can be tank mixed with other postemergence and residual herbicides labeled for use in tree nuts for broader spectrum control and complete burndown of all existing weeds. Tangent may be applied during the winter dormant period up to March 15th. A sequential application of 1 oz maybe applied up to 60 days prior to harvest.

[TM] Trademark of Dow AgroSciences LLC

Always read and follow label directions.

WEED CONTROL WITH PENOXSULAM + OXYFLUORFEN IN CALIFORNIA TREE NUTS. Richard K. Mann*[1], Monica Sorribas[2], James Mueller[3], Barat Bisabri[4], Marc Fisher[5], Debbie Shatley[6], Jesse Richardson[7]; [1]Dow AgroSciences, Indianapolis, IN, [2]Dow AgroSciences LLC, Indianapolis, IN, [3]Dow AgroSciences LLC, Brentwood, CA, [4]Dow AgroSciences LLC, Orinda, CA, [5]Dow AgroSciences LLC, Fresno, CA, [6]Dow AgroSciences LLC, Lincoln, CA, [7]Dow AgroSciences LLC, Hesperia, CA (053)

Penoxsulam + Oxyfluorfen (Pindar[TM] GT) is a new broadspectrum tree nut herbicide product being launched in the United States for the control of many winter annual weeds in almonds, walnuts, pistachios and pecans. Pindar GT is a 4.04 lb ai/gallon SC (Suspension Concentrate) formulation premix containing 10 g of penoxsulam + 476 g of oxyfluorfen/liter. Pindar GT provides pre-emergence and post-emergence control of glyphosate resistant and susceptible horseweed (*Conyza canadensis*) and hairy fleabane (*Conyza bonariensis*), as well as the control of many other winter annual weeds including annual bluegrass (Poa annua), annual sowthistle (Sonchus oleraceus), California brome (Bromus carinatus), coast fiddleneck (*Amsinckia menziesii* var. *intermedia*), common chickweed (Stellaria media), cudweed (Gamochaeta spp.), cutleaf evening-primose (Oenothera laciniata), filaree (*Erodium* spp.*)*, henbit (*Lamium amplexicaule*), mallow (*Malva* spp.), mustards (*Sinapis* and *Brassica* spp.), prickly lettuce (*Lactuca serriola*), redmaids (Calandrinia ciliata), mallow (Hibiscus spp.), shepherd's-purse (Capsella bursa-pastoris), and willowherb (*Epilobium* spp.).

Pindar GT at 1.5 to 3.0 pints/acre will provide from 3 to 6 months residual weed control of many winter annual weeds when applied during the winter dormant period from October to February, providing equivalent or better weed control than other standards. For complete burndown of all existing weeds, tankmix Pindar GT with a broadspectrum postemergence herbicide.

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TWO YEARS EFFICACY COMPARISON WITH TWO GLYSORTIA GLYPHOSATE FORMULATIONS AND TWO INDUSTRY STANDARDS. Jim T. Daniel*[1], Philip Westra[2]; [1]Self, Keenesburg, CO, [2]Colorado State University, Ft. Collins, CO (054)

Two Glysortia glyphosate formulations, GLYSORT and GLYSORT PLUS, were compared to ROUNDUP POWERMAX, ROUNDUP WEATHERMAX and TOUCHDOWN HIGH TECH in two greenhouse and three field efficacy trials in 2009 and 2010. Greenhouse evaluations were conducted using corn, dry beans, sunflower, barnyardgrass, velvetleaf, redroot pigweed, green foxtail, kochia, and common lambsquater. Evaluations included both visual observations and dry weight. One field study was conducted with kochia in 2009 and two field studies with kochia and prickly lettuce were conducted in 2010. Visual percent control ratings were taken in all three field studies.

There were no differences in weed control among like glyphosate formulations when averaged across trials and species. GLYSORT PLUS provided weed control equal to ROUNDUP POWERMAX (both with 14% surfactants included) but GLYSORT provided weed control equal to or better than TOUCHDOWN HIGH TECH (7% surfactants included).

INVESTIGATING THE MECHANISMS OF GLUFOSINATE RESISTANCE IN ITALIAN RYEGRASS POPULATIONS. Wilson V. Avila*, Elena Sanchez, Carol Mallory-Smith; Oregon State University, Corvallis, OR (055)

Glufosinate is a broad spectrum post-emergence herbicide used in vineyards, orchards, and cropping systems with the Liberty-Link® trait. Glufosinate is a potent inhibitor of the enzyme glutamine synthetase (GS) which is essential for recycling the ammonia that is released during nitrate reduction, amino acid degradation and photorespiration. GS is a nuclear-coded enzyme that is present in the cytoplasm and plastid, with the plastidic isoform more prevalent in Poaceae species. Italian ryegrass is a troublesome weed in orchards and major cereal crops and has evolved resistance to at least five different herbicide chemical groups. In an herbicide screening test, two Italian ryegrass populations (OR1 and MG) showed a differential pattern of sensitivity to glufosinate. The OR1 population was collected from a hazelnut orchard and also is glyphosate resistant. The mechanism of glyphosate resistance in OR1 is due to reduced herbicide translocation. The MG population was collected from a wheat field and also is resistant to ALS inhibitors. Dose-response, ammonia accumulation and enzyme activity studies were conducted to test the sensitivity of the two populations to glufosinate. A control population (Gulf) was included in the experiments. The rates of glufosinate required to reduce growth by 50% (GR_{50}) were 0.48 and 0.43 kg ai ha^{-1} for OR1 and MG, respectively; whereas, the GR_{50} value for the control population was 0.15 kg ai ha^{-1}. The control population accumulated on average three times more ammonia than the resistant population OR1 and two times more than the MG population at 48, 72, and 96 hours after glufosinate treatment. There were no differences in GS enzyme activity between the control population and the resistant population OR1. However, the MG population was different and had a less sensitive enzyme. These results confirm that both populations evolved resistance to the herbicide glufosinate and two different mechanisms of resistance are likely involved. In the case of the OR1 population, the reduced herbicide translocation mechanism that is responsible for glyphosate resistance appears to be involved in the resistance to glufosinate. However, an altered target site may be responsible for glufosinate resistance in the MG population.

SURVEY OF HERBICIDE-RESISTANT ITALIAN RYEGRASS IN OKLAHOMA. Jon-Joseph Armstrong*, Mark C. Boyles, Joshua A. Bushong, Amanda E. Stone, Thomas F. Peeper; Oklahoma State University, Stillwater, OK (056)

Italian ryegrass (*Lolium multiflorum*) is one of the most widespread and difficult-to-control weeds in winter wheat production in Oklahoma. In recent years, Oklahoma winter wheat producers have been noticing a lack of control of Italian ryegrass with ALS inhibitor herbicides where they previously had satisfactory control. To address the issue of potential herbicide-resistance, seed samples from 300 Italian ryegrass populations were collected from winter wheat fields in Oklahoma in 2008 and 2009 and screened in the field for resistance with nine herbicides (chlorsulfuron + metsulfuron, mesosulfuron, pyroxsulam, imazamox, flufenacet + metribuzin, diclofop-methyl, pinoxaden, quizalofop P-ethyl, clethodim, and glyphosate) representing five modes of action (ALS inhibitor, shoot growth inhibitor + PSII inhibitor, ACCase inhibitor, and aromatic amino acid synthesis inhibitor). Standard field use rates for each herbicide were used. Visual estimates of weed control were collected and populations were characterized as “susceptible” (80-100% control), “suppressed” (51-79% control), or “resistant” (≤50% control). In 2008 and 2009, though control varied among individual herbicides, only 28-51% of the populations tested were classified as controlled with ALS inhibitor herbicides, indicating that ALS-resistant Italian ryegrass is prevalent throughout Oklahoma. All ryegrass populations collected in 2008 and 2009 were susceptible to flufenacet + metribuzin, quizalofop P-ethyl, clethodim, and glyphosate. Though ACCase-resistant Italian ryegrass is not thought to be present in Oklahoma, three populations collected in 2009 were controlled at less than 50% with diclofop-methyl and pinoxaden. Herbicide-resistance testing efforts will continue to monitor the development and spread of ACCase- and glyphosate-resistant Italian ryegrass.

EFFECT OF SAFLUFENACIL AND FLUMIOXAZIN APPLIED PRE-HARVEST ON CANOLA YIELD AND SEED QUALITY. Jordan L. Hoefing*, Brian Jenks, Gary Willoughby; North Dakota State University, Minot, ND (057)

A study was conducted in 2010 to evaluate the use of desiccants as a canola harvest aid. The objectives were to determine the effect of desiccants applied preharvest on canola yield, seed moisture, and seed quality. The desiccation treatments were applied when at least 60% of the seeds had started to turn color. Treatments included saflufenacil at 1, 2 and 4 fl oz; glyphosate at 0.75 lb ae; saflufenacil plus glyphosate (1 fl oz + 0.75 lb ae); diquat at 1.5 pt; and flumioxazin at 1 oz ai. A swathed treatment and straight cut-only treatment were also included. Diquat was applied at 20 gpa. All other desiccation treatments were applied at 10 gpa. Treatments were evaluated for percent pod and stem desiccation at 4, 8, 11, and 14 days after treatment (DAT). Seed moisture at harvest was estimated using a hand-held moisture tester. Yield and test weight were determined by harvesting the middle four feet of each plot with a small plot combine. Seed samples were evaluated for green count, damage, and overall grade. Diquat provided faster visual pod and stem desiccation throughout the study. Glyphosate alone was slower compared to other treatments; however, there was some maturity variability between reps. Treatments containing glyphosate tended to have lower canola yield; however, we do not know if this is a true treatment effect or just due to natural plot variability. The swathed treatment yielded slightly higher than desiccated treatments, which is in contrast to previous studies. Test weight was not impacted by any of the desiccants. Test weight for the straight cut treatment was slightly lower, which may be due to harvesting at slightly higher seed moisture. Green count was higher in the diquat and swathed treatments compared to the other desiccants and the straight-cut treatment. In a 3-year desiccation study from 2005-2007, we did not observe yield reductions from diquat or paraquat treatments compared to swathing. This study will be conducted again in 2011 to help answer these questions.

WEED CONTROL WITH SAFLUFENACIL IN SOYBEAN. Gregory J. Endres*, Blaine G. Schatz; NDSU, Carrington, ND (058)

Field trials were conducted in 2009 and 2010 at the NDSU Carrington Research Extension Center to evaluate early-season weed control and soybean response to soil-applied saflufenacil. Experimental design was a randomized complete block with three replicates. The reduced-till, dryland trials were conducted on Heimdal-Emrick loam soil with 5.9 pH and 3.9 to 4.2% organic matter. Dairyland Seed RR ‘0401’ inoculated soybean was direct-seeded in standing small grain stubble in 30-inch rows on May 21 (2009) and May 19 (2010). Preplant (2009) or PRE (2010) burn-down herbicides were applied to annual broadleaf weeds ranging from 0.5- to 2-inches tall. Rainfall ranging from 0.9 to 1.1 inches occurred within 4 to 9 d after treatment (DAT). Herbicide treatments included glyphosate at 0.75 lb ae/A, saflufenacil at 0.023 lb ai/A plus glyphosate at 0.75 lb ae/A, and saflufenacil at 0.023 lb ai/A plus imazethapyr&glyphosate at 0.048&0.56 lb ae/A (2010). POST glyphosate at 0.75 lb ae/A was applied during early July across the trial except the untreated check. Soybean was harvested with a plot combine during the first half of October. In 2009, kochia control 4 DAT was 40% with glyphosate compared to saflufenacil plus glyphosate at 86%. However, 13 and 27 DAT, kochia control was similar between glyphosate and saflufencil plus glyphosate (96 to 98% and 83 to 89%, respectively). Kochia control declined to 50% with glyphosate 47 DAT compared to control at 72% with saflufenacil plus glyphosate. In 2010, common lambsquarters control 19 DAT was 77% with glyphosate compared to saflufenacil treatments at 87 to 91%. At 42 DAT, common lambsquarters control was 91% with saflufenacil plus imazethapyr&glyphosate. Wild buckwheat control at 7 and 19 DAT with glyphosate was 75 to 77% compared to 86 to 94% with saflufenacil treatments. No crop response was observed during either trial. Soybean seed yield was similar among treatments in 2009. In 2010, soybean yield increased with herbicides compared to the untreated check. During both years, yield tended to be highest with saflufenacil treatments.

DRY PEA AND CHICKPEA TOLERANCE TO SAFLUFENACIL TANK MIXED WITH OTHER PPO INHIBITORS. Brian M. Jenks*, Jordan L. Hoefing, Gary Willoughby; North Dakota State University, Minot, ND (059)

The 2010 Sharpen label prohibits tank mixing saflufenacil with other PPO inhibitors such as sulfentrazone and flumioxazin. Previous NDSU and MSU research has shown that these combinations may provide better weed control than either herbicide applied alone. This study was conducted at Minot, ND and Bozeman, MT to confirm whether a tank mix of two PPO inhibitors is safe on dry pea and chickpea. All treatments were applied preemergence (PRE). Treatments included saflufenacil (25 g/ha), sulfentrazone (158 g/ha), fomesafen (210 g/ha), flumioxazin (72 g/ha), and pendimethalin (1,600 g/ha). Saflufenacil (25 g/ha) was also tank mixed with each of the other herbicides. Glyphosate was applied PRE across the entire study. The studies were conducted using traditional small plot techniques. At Minot, flumioxazin was the only treatment that caused significant dry pea or chickpea injury (≤15%). Tank mixing saflufenacil with flumioxazin did not significantly increase injury in either crop. There was essentially no injury from saflufenacil alone or tank mixed with other PPO inhibitors such as sulfentrazone and fomesafen. In chickpea, saflufenacil and sulfentrazone applied alone provided about 80% biennial wormwood control. Applied together as a tank mix, saflufenacil + sulfentrazone provided 99% biennial wormwood control. Similar increases were observed with saflufenacil + fomesafen and saflufenacil + flumioxazin. At Bozeman, the study was conducted in dry pea only. No crop injury was observed. All treatments provided good to excellent control of a light population of Russian thistle, kochia, prickly lettuce, wild mustard, and wild buckwheat. Previous MSU trials have shown an advantage in weed control when two PPO herbicides are combined as PRE treatments in a pea crop.

GREENHOUSE SCREENING OF CORN GLUTEN MEAL AND MUSTARD SEED MEAL AS NATURAL WEED CONTROL PRODUCTS. Jialin Yu*[1], Don W. Morishita[2]; [1]Univer. of Idaho, Moscow, ID, [2]University of Idaho, Moscow, ID (060)

Allelopathy is defined as any process that involves allelochemicals produced from plants in natural or agricultural systems to restrain the emergence, growth, and reproduction of neighboring plants. Corn (*Zea mays* L.) gluten meal (CGM) and yellow mustard (*Sinapis alba* L.) seed meal (MSM) can release biologically active allelochemicals and might be useful as pre-emergent alternative weed control products. The objective of study was to compare the effects of CGM and MSM, applied at three rates, on the emergence and above-ground dry weight of five broadleaf and two grass weed species. A greenhouse experiment was conducted using 25 by 71 cm plastic trays filled with a 4:1 ratio of field soil and potting mix. CGM and MSM were mixed with 1.5 kg amount of soil mix and applied at rates equivalent to 2240, 4480, and 6720 kg ha^{-1}. This mixture of CGM and MSM with the soil mix simulated a soil incorporation application. MSM was generally more effective than CGM for controlling weeds. Both meals and application rates were significantly different for redroot pigweed (*Amaranthus retroflexus* L.) and green foxtail (*Setaria viridis* (L.) Beauv.) control. However, kochia (*Kochia scoparia* (L.) Schrad.) and Russian-thistle (*Salsola tragus* L.) control was very similar between the two meals and three rates . Common lambsquarters (*Chenopodium album* L.) control was better with MSM than CGM averaged over the three application rates. Variability between the two studies was observed for controlling barnyardgrass (*Echinochloa crus-galli* L. Beauv.) and annual sowthistle

(*Sonchus oleraceus* L.). In contrast to the Kimberly results, above-ground biomass inhibition of these two weed species was significantly better in the Moscow study with MSM than CGM. At Kimberly, there were no differences in barnyardgrass or annual sowthistle control with CGM or MSM.

COMPARISON OF SEED PRODUCTION AND GERMINABILITY IN THE ANNUAL WEEDS *ANODA CRISTATA*, *IPOMOEA PURPUREA* AND *PHYSALIS WRIGHTII* WITH AND WITHOUT MELOIDOGYNE INCOGNITA INOCULATION. Cheryl Fiore*[1], Jill Schroeder[1], Stephen Thomas[1], Leigh Murray[2], Jacki Trojan[1], Naomi Schmidt[1]; [1]New Mexico State University, Las Cruces, NM, [2]Kansas State, Manhattan, KS (061)

Various studies have provided estimates of seed counts for a variety of weeds Studies have estimated "one *Ipomoea purpurea* (PHBPU) can produce 26,000 seeds/plant and another study reported *Anoda cristata* (ANVCR) produced up to 17,832 seeds/plant. Numerous biotic and abiotic factors contribute to the quality and quantity of seeds produced by an individual plant as well as the germinability of the seed once it has matured. A trial was conducted over the summer of 2009 to determine the effect of *Meloidogyne incognita* (RKN) on seed production and germinability of three annual weeds common in crop production in southern New Mexico: ANVCR, PHPBU *Physalis wrightii* (PHYWR). The study was established in 76-cm- diameter microplots containing fine sandy loam in a completely randomized paired split plot design. Seven pairs of plots were planted with one species to establish three plants for each plot; each pair of micoroplots consisted of one RKN inoculated (+RKN) plot and one non-inoculated (-RKN) plot for each species for a total of 42 plots. Growing degree hours were calculated for seed emergence, flowering, seed set and harvest dates. Seeds were harvested and dried; 100 seeds/species were counted and weighed to estimated total number of seeds/plot. One hundred seeds/ species were planted and counted as they germinated. Separate analysis for each species was performed using SAS GLM and GENMOD. The analysis of growing degree days from emergence to seed production was not statistically different for +RKN or -RKN. Total estimated seed production (dry seed weight) was not significantly different within each species. The analysis of seed germination by species and RKN treatment was statistically different for ANVCR with a trend of fewer seed germinating from plants that had grown in the presence of RKN. In the analysis for PHYWR fewer seeds germinated from the plants grown in the absence of RKN than in the presence of RKN, but the difference was not statistically different. PHPBU germination was statistically different for the RKN treatments with fewer seeds germinating from the plants grown in the presence of RKN.

CAMELINA TOLERANCE TO SOIL-APPLIED HERBICIDES. Prashant Jha*[1], Robert Stougaard[2], Josefina Garcia[1]; [1]Montana State University, Huntley, MT, [2]Montana State University, Kalispell, MT (062)

Field experiments were conducted in the Northwestern Agricultural Research Center, Kalispell, and in the Southern Agricultural Research Center, Huntley, MT, in 2010, to determine the tolerance of *Camelina sativa* cv. 'Ligena' to soil applied preemergence herbicides. Camelina was seeded 0.6 cm deep at 5.6 kg ha^{-1} in 17.8-cm wide rows on May 4 in Kalispell and March 29 in Huntley. The soil type at Kalispell was very fine sandy loam, while the soil at the Huntley site was Fort Collins and Thurlow clay loam. Experiments were conducted in a randomized complete block design with a factorial arrangement of treatments and four replications. Treatments included herbicides dimethenamid (Outlook), pendimethalin (Prowl), quinclorac (Paramount), metolachlor (Cinch) and pyroxasulfone (KIH-485) applied preemergence at three different rates. A non-treated control was included for comparison. Percent crop injury was visually rated at 40 days after application (DAA) using a scale of 0 to 100, where 0 represents no injury and 100 represents complete injury or plant death. Plant density and biomass were determined 90 DAA by collecting the above ground biomass from two 2-m^2 quadrates placed at the center of each plot. Plant height (90 DAA) and days to flowering were recorded. Plots were kept weed-free by hand weeding until harvest. Depending on the herbicide and rate applied, crop injury was 0 to 78% at Kalispell (sandy loam soil) compared with 0 to 35% injury at the Huntley site (clay loam soil). Injury from medium to high rates of dimethenamid (0.94 and 1.26 kg ai/ha), pendimethalin (4.26 kg ai/ha), and metolachlor (3.2 kg ai/ha) and low to high rates of pyroxasulfone (0.06 to 0.25 kg ai/ha) exceeded 37% in the sandy loam soil. In the clay loam soil, injuries greater than 31% were evident only with high rates of pyroxasulfone (0.25 kg ai/ha) and pendimethalin (4.26 kg ai/ha). Across years and locations, quinclorac (0.28 to 0.84 kg ai/ha) caused the least injury (0 to 10%). Crop injury due to herbicides mainly occurred as plant density reductions, but stunting also contributed to the injury. Although several treatments reduced plant densities, late-season measurements including plant height and biomass did not differ. This suggests that camelina has robust growth and compensatory abilities. At Kalispell site, only dimethanamid treatment at the high rate yielded lower than the non-treated check (2160 kg/ha). At Huntley site, high rates of dimethenamid and pendimethalin and medium to high rates of pyroxasulfone caused up to 31% yield reductions compared to the non-treated check (2395 kg/ha). In conclusion, all herbicides evaluated except quinclorac caused early-season injury to camelina, especially at high rates in sandy soil. There is a need for further evaluation of these herbicides for use in camelina. The data generated will be used to register these herbicides through IR4 and EPA.

CHEMICAL PRODUCERS AND DISTRIBUTORS ASSOCIATION (CPDA) ADJUVANT CERTIFICATION PROGRAM. Gregory K. Dahl*[1], Joe V. Gednalske[2], Bill Bagley[3], Bruce Bollinger[4], Mark Bernards[5]; [1]Winfield Solutions LLC, St. Paul, MN, [2]Winfield Solutions LLC, River Falls, WI, [3]Wilbur Ellis Company, San Antonio, TX, [4]Rosen's Inc., McCordsville, IN, [5]University of Nebraska-Lincoln, Lincoln, NE (063)

The Chemical Producers and Distributors Association (CPDA) has instituted a certification program for adjuvants. This program was developed to address issues including adjuvants not being registered like pesticides, customer confusion and frustration from lack of standardized definitions, undefined functionality claims, safety and handling concerns, inconsistent composition, variable performance and use of incorrect products or rates.

The adjuvant certification program is voluntary. The applicant submits an application, including the company address, contact information, product name, product type, product label, toxicity studies, and the MSDS. CPDA reviews the application information for accuracy, completeness, and compliance with CPDA labeling and performance standards.

After the review is completed and certification fees are paid the product is designated as a “CPDA Certified Adjuvant”.

The CPDA Certified Adjuvant program has improved understanding of adjuvants. CPDA developed and adopted “Labeling and Performance Standards for Spray Adjuvants and Soil Conditioners”. Adjuvant terminology has been standardized using terminology in ASTM

Designation E 609 and E 1519. The CPDA Certified Adjuvant Program is gaining recognition in the industry and now includes several dozen products.

Project 4. Teaching and Technology Transfer

THE IMPORTANCE OF EDUCATION IN MANAGING INVASIVE PLANT SPECIES.
Stephen L. Young*; University of Nebraska-Lincoln, North Platte, NE (064)

Clearly, the effects of invasive plant species have reached global scales and their related costs have been estimated in the billions of dollars. The question that has not adequately been addressed is whether landowners and managers are making significant progress in managing invasive plant species populations. Control techniques are widely available and include biological, chemical, cultural, and mechanical, yet invasive plant species continue to threaten many ecosystems on regional scales, particularly rangelands, wild lands, and grasslands.

One way to indirectly address the rapid advancement of invasive plant species is through awareness and education. Opportunities are needed to provide land owners and managers with the basic principles and practices related to invasive plant ecology and management. In addition, policy makers and the public need to be made aware of the seriousness of invasive plant species. Several short courses that focus on or include invasive plant species have been developed recently and could play a major role in educating individuals with broad backgrounds and experiences. This poster will summarize these courses and speculate on their far-reaching effects. The most successful programs have started with awareness and then education. Maybe it is time to take a page out of one of the most successful public service announcements from the US Forest Service, which reminds us that "only you can prevent forest fires".

ESTABLISHING WEED PREVENTION AREAS (WPAS): A STEP-BY-STEP GUIDE.
Stephanie D. Christensen*[1], Corey V. Ransom[1], Brenda Smith[2], Ralph E. Whitesides[1]; [1]Utah State University, Logan, UT, [2]USDA-ARS, Burns, OR (065)

Weed Prevention Areas (WPAs) are a relatively new tool developed to help slow the spread of weeds into non-infested areas, and minimize environmental and economic costs. They are defined as cooperatively managed areas that focus on implementing weed prevention and early detection at a community level. A guide was designed to provide interested groups a step-by-step process for effectively implementing a prevention program in their area. The process includes five main steps 1) introduce the WPA concept, 2) organize the WPA, 3) develop the action plan, 4) implement the action plan, and 5) evaluate the action plan. For each step the guide contains information, explanations, and ideas providing guidance while remaining flexible enough that a WPA can be developed to fit different situations and needs. At the end of each step, an additional resources page provides links and references to ensure that interested groups have the necessary information and tools to succeed. Several worksheets and templates are also included for use in planning and recording management activities. This guide will assist landowners in developing proactive, coordinated management efforts to protect valuable resources from the costly, damaging effects of invasive weeds.

COMMON WEEDS OF THE YARD AND GARDEN - A GUIDEBOOK. Brenda J. Lowry, Ralph E. Whitesides*, Corey V. Ransom, Roger E. Banner, Steve A. Dewey; Utah State University, Logan, UT (066)

The State of Utah has listed 27 plants on their noxious weed list. An Extension Publication titled "Noxious Weed Field Guide for Utah" has been used extensively to teach the public about the identification and biology of the legally listed noxious weeds. More than 25,000 copies of the Noxious Weed Field Guide for Utah have been sold during a 10-year period. Utah State University County Agents, County Weed Supervisors, and members of the Utah Nursery and Landscape Association requested a weed identification guidebook that was smaller than "Weeds of the West" but more expansive than the Noxious Weed Field Guide. In addition, many horticulturalists said that they had problems with commonly occurring weeds that are not on the noxious weed list and thus would like a weed identification guide that included noxious weeds (as appropriate) but focused on weeds more commonly encountered in the yard and garden. The concept of a guidebook to be titled "Common Weeds of the Yard and Garden" was developed in the summer of 2005. A graduate student was recruited for the project in 2006 and support from external sources such as County Agents, Weed Supervisors, and horticulturalists was solicited. The advisory committee limited the publication to 50 weeds. Text was written and images were collected during 2007 and 2008. Guidebook layout considerations included listing weeds alphabetically by common names; categorizing weeds according to problem area, such as weeds of turf, weeds of gravel driveways, weeds of gardens and weeds of flower beds; organizing by appearance (color, type of inflorescence, prostrate, woody, etc.); and, listing weeds from most detrimental to least. Ultimately weeds were organized alphabetically by scientific family name, and within families by scientific generic and specific names. Fourteen references were used throughout the guidebook. The objective was to have all information in the guidebook corroborated by at least two credible sources. An internet-accessible version was developed in 2007. The expanded version of the guide (web version) was completed by summer 2009. The shorter booklet version was completed by fall 2009. The guidebook was completed and 5000 copies were printed in February 2011. Online access of the expanded version of the guidebook is found at extension.usu.edu/weedguides. Of the 50 weeds listed in the "Common Weeds of the Yard and Garden" guidebook only five are also listed on the state noxious weed list for Utah.

Project 5. Basic Biology and Ecology

NEW HOST-FUNGUS RECORDS FOR POWDERY MILDEWS ON WEEDY PLANTS OF THE PACIFIC NORTHWEST. Frank M. Dugan*[1], Renuka Attanayake[2], Dean A. Glawe[2], Weidong Chen[3]; [1]USDA-ARS WRPIS, Pullman, WA, [2]Washington State University, Pullman, WA, [3]USDA-ARS Grain Legume Genetics, Pullman, WA (067)

New state host-fungus records documented in our research include *Golovinomyces cynoglossi* on houndstongue (*Cynoglossum officinale*) collected in Montana; and *Golovinomyces* sp. on annual sowthistle (*Sonchus oleraceus*) and *Erysiphe trifolii* on yellow sweetclover (*Melilotus officinalis*) in Washington State. With artificial inoculation, we obtained infection of *E. trifolii* originating from field pea (*Pisum sativum*) on several plants, including yellow sweetclover and California burclover (*Medicago polymorpha*), both well documented in the Pacific Northwest. *E. trifolii* is recently documented on pea and lentil (*Lens culinaris*), important crops in the Pacific Northwest. G. cynoglossi has been previously reported on houndstongue in the U.S. and Canada, and used as an experimental biological control agent for that host. Prior records of *Golovinomyces* sp. on species of sowthistle in Florida, Oklahoma and Pennsylvania are attributed to *Golovinomyces (Erysiphe) cichoracearum*, a pathogen of many asteraceous plants. Thousands of host-fungus records such as these, entered into the online Systematic Mycology and Microbiology Laboratory databases, now enable formulation and testing of hypotheses on invasion biology.

NITROGEN SUPPLEMENTATION DOES NOT AFFECT LEVEL OF AN ALKALOID SWAINSONINE IN FOUR LOCOWEEDS. Nina S. Klypina*[1], Janakiraman Maruthavanan[1], Kevin J. Delaney[2], Carol J. Lange[1], Tracy M. Sterling[3]; [1]New Mexico State University, Las Cruces, NM, [2]USDA-ARS NPARL, Sidney, MT, [3]Montana State University, Bozeman, MT (068)

Locoweeds are plants of the Fabaceae family that can be highly poisonous to livestock and wild animals. Locoweed toxicity depends on the association of a plant and a fungal endophyte which produces the alkaloid swainsonine (SWA); however, environmental factors affecting SWA synthesis are unknown. Additionally, locoweeds can be associated with a bacterial symbiont, nitrogen-fixing *Rhizobium* spp. that provides reduced nitrogen for plant growth and may alter SWA synthesis. We examined responses of SWA production, photosynthetic activity, pigment levels, and plant growth to nitrogen (N) supplementation in four locoweed taxa which differ in average leaf SWA concentration. Plants were grown in a greenhouse environment and provided 0 to 4 mM of ammonium nitrate; leaves were collected several times over a three-month period and analyzed for SWA. Shoot and root mass, leaf photosynthetic rate, and pigment concentrations had positive N dose responses and supplemental N increased shoot growth more than root growth in all four locoweeds. A small, temporary increase of SWA with increasing N was detected only in the very low SWA producer (0.001 % SWA in leaves) *Astragalus mollissimus* var. *matthewsii*. SWA levels in moderately high producers (0.15-0.20 % SWA) *Oxytropis sericea* and *A. m.* var. *bigelovii* had negative dose response to supplemental N, while the highest SWA producer (0.35 % SWA) *A. m.* var. *mollissimus* did not have a significant response. Our results demonstrate that nitrogen supplementation, even at levels which promote locoweed growth and photosynthesis, does not have a consistent effect on SWA production.

A STABLE CARBON ISOTOPE METHOD FOR MONITORING WEED SEED DYNAMICS. David A. Claypool*[1], Andrew R. Kniss[1], Dennis C. Odero[2]; [1]University of Wyoming, Laramie, WY, [2]University of Florida, Belle Glade, FL (069)

Weed seed germination patterns and soil seed bank depletion are strongly influenced by seed dormancy which is inextricably tied to the age structure of weed seed banks. No method currently exists to quantify weed seed bank age structure *in situ*. Once seed is shed from the maternal plant to the soil, there is no way to differentiate that seed from others already in the soil. The objective of this project was to develop a method for using stable carbon isotopes as tracers so we may better study the impact of land management practices on weed seed banks. Maternal jointed goatgrass plants were tagged under greenhouse and field conditions with a carbon isotope signature, and that signature was passed on to the seed that was produced. $\delta^{13}C$ values for jointed goatgrass seed produced under ambient CO_2 conditions averaged -26.4, with a 99% confidence interval of -25.4 to -27.4. When maternal plants were exposed to 99-atom % $^{13}CO2$ for 2 hours during seed production, $\delta^{13}C$ values increased to 15.9 on average, with 99% confidence interval of -5.6 to 37.4. Due to these differences, plants exposed to a single pulse of $^{13}CO2$ produced seed that was easily and reliably traceable. By analyzing the soil seed bank for the carbon isotope signature in subsequent years, we will be able to monitor the dormancy, viability, and emergence patterns under normal agricultural practices without the need for soil sterilization or artificial seed bank supplementation. This line of research may lead to a new understanding of how weed and crop management practices influence weed seed bank dynamics.

EFFECTS OF AMINOPYRALID, AMINOCYCLOPYRACHLOR, AND CLOPYRALID HERBICIDES ON SEED GERMINATION AND SEEDLING DEVELOPMENT OF SCOTCH BROOM. Timothy B. Harrington*; USDA Forest Service, Olympia, WA (070)

Scotch broom (*Cytisus scoparius*) is a large non-native shrub that has extensively invaded forest and grassland sites in 27 U.S. states. Three herbicides were compared in a growth chamber study for their ability to control seed germination and seedling development: Method® (aminocyclopyrachlor), Milestone® (aminopyralid), and Transline® (clopyralid). Populations of 50 seeds each were sown in rectangular containers filled with a fixed weight of glacial outwash soil (Grove series, Matlock WA). For each herbicide, three rates (0%, 50%, and 100% of the maximum labeled rate) were replicated six times in a randomized complete block design with blocking on location within the growth chamber. Growing conditions consisted of a dark/light regime of 14 hr/10 hr at 15°/20°C with soil water maintained near field capacity. Seedling emergence and mortality were counted every 1 to 3 days for 90 days. At study completion, seedlings were removed from each container and dried to a constant weight at 65°C to estimate average biomass. Data were subjected to analysis of variance (ANOVA) to test effects of herbicide, rate, and their interaction (α=0.05). Final emergence averaged 40% of seeds sown, and it did not differ among herbicides, rates, or their interaction. However, each of the herbicides caused swelling and negative geotropism of the hypocotyl and inhibited development of root hairs. Seedling mortality began approximately 5 days after treatment, and at study completion it averaged 84%, 76%, and 62% for containers treated with Method®, Milestone®, and Transline®, respectively. Main effects of herbicide and rate were significant in the ANOVA for seedling mortality. Mortality averaged greater for containers treated with Method® than those treated with Transline®. Seedling mortality also increased with increasing herbicide rate. For average biomass per seedling, main effects of herbicide rate were significant but main effects of herbicide were not. Biomass of seedlings growing in the 50% and 100% rates averaged 42% and 31%, respectively, of that in the non-treated check. Each of the herbicides tested provided excellent control of newly-germinated Scotch broom seedlings with mortality averaging over 80% when applied at the maximum labeled rates. Frail condition of surviving seedlings is likely to render them susceptible to stress of normal field conditions. These treatments provide highly effective tools for controlling establishment of Scotch broom where a seed bank is present.

COMPARISON OF FOLIAR VS BASAL BARK APPLICATIONS OF RADIOLABELED AMINOCYCLOPYRACHLOR IN SELECT TREE SPECIES. Jared L. Bell*, Ian C. Burke, Dilpreet S. Riar; Washington State University, Pullman, WA (071)

Aminocyclopyrachlor is a new herbicide proposed to control weeds in nonagricultural areas. Absorption and translocation were evaluated on quaking aspen (*Populus tremuloides*) and black cherry (*Prunus serotina).* Three formulations were studied using two application methods. The acid (DPX-MAT28) was applied foliarly. Two formulations were applied basally; an oil soluble liquid of the acid (DPX-MAT28OL) and an emulsifiable concentrate of the ester (DPX-

KJM44EC). For foliar treatment, the second leaf on the lowest branch was covered and plants were treated with a non-radiolabeled mixture containing 210 g ai/ha DPX-MAT28 and nonionic surfactant at 0.25% v/v. Covered leaves were treated with 29.29 kBq radioactive herbicide. For basal applications stems were spotted with 10 µL of herbicide mixture containing non-radiolabeled (0.25 mg ai), radiolabeled material (22.56 kBq) and bark oil. Plants were harvested at 2, 8, 24, or 72 hours after treatment (HAT) and divided into parts. Parts were dried, weighed, ground and sub-sampled for oxidation and ^{14}C recovery. Foliar-applied DPX-MAT28 reached a maximum absorption of 9.9% in aspen and 8.0% in cherry. Translocation of applied radiolabeled herbicide was 2.0% and 1.2% at 72 HAT. Basal-applied DPX-MAT28OL absorption was 48.3% in aspen and 67.7% in cherry at 72 HAT. Translocation 72 HAT was 13.0% in aspen and 20.2% in cherry. Basal application of DPX-KJM44EC had absorption of 54.8% in aspen and 53.0% in cherry at 72HAT. Translocation was 24.0% in aspen and 15.8% in cherry 72 HAT. Woody plants may be better controlled using basal bark herbicide application when compared to foliar application.

HERBICIDE CROSS-RESISTANCE IN ACETOLACTATE-SYNTHASE INHIBITOR RESISTANT PRICKLY LETTUCE. Alan Raeder*, Isaac Madsen, Ian C. Burke; Washington State University, Pullman, WA (072)

Sulfonylureas and imidazilinones are important classes of herbicides used to control many broadleaf weeds including prickly lettuce (*Lactuca serriola*) in small grain production systems in the inland Pacific Northwest. Over the last two decades, prickly lettuce has developed resistance to several acetolactate synthase (ALS) inhibitors in two chemistry classes. To begin to understand the possible mechanisms of resistance present in ALS in prickly lettuce, six known ALS-resistant biotypes of prickly lettuce from the inland Pacific Northwest were screened for resistance to 13 ALS-inhibitors in the four chemistry classes. The study was conducted with a randomized complete block design with split plots and four replications. The herbicide treatments were main plots, and the biotypes were sub-plots. The study was repeated in space. At the 4 to 6 leaf stage, individual treatments containing all six biotypes were sprayed with imazapic, imazapyr, imazethapyr, flucarbazone, propoxycarbazone, chlorsulfuron, iodosulfuron, metsulfuron, prosulfuron, thifensulfuron, triasulfuron, tribenuron, and pyroxsulam at maximum labeled rates. For comparison purposes, a non-treated check was included. Visual estimates of control were recorded 20 days after treatment. Aboveground biomass was harvested after rating. Both fresh and dry weights were recorded. The six prickly lettuce biotypes were resistant to most of the ALS-inhibiting herbicides used. While the majority of the selected herbicides were not effective at controlling these prickly lettuce biotypes, control was observed when imazapyr, triasulfuron, and prosulfuron were applied at labeled rates in several biotypes. Some biotypes were resistant to a greater number of the herbicides than others suggesting variation of binding efficiency to ALS within herbicide chemical subclasses, increased herbicide metabolism, or variation in mutations in the binding site. Prickly lettuce is a highly variable weed species that displays herbicide resistance to a wide range of ALS inhibiting herbicides.

POLITICS AND PROMISCUITY: THE UNINTENDED CONSEQUENCES OF GOING GREEN. Michael P. Quinn, Carol A. Mallory-Smith*, James Myers; Oregon State University, Corvallis, OR (073)

In Oregon's Willamette Valley, a combination of need for broadleaf rotational crops and an increased desire for local biofuel production has created interest among growers for planting *Brassica napus* (canola). However, questions have arisen over the potential damage large scale canola production could have on the existing *Brassica* vegetable seed production industry. The reputation of the *Brassica* vegetable seed production industry is based on the purity and the high quality of seed. In fact, a seed lot may be rejected if more than three outcrossed seed per 1,000 seed is found. The risk is even greater if the crops are cross pollinated with transgenic canola because some international purchasers of the vegetable seed crops have zero tolerance for transgenic contamination. While there is a great deal of information on hybridization between canola and weedy species, very few studies address hybridization between canola and related vegetable species. To address this issue, experiments were conducted in 2007, 2008, and 2009 using *Brassica rapa* and *Brassica oleracea* inbred lines as pollen receptors placed within a conventional (non GMO) *B. napus* field. Flow cytometry, morphological analysis, and molecular markers were used to identify hybridization between the species. Greenhouse crosses were conducted using either a conventionally produced imazamox resistant or a transgenic glyphosate resistant *B. napus* line as the pollen parent and either a self-incompatible *B. rapa* var. *chinensis* (Chinese cabbage) or cytoplasmic male sterile (CMS) *B. oleracea* var. *italica* (broccoli) inbred lines as the maternal parent. Herbicide resistant *B. napus* lines were used because they provide a reliable selectable marker for positive identification of a cross. Results of the field experiments indicated that hybridization occurred 74% in 2007, 89% in 2008, and 15% in 2009 between *B. napus* and *B. rapa* inbred lines. However, no hybridization occurred between *B. napus* and either *B. oleracea* inbred line. Results of the greenhouse crossing experiments using *B. rapa* as the maternal parent resulted in hybridization rates which ranged from 0 to 15.3% depending on *B. rapa* var. *chinensis* inbred line, and on which herbicide resistant *B. napus* paternal parent was used in the cross. Greenhouse crosses using *B. oleracea* inbreds as the maternal parent produced no germinable seed, and none of the aborted seed tested positive for the presence of the transgene. Presence of transgenic material was detected in both germinable and non-germinable seed produced on non-transgenic *B. rapa* female plants in the greenhouse crosses. We believe this is the first documentation of transgenic material identification in non-germinable seed produced on non-transgenic plants. This research demonstrates that the potential exists for hybridization between canola and some *Brassica* vegetable species under field conditions.

GENERAL SESSION

WELCOME AND INTRODUCTIONS. Vanelle F. Peterson*; Dow AgroSciences, Mulino, OR

WELCOME TO SPOKANE. Mary Verner*; Spokane, Spokane, WA

PRESIDENTIAL ADDRESS. Joseph M. DiTomaso*; University of California, Davis, CA

NATIONAL AND REGIONAL WEED SCIENCE SOCIETIES: DIRECTOR OF SCIENCE POLICY UPDATE. Lee Van Wychen*; WSSA, Washington, DC

ICE AGE MEGAFLOODS AND THE LANDSCAPE IN EASTERN WASHINGTON. Victor Baker*; University of Arizona, Tucson, AZ

RESTORATION OF WEYERHAUSER'S MT ST HELENS TREE FARM: 30 YEARS LATER. Dick Ford*; Weyerhaeuser, Chehalis, WA

PROJECT 1: WEEDS OF RANGE AND NATURAL AREAS

EFFICIENCY AND ACCURACY OF WILDLAND WEED MAPPING METHODS. Stephanie D. Christensen*, Corey V. Ransom, Kimberly Edvarchuk, Steven A. Dewey; Utah State University, Logan, UT (074)

Land managers must set weed management priorities if limited resources are to be utilized effectively. Weed surveys/inventories assist land managers in this process by providing information regarding the identity, location, and relative abundance of weeds on their land. Although this information is vital, it can be challenging to select an approach that provides the necessary data to meet management objectives while remaining efficient and cost effective. This paper critically evaluates four wildland weed mapping methods. These methods were defined as: 1) paper-drawn: patch size and shape depicted by hand drawing on a topographic map, 2) buffered point: each patch is assigned to a patch size category and recorded as a single GPS point 3) screen-drawn: patch size and shape estimated and drawn to scale on a DRG topographic map displayed on a GPS screen, and 4) perimeter-walked: patch perimeter walked while GPS unit continuously collects position points at one second intervals. Six experienced weed mappers independently recorded the location and size of eight sagebrush patches using each method. Time and accuracy were evaluated for each method based upon mapping time, distance walked, horizontal precision error, estimated size error, and shape error. The paper-drawn method was significantly less accurate than other methods at recording patch size and location. There was no significant difference in the accuracy of the buffered point, screen-drawn, and perimeter-walked methods at reporting patch size and location. The need to cover land area quickly and efficiently favors the selection of the buffered point or screen-drawn method due to time and distance factors. However, if patch shape is an important factor, the perimeter-walked or buffered point may be the best choice of methods tested. Overall, the accuracy of any data collected is dependent upon the proficiency of the weed mapper in using the selected method.

MODELING PROCESS AND PATTERNS OF BUR CHERVIL: A NEW CANYON GRASSLAND INVADER. John M. Wallace*, Timothy Prather; University of Idaho, Moscow, ID (075)

Bur chervil, *Anthriscus caucalis* M-Bier, is an exotic winter-annual forb in the Pacific Northwest. Significant bur chervil population expansion has recently been observed in the Snake River canyon grassland system, where it has been established since the 1960s. Within this system, dense local populations and rapid landscape-level expansion have been observed. A multi-scale approach has been adopted to investigate the ecology of bur chervil in canyon grasslands. A demography study of bur chervil populations was conducted for four growing seasons (2006-2009) across four different plant associations, and within two levels of grazing regimes. Two bunchgrass- and two shrub-dominated plant associations that occupy characteristic topographic positions in canyon grasslands were selected for observation at a spring grazed and ungrazed site. Bluebunch wheatgrass associations are found on mid to upper slopes from E to SW aspects, and Idaho fescue associations are on found on moderate slopes of ridges at all aspects. Low-shrub associations are found on lower to mid slopes on northern aspects under more favorable moisture regimes, and high-shrub associations are found in lower positions in deep canyons occupying seepage lines or riparian margins. Results of the demographic study suggested that the trend of mean population flux between plant associations was similar at each site across years, with annual population growth rates ranging from 0.5 to 3.7. Population growth rates were highly variable within plant associations and across sites. Estimated carrying capacities were generally higher at the ungrazed site, and higher probabilities of sub-population extinction, estimated from randomly placed quadrats within the plant association, were observed in the bluebunch wheatgrass association at the grazed site. Per-capita fecundity was significantly higher in high-shrub plant associations across sites, indicating possible source populations at a landscape level. In 2009, a landscape-level survey of bur chervil occurrence was conducted across the study region utilized for demographic research, using a stratified random sampling technique across three strata: grazing history, slope and aspect. Survey results indicated that slope position and estimated incident solar radiation were significant predictors of bur chervil occurrence. However, the occurrence model was improved by the inclusion of plant association type and grazing history as explanatory variables. A higher probability of occurrence was observed in high shrub associations and across ungrazed sites. The population-level studies suggest underlying mechanisms for bur chervil occurrence at the landscape level. The probability of bur chervil occurrence in less suitable habitats may be a function of distance to high-shrub patches where populations are stable at higher carrying capacities and have greater fecundity rates, leading to a higher frequency of dispersal events. Little is known about primary dispersal agents, but seed characteristics suggest that bur chervil is adapted for short- and long-distance dispersal, as well as lateral expansion of established populations. Bur chervil seeds are small with hooked bristles, and are easily dispersed from open umbels by animals. A spatially-explicit habitat based approach may be utilized to improve prediction of bur chervil along range expansion fronts by incorporating likely dispersal pathways.

COMPARISON OF GREENHOUSE TO NATIVE GROWN FORBS FOR AMINOPYRALID TOLERANCE. Jonathan R. Mikkelson, Rodney G. Lym*; North Dakota State University, Fargo, ND (076)

Aminopyralid has been widely used to control invasive broadleaf weeds on range, pasture, and wildlands. The effect of aminopyralid on native forbs is an important consideration for land managers when deciding to implement a weed management program. Recent research has found many native forbs are tolerant or recover quickly following aminopyralid application. However, aminopyralid tolerance to some native forbs could not be determined in the field because of their rarity or tendency to grow singularly in the wild. The nine forb species chosen for this study included harebell (*Campanula rotundifolia* L.), white prairie clover (*Dalea candida* Michx. ex Willd.), purple coneflower [*Echinacea purpurea* (L.) Moench], blanket flower (*Gaillardia aristata* Pursh), closed bottle gentian (*Gentiana andrewsii* Griseb.), great blue lobelia (*Lobelia siphilitica* L.), prairie coneflower [*Ratibida columnifera* (Nutt.) Woot. & Standl.], showy goldenrod (*Solidago speciosa* Nutt.), and azure aster (*Symphyotrichum oolentangiensis* Riddell). The prairie forbs were obtained from a nursery and transplanted into conetainers (6.3-cm diameter by 25-cm deep) containing a blend of commercial media and sandy loam soil (4:1 by volume). Plants were grown approximately 20 to 32 wk in a greenhouse maintained between 20 and 28 C, with a 15-hr photoperiod of natural and supplemental metal halide light. After establishment, the photoperiod was adjusted to 13 hr for purple coneflower and closed bottle gentian, and to 16 hr for blanket flower and showy goldenrod to initiate flowering. Plants were treated at the approximate growth stage found when aminopyralid is fall-applied for Canada thistle control in the field. Aminopyralid at 0, 30, 60, and 120 g/ha was applied with an air-pressurized greenhouse cabinet-type sprayer and a non-ionic surfactant at 0.25% v/v was included to maximize potential forb injury. Prairie forb susceptibility to aminopyralid varied by species. Purple coneflower, azure aster, and showy goldenrod were the most tolerant to aminopyralid while great blue lobelia, white prairie clover, harebell, and prairie coneflower were severely injured or killed, even when aminopyralid was applied at 30 g/ha. Since the results of this study closely followed the results of similar species in the field, these data could be used to estimate tolerance of these particular species to aminopyralid.

MODELING SPATIAL PATTERNS FOR RUSH SKELETONWEED DISPERSAL IN THE SALMON RIVER CANYON. Sandya Rani Kesoju*, Bahman Shafii, Timothy Prather, William Price, Larry W. Lass; University of Idaho, Moscow, ID (077)

Rush Skeletonweed (*Chondrilla juncea* L.) is a perennial *Asteraceae* that infests well-drained, light textured soils commonly found in the mountain foothills and canyon grasslands of the Pacific Northwest. Approximately 1.2 million ha are infested in Idaho with dispersal into Montana. Spatial network models based on likelihood of occurrence are being used to model dispersal. Overall, our research focuses to produce dispersal models for use in making land management decisions at a landscape scale. One part of the effort includes assessing spatial dependence of rush skeletonweed dispersal and relate those to the role of wind speed and wind direction in determining the potential patterns of dispersal. A study area including the Salmon River Canyon, Idaho was used for modeling spatial patterns of rush skeletonweed dispersal. The area was divided into five subunits for the purpose of modeling the presence or absence of rush skeletonweed. In each subunit, geostatistical modeling techniques were used to provide insight into the spatial patterns of rush skeletonweed. These models provide useful information for modeling rush skeletonweed dispersal. After obtaining an empirical semivariogram, a theoretical semivariogram model was estimated for each subunit. Subunit models indicated different azimuth orientations and infestation patterns within the river canyons. Model forms encompassed spherical, Gaussian, exponential and wave-effect models. Spatial dependence distance ranged from 2 km to 5 km and demonstrated an anisotropic pattern from 0 to 45 degrees. The results indicate a strong effect of canyon orientation and are likely due to local wind patterns within the canyon grasslands. Results provide justification for a large scale effort to create a wind GIS layer that will be used within a network model for the purpose of identifying direction and relative force for movement within grasslands and foothills of Idaho and western Montana.

COMMON TANSY CONTROL IN RIPARIAN AREAS. Celestine A. Duncan*[1], Jerry Marks[2], Mary Halstvedt[3]; [1]WMS, Helena, MT, [2]Cooperative Extension Service, Missoula, MT, [3]Dow AgroSciences, Billings, MT (078)

Common tansy (*Tanacetum vulgare* L.) was first introduced to the United States from Europe in the 1600s. Cultivation for traditional folk medicines and other domestic uses accelerated its spread throughout temperate regions of North America. Common tansy is currently listed as a noxious weed in four western states. The plant contains alkaloids that can be toxic to humans and livestock if consumed in large quantities. Sites susceptible to invasion include roadsides, fence rows, irrigated pastures, and ditch or stream banks. The plant often occurs in association with other noxious weeds such as Canada thistle (*Cirsum arvense*) or knapweeds (*Centaurea* sp.).

Field trials were established at two locations in Missoula, MT in June 2006 and 2008 to determine effectiveness of various herbicide treatments on common tansy. Sites included either common tansy alone or in a complex with spotted knapweed (*C. stobe*). Herbicide treatments were applied with a CO_2 backpack sprayer at 13.5 gpa in a randomized complete block design with three replications per treatment. Aminopyralid was applied alone at 1.25 and 1.75 oz ae/A (Milestone® at 5 and 7 fl oz/A) , aminopyralid plus 2,4-D at 1.75 oz ae/A + 14 oz ae/A (ForeFront® R&P at 2.6 pts/A), aminopyralid plus metsulfuron at 0.8 + 0.14, 1.3 + 0.24, 1.71 + .31 oz ae/A (Chaparral™ at 1.5, 2.5 and 3.3 oz product/A), and metsulfuron alone at 0.3 oz ae/A. Plots were visually evaluated for percent control 12 and 27 months after treatment (MAT).

Aminopyralid plus metsulfuron at all rates provided greater than 95% common tansy control 12 MAT. This level of control was maintained for 27 MAT with rates used in this study that were greater than 0.8+0.14 oz ae/A. Control with aminopyralid plus metsulfuron was similar to metsulfuron alone at 0.3 oz ae/A. Aminopyralid alone and aminopyralid plus 2,4-D did not provide acceptable common tansy control either 12 or 27 months after treatment. Aminopyralid plus metsulfuron (Chaparral) was the only herbicide treatment that provided excellent control (>95%) of both spotted knapweed and common tansy. On sites having a complex of weeds such as common tansy, spotted knapweed, and Canada thistle, aminopyralid plus metsulfuron at rates of 1.3 + 0.24 oz ae/A (Chaparral at 2.5 oz product/A) and above provided superior control of the weed complex compared to either metsulfuron or aminopyralid alone.

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EFFECT OF AMINOPYRALID ON NATIVE FORBS AND GRASSES. Pat Green*[1], Vanelle F. Peterson[2], Carl Crabtree[3], Timothy Prather[4], John Wallace[4]; [1]USDA US Forest Service, Grangeville, ID, [2]Dow AgroSciences, Mulino, OR, [3]Idaho County Noxious Weed Board, Grangeville, ID, [4]University of Idaho, Moscow, ID (079)

Aminopyralid and clopyralid are broadleaf herbicides that are less likely to adversely affect desirable plants than other herbicides with similar use site registrations. This makes them potentially suitable for invasive weed control on rangeland and wildland sites where conservation of native species is an objective. An experiment was established in north central Idaho to determine relative effectiveness of two rates of aminopyralid and one rate of clopyralid applied in fall, for control of invasive species and to determine effects on native plant species and plant community structure.

Early fall application was chosen in part to test the ability of aminopyralid to suppress late fall germination of annual grasses, which has been observed in other trials in the western U.S. Herbicide treatments applied were aminopyralid at 0.047 and 0.078 ai/A (Milestone® at 3 and 5 oz per acre) and clopyralid at 4 oz ai/A (Transline® at 11 oz per acre), and no herbicide. Field experiments were designed as randomized complete blocks with five replications and initiated in 2009. Pre-treatment sampling was conducted in early July 2009, and the first year post-application vegetation sampling was conducted in early July of 2010. Broadcast ground applications were made with a CO_2 backpack sprayer in September of 2009. Data collection included canopy cover in 36, 0.25m^2 microplots within each of twenty macroplots. Within each microplot nested rooted frequency was also assessed for weeds of interest. There were a total of 38 species present on the site at initiation of the experiment in 2009 and 50 in 2010. Exotic annual grasses and forbs dominated the site, but remnants of native grasses (bluebunch wheatgrass) occurred as well as native biscuitroots, lupine, milkvetch, and other natives.

Evaluations of herbicide effects were based on changes in canopy cover compared to non-treated controls. Pretreatment canopy cover data was used as a covariate. Differences (as the estimated marginal means) between treatments and treatment and control indicated that yellow starthistle, thymeleaf sandwort, black medic lentil vetch, and winter (hairy) vetch were readily controlled (>90 percent) by all of the treatments. Other exotic forbs increased in cover, sometimes significantly for a specific herbicide: small geranium, Dalmatian toadflax, common St Johnswort, and some exotic forbs were little changed (chicory).

Aminopyralid at 0.078 oz ai/A (5 oz/A) reduced field brome and medusahead (40 to 50 % canopy cover), but had little effect on downy brome. Downy brome germination appeared to occur before spraying as early as August, and continued throughout spring. Ventenata dubia increased regardless of rate of aminopyralid or clopyralid applied. Of the native forbs observed or tested, common yarrow, two biscuitroots, silky lupine, grassy tarweed, Douglas knotweed, and Menzies' fiddleneck canopy cover did not change during course of the experiments. Bluebunch wheatgrass increased in plots where aminopyralid at 0.078 oz ai/A (5 oz/A) was applied. The relative cover and dominance of native species increased over the course of the experiment, due both to increased native annual forbs and bluebunch wheatgrass. Some non-susceptible exotic forbs (Dalmatian toadflax and common St. Johnswort) and grasses (Ventenata) increased in cover and frequency on herbicide-treated plots. Response of these undesirable species to treatments in these experiments highlights that the essential first step of developing a vegetation management strategy is to determine plant community structure. With this community information, selection of best practices and sequence and combination in which they should be applied can be determined to best meet land management objectives. Additional sampling is planned in 2011 to determine to further understand the long-term response of plant populations to herbicide treatments.

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THE EFFECT OF APPLICATION TIMING ON FORB TOLERANCE TO AMINOPYRALID.
Mary B. Halstvedt*[1], Vanelle F. Peterson[2], K. George Beck[3], Michael J. Moechnig[4], Peter M. Rice[5]; [1]Dow AgroSciences, Billings, MT, [2]Dow AgroSciences, Mulino, OR, [3]Colorado State University, Ft. Collins, CO, [4]South Dakota State University, Brookings, SD, [5]University of Montana, Missoula, MT (080)

Aminopyralid was designated as a reduced risk pesticide compared to other registered herbicides by the US EPA during registration. Aminopyralid (Milestone®) is a desirable alternative to other herbicides for broadleaf invasive weed control on rangeland and wildland sites. Effects of aminopyralid on desirable native forbs and shrubs are a consideration for land managers when making decisions about controlling invasive plants. Many land managers have made the assumption that applying aminopyralid in the fall to dormant forb species would provide better tolerance than would summer applications. The purpose of this research was to determine the effect of date of aminopyralid application on forb tolerance. Experiments were established on diverse native plant communities near Missoula, Montana; Steamboat Springs, Colorado; Ortonville, Minnesota; and Big Stone, South Dakota. Field experiments were designed as randomized complete blocks with four to eight replications and initiated in 2008 or 2009. Herbicide treatments were aminopyralid at 0, 1.25 or 1.75 oz ae/A. Broadcast ground applications were made in June, July, and October with CO_2 backpack or bicycle sprayers. Data collected across sites varied from either canopy cover or plant counts along permanent transects, 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. Tolerances to aminopyralid were established for 20 native forb species at the different application dates. Evaluations were based on individual species reduction in canopy cover or density compared to non-treated controls or baseline density counts data. Four tolerance categories were used: susceptible (S - 75% or more reduction in canopy cover or density), moderately susceptible (MS - 75 to 50% reduction), moderately tolerant (MT- 49 to 16% reduction) and tolerant (T – 15% or less reduction). Of the 20 forb species categorized, tolerance ratings of 12 species were not different regardless of application date. Species with greater tolerance to aminopyralid following a summer application compared to autumn application were stiff sunflower, Canada goldenrod, stiff goldenrod, and purple prairie clover. Species more tolerant to an October application of aminopyralid were subalpine buckwheat, lupine, little sunflower, and white prairie aster. Based on these results tolerance of forb species to aminopyralid may vary depending on application date. Previous research has shown that most native forbs and shrubs were moderately tolerant to tolerant, or recovered following treatment with aminopyralid applied at various application date. Understanding desirable forb species tolerance to aminopyralid is useful when determining how to utilize this herbicide into invasive plant management programs.

EFFECTS OF AMINOPYRALID ON A MEADOW COMMUNITY INVADED BY CANADA THISTLE IN THE WASHINGTON CASCADES. Timothy B. Harrington*, David H. Peter, Warren Devine; USDA Forest Service, Olympia, WA (081)

Four rates of aminopyralid (Milestone®) (0.03, 0.06, 0.09, and 0.12 kg ae/ha) were compared for their ability to control Canada thistle (*Cirsium arvense*) and other non-native, invasive plant species at a meadow site in the Cascade Range near Trout Lake, WA. The experimental design of the study was completely randomized with six replications of the four herbicide rates arranged in a split-plot design. Milestone® rate was randomly assigned to each main plot, and a treated versus non-treated designation was randomly assigned to each split plot. Crown cover of each plant species was estimated immediately prior to (June 2009) and one year after treatment (June 2010). An angular transformation was applied to the cover data for each species, and the data were subjected to analysis of variance (ANOVA) with the covariate, pre-treatment cover, to adjust for differences in species' abundance that existed prior to treatment. Control of a given species from treatment was calculated as the percentage reduction in mean cover relative to the non-treated split plots. Control of Canada thistle increased linearly from 66% to 100% as Milestone® rate increased from 25% to 100% of the maximum labeled rate. Control of oxeye daisy (*Leucanthemum vulgare*), sheep sorrel (*Rumex acetosella*), and white clover (*Trifolium repens*) averaged 80%, 94%, and 100%, respectively, across the four herbicide rates. Control of dandelion (*Taraxacum offincinale*) and narrowleaf plantain (*Plantago lanceolata*) (57% and 79%, respectively) was statistically significant only at the maximum labeled rate for Milestone®. Two species, Kentucky blue grass (*Poa pratense*) and selfheal (*Prunella vulgaris*), were released at the maximum labeled rate for Milestone®, demonstrating absolute increases in cover of 22% and 2%, respectively. Milestone® provided excellent control of Canada thistle and other broadleaf species, thereby stimulating cover development of herbicide-tolerant monocot species, especially Kentucky bluegrass.

RANGELAND GRASS SPECIES TOLERANCE TO PRE-PLANT APPLICATIONS OF AMINOPYRALID AND AMINOCYCLOPYRACHLOR. Cameron Douglass*[1], Joseph D. Vassios[1], Scott Nissen[1], Vanelle F. Peterson[2]; [1]Colorado State University, Fort Collins, CO, [2]Dow AgroSciences, Mulino, OR (082)

One strategy to achieve long-term perennial weed management involves integrating chemical control with the establishment of competitive plant communities. Establishing native plant communities or plant communities that are dominated by native species is considered desirable in many situations. The problem is that information about the relative sensitivity of native species to herbicide residues and techniques that might reduce any negative impacts from these soil residues are not readily available. This study was initiated to examine the impacts of application timing, herbicide rate and herbicide combinations on native grass establishment. Picloram, aminopyralid, clopyralid, aminopyralid plus clopyralid, aminopyralid plus metsulfuron methyl, and aminocyclopyrachlor were applied pre-plant in July and September 2009 to a prepared seedbed. In April 2010, ten cool and seven warm season native grasses were seeded perpendicular to the herbicide treatments. Grass biomass was determined in September 2010. None of the experimental factors (application timings, rates or herbicide combinations) significantly reduced native grass biomass when compared to hand-weeded controls; however, results indicated that individual species responded differently to these factors. Plant responses could not be adequately explained by functional groupings (cool versus warm season), for example, Canada wildrye (cool season), slender wheatgrass (cool season), galleta grass (warm season) and sideoats grama (warm season) were found to be the most tolerant species. These data suggest that pre-plant applications of these herbicides made either the spring or fall prior to grass seeding can be used to assist in the establishment of native grasses by controlling otherwise competitive weeds.

NATIVE GRASS ESTABLISHMENT WITH AMINOPYRALID. Mary B. Halstvedt*[1], Vanelle F. Peterson[2], Roger L. Becker[3], Rodney G. Lym[4], Michael J. Moechnig[5]; [1]Dow AgroSciences, Billings, MT, [2]Dow AgroSciences, Mulino, OR, [3]University of Minnesota, St. Paul, MN, [4]North Dakota State University, Fargo, ND, [5]South Dakota State University, Brookings, SD (083)

Invasive plants often interfere with and displace desirable plant populations making site re-vegetation necessary to return desirable plant species to acceptable levels. Aminopyralid has great utility to control invasive broadleaf plants in natural areas and wildlands, It is critical that land managers understand how aminopyralid is best used to control invasive plants and facilitate establishment of desirable grass species. The current label for aminopyralid-containing products allows for its use on established desirable grasses or it can be applied in the spring before a fall grass planting. The objective of this research was to determine if grasses can be planted either as a dormant seeding or in the spring following an autumn herbicide application. Research was conducted at; University of Minnesota, North Dakota State University and South Dakota State University research farms. Experiments were designed as randomized complete blocks with four replications per treatment combination. Pre-plant herbicide treatments were applied on September 15, 16, and 22, 2009 at the ND, MN, and SD locations respectively. Treatments included aminopyralid at 0.75, 1.75, and 3.5 oz ai/A (2 times the maximum registered use rate), clopyralid at 6 oz ai/A, and picloram at 8 oz ai/A. Grasses planted in these experiments were cool season grasses (intermediate wheatgrass, Canada wildrye, and green needlegrass) and warm season grass (big bluestem, little bluestem, sideoats grama, switchgrass, and indiangrass). The SD location included 2 planting times, November 9, 2009 and April 4, 2010, grasses were planted in ND on April 22, 2010 and in MN on November 17, 2009. The non-treated checks were hand weeded for most of the early season. Plant count (number of plants per 0.5 meter of row) and frequency of occurrence (%) were measured in July 2010 at all sites. The planting date main effect was significant (P<0.05) for grass counts and frequency of occurrence. The herbicide by planting interaction for counts of big bluestem planted in the spring was the only significant (P<0.05) interaction. Averaged across herbicide treatment and grass species (except big bluestem) the average grass count from fall plantings was 2.5 plants per 0.5 meter row compared to 5.0 plants per 0.5 meter row for spring plantings. There were no differences across herbicide treatments for fall-planted grasses for either cool or warm season grasses. For the spring planting, the combined warm-season grasses (except big bluestem) showed a trend for a greater number of plants in herbicide-treated plots compared to non-treated areas. Cool-season grass counts in spring plantings in aminopyralid-treated plots ranged from, 7.2 to 7.6 plants per 0.5 meter row compared to clopyralid at 6 oz ai/A and 8 oz ai/A of picloram at 6.6 and 5.2 plants per 0.5 meter row respectively and 5.4 in non-treated plots. There was a trend for counts of warm-season grasses to be less in plots treated with aminopyralid at 3.5 oz ai/A, clopyralid, and picloram (mean of 3.7, 4.2, and 3.2 plants per 0.5 m of row, respectively) when compared to 5.7 plants per 0.5 m of row in plots treated with 1.75 oz ai/A aminopyralid and higher than the 2.2 plants in non-treated plots. Based on these results aminopyralid (Milestone® herbicide) can be applied in the autumn and several cool- and warm-season grasses planted either as a dormant seeding during the autumn/winter or in the spring will successfully establish if environmental conditions are favorable. This demonstrates another important utility of Milestone, which is to control invasive broadleaf plants and facilitate revegetation of desirable grasses on sites where remnant populations of desirable grasses are insufficient to recover after invasive plant control. These data are corroborated by other field experiments conducted in the western US and confirm Milestone fit in rangeland grass revegetation programs.

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CHARACTERIZATION OF AMINOCYCLOPYRACHLOR, AMINOPYRALID, AND CLOPYRALID SOIL ACTIVITY. Brad Lindenmayer*[1], Philip Westra[2], Scott Nissen[1], Dale Shaner[3]; [1]Colorado State University, Fort Collins, CO, [2]Colorado State University, Ft. Collins, CO, [3]USDA/ARS, Fort Collins, CO (084)

Continued evaluation of Canada thistle (*Cirsium arvense*) plots treated with aminocyclopyrachlor or aminopyralid has provided additional control data and prompted further investigation. Herbicide was applied 140 g ai/ha in three formulations of aminocyclopyrachlor and one rate of aminopyralid (126 g ai/ha) in September, 2008 to C. thistle foliage and to soil where the thistle had recently been shallowly tilled at two sites, one irrigated and one dryland site. Biomass was collected 1 year after treatment (YAT). All herbicides performed equivalently at both sites over the duration of the experiment, but the soil-applied herbicides were more effective than foliar applied at 1 YAT. A site-of-absorption study was also done to determine how the herbicides were being taken up by the plants in the soil. C. thistle root segments were planted in soil where a treated layer of soil was located above (A) or below (B) the root segments and plant growth was evaluated 28 days after treatment. Aminocyclopyrachlor and aminopyralid, and were applied at 70 g ai/ha. Shoot production and total shoot biomass for all A treatments were not significantly different between the herbicides or the untreated check. However, shoot production and biomass were significantly lower for aminocyclopyrachlor and aminopyralid when the herbicides were located below the root segments (B treatement). Interestingly, the total root biomass was not significantly affected in either A or B treatments. These results suggest that aminocyclopyrachlor and aminopyralid are absorbed by the root system and translocated to the shoots where growth is inhibited, but there is limited uptake by emerging shoots. Therefore, root uptake and soil residual activity may be very important factors in perennial weed control with these two similar herbicides.

LEAFY SPURGE (*EUPHORBIA ESULA* L.) BIOLOGICAL CONTROL AGENTS EFFECT NATIVE GRASS ESTABLISHMENT. Cassandra Setter*, Rodney G. Lym; North Dakota State University, Fargo, ND (085)

Aphthona spp. flea beetles have reduced leafy spurge throughout North Dakota and native plant species diversity was expected to increase. However, the reestablishment of native plant species has been slow in areas where the beetles have reduced the weed compared to when herbicides were applied. A bioassay was conducted in 2004 and 2010 to evaluate the establishment of native grass species in soil taken from Aphthona spp. release and nearby non-release sites. The native grass species included green needlegrass *[Nassella viridula* (Trin.) Barkworth], little bluestem [*Schizachyrium scoparium* (Michx.) Nash], switchgrass (*Panicum virgatum* L.), and western wheatgrass [*Elymus smithii* (Rydb.) Gould]. Soil was collected near Medora, ND in 2004 and again in 2010 along with five other locations throughout the state. In 2004, native grass production was reduced nearly 50% when grown in soil from Aphthona spp. release sites compared to non-release sites. The greatest reduction occurred with switchgrass, which was reduced 66% compared to plants grown in soil from non-release sites. Leafy spurge was present at insect-release and non-release sites, suggesting slow native species reestablishment may not be caused by leafy spurge. The 2010 study is still in progress, but results to date do not confirm the results from the 2004 study as grasses grew equally in soil from release and non-release sites. The slow recovery of native grass species is unknown and may be due to a chemical inhibition found within the soil not yet identified.

CANADA THISTLE (*CIRSIUM ARVENSE*) CONTROL AND NATIVE GRASS PRODUCTION A YEAR AFTER PRESCRIBED BURNING. Gustavo M. Sbatella*, Robert G. Wilson; University of Nebraska-Lincoln, Scottsbluff, NE (086)

In spring of 2009, nearly 25 acres of rangeland infested with Canada thistle, was burned three miles west of Mitchell, NE as part of a restoration program. A field trial was established to evaluate the effects of fire on Canada thistle control with herbicides and the impact on plant communities. 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 plus 0.43 kg ai/ha respectively. Herbicides applications were timed at Canada thistle emergence or late bolting. The study area was flooded in the fall of 2009 for a 3 month period. Visual evaluations of Canada thistle control and plant biomass were collected 120 and 365 days after treatment (DAT). Canada thistle control differed between time of evaluation and was affected by burning and time of herbicide application. Thistle control 120 DAT was above 90% in the burned and unburned sections. A year after, Canada thistle control was successful only in the burned section with 95% control. Biomass collected 120 and 365 DAT reflected a major change in total biomass production and composition. Total biomass was reduced in the burned section 120 DAT from 5757 kg/ha to 4312 kg/ha, due to the elimination of dead plant matter. Nevertheless, grass species accounted for 86% of the total, compared to 39% in the unburned section. Fire reduced litter or dead matter from 45% to 3% the first summer, but 365 DAT the percent litter rapidly reestablished to 47%.

YELLOW TOADFLAX POPULATIONS AND THEIR RESPONSE TO ALS INHIBITORS. Nicholas J. Krick*, K. George Beck; Colorado State University, Ft. Collins, CO (087)

Yellow toadflax (*Linaria vulgaris* Mill.) is an exotic perennial forb that is a serious weed in the Intermountain West and its range is expanding. It is a difficult plant to control and site to site variation has been dramatic. Identical herbicide trials were conducted at 5 geographically separated field sites in Colorado. Chlorsulfuron and imazapyr were each applied at 4 rates. Field trials were supported by a common garden study and an observational study of root bud phenology. Biomass from the field sites was analyzed by ANOVA. Chlorsulfuron applied at 94 g ai/ha controlled > 86% of yellow toadflax at 3 sites and <73% at 2 sites. Imazapyr applied at 380 g ai/ha controlled > 92% of yellow toadflax at 3 sites, and 53 and 5% at 2 sites. To better explain the site variation, GR_{50} values for biomass were calculated and subjected to a correlation matrix with site characteristics. The correlation matrix revealed that sites at higher elevation and sites with fewer shoots flowering at the time of application required less herbicide for acceptable control. Lower elevation sites and sites with more shoots flowering at the time of application required more herbicide for acceptable control. The common garden study indicates genetic differences among sites; however, no tolerance or resistance was observed. The observational study of root bud phenology suggests that applications which occur during a more progressed growth stage provide better control. Through these studies, a better understanding of the source of variation has been determined and managers can use timing of application to achieve better control of yellow toadflax.

INVASIVE PLANT MANAGEMENT: BC STYLE! Becky Brown*[1], Linda M. Wilson[2]; [1]British Columbia Ministry of Natural Resource Operations, Victoria, BC, [2]British Columbia Ministry of Agriculture, Abbotsford, BC (088)

The paper describes the challenges and opportunities for invasive plant management in British Columbia. BC is biologically, culturally and economically diverse, encompassing 14 distinct climatic zones across 365,000 sq mi, roughly the combined area of Washington, Idaho, Oregon, and 85% of California. 94% of the land in BC is public, placing significant responsibility on the provincial government to fulfill the provincial invasive plant management mandates. BC shares 7 jurisdictional borders with states, provinces, and territories, has over 15,535 mi of rugged coastline, and has the second-largest parks system in Canada. Floristically, BC yields almost 1600 native vascular plant species, 27% considered species at risk. The vastness and diversity that define BC requires a complex, cross-jurisdictional network of community-based collaborations to plan and deliver all aspects of invasive plant management. The Inter-Ministry Invasive Species Working Group coordinates the six million dollars spent on invasive plant management annually. Government staff provide expertise, education, coordination and facilitation services to all agencies, NGOs, regional weed committees and the Invasive Plant Council of BC. Despite the challenges created by a large land base and small tax base, BC boasts numerous significant achievements. The provincial-scale weed containment program, formalized early detection and rapid response, online database, leading-edge biological control, economic analyses, and weed ranking tool are measures of our success and collectively form the comprehensive and strategic provincial program. This coupled with strong public interest in protecting the environment will maintain the momentum necessary for positive change as BC manages invasive plants, their vectors, and pathways.

AMINOPYRALID + TRICLOPYR CONTROL OF RUSSIAN-OLIVE AND SALTCEDAR: MAINTAINING GRASS UNDERSTORY. Byron B. Sleugh*[1], Mary Halstvedt[2], Vanelle F. Peterson[3], Robert G. Wilson[4], Gustavo M. Sbatella[4], Scott Nissen[5], Brian Mealor[6]; [1]Dow AgroSciences, West Des Moines, IA, [2]Dow AgroSciences, Billings, MT, [3]Dow AgroSciences, Mulino, OR, [4]University of Nebraska-Lincoln, Scottsbluff, NE, [5]Colorado State University, Fort Collins, CO, [6]University of Wyoming, Laramie, WY (131)

Chemical control of saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia* L.) has had varying degrees of success. Often, these trees are mechanically removed but the stumps are not treated so they readily regrow. Some non-selective herbicides used to control these invasive plants cause unacceptable injury to desirable species, especially grasses in the understory, or do not control other invasive plants under the tree canopy. Aminopyralid (Milestone®) controls many invasive herbaceous broadleaf weeds, but control of saltcedar and Russian olive had not yet been fully explored. Experiments were established in Nebraska, Colorado, and Wyoming to assess the efficacy on saltcedar and Russian olive regrowth or small trees and understory grass tolerance to aminopyralid plus triclopyr (Garlon® 3A or Garlon® 4 Ultra) mixtures and combinations with lower than recommended rates of the commonly used herbicide, imazapyr. Lower than recommended rates of imazapyr were used in an attempt to reduce injury to desirable understory grasses and improve saltcedar control with mixtures of aminopyralid and triclopyr. Treatments included triclopyr amine at 3.37 or 4.5 kg ae/ha (3 or 4 lb ae/A) and triclopyr ester at 2.24 or 3.37 kg ae/ha (2 or 3 lb ae/A) plus aminopyralid at 120 g ae/ha (0.l1 lbs ae/acre), Milestone® VM Plus at 9.6 L/ha [triclopyr amine at 1.12 kg ae/ha (1 lb ae/acre) plus aminopyralid 120 g ae/ha (0.11 lb ae/acre)], and combinations of imazapyr at 0.14 and 0.28 kg ae/ha (0.125 and 0.25 lb ai/acre, respectively) with some aminopyralid plus triclopyr treatments. 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 saltcedar (94%), similar to efficacy of imazapyr at 1.12 kg ae/ha (1 lb ae/acre) but with significantly less understory grass injury. Triclopyr plus aminopyralid treatments caused little to no grass injury (0 to 5%) compared to the imazapyr treatments (50 to 85%). Addition of imazapyr to aminopyralid plus triclopyr did not improve control of either brush species, but increased grass injury compared to aminopyralid plus triclopyr. At the Colorado site, aminopyralid plus triclopyr amine tended to cause more grass injury than aminopyralid plus triclopyr ester, but caused less injury than than when imazapyr was included in treatments. Adding aminopyralid to either the triclopyr amine or triclopyr ester increased control of Russian olive and saltcedar. The combination of aminopyralid plus triclopyr is an excellent option to control Russian olive and saltcedar without injuring desirable understory grass vegetation.

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SALTCEDAR AND RUSSIAN-OLIVE CONTROL WITH DPX MAT28 AND OTHER HERBICIDES IN ARIZONA. John H. Brock*; Brock Habitat Restoration and Invasive Plant Management, Tempe, AZ (132)

Saltcedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) have invaded many streams in Arizona. Beginning in 2008, DPX MAT 28 (aminocyclopyrachor), metsulfuron methyl, imazapyr and triclopyr have been applied to Russian olive near Holbrook and Ganado in northeastern Arizona, and to saltcedar near Avondale in central Arizona. The treatments have included foliage sprays, cut stump and basal bark applications, under spring and fall growth conditions. Canopy reduction and plant mortality data were collected from all sites and times of treatment. MAT 28 has provided acceptable canopy mortality and kill of the plants, with values slightly lower than those estimated for the standards of imazapyr or triclopyr, depending on the type of treatment. In most cases the degree of mortality is not significantly different among herbicide treatments except for the lower herbicide rates. MAT 28 plus metsulfuron methyl as foliage sprays has given canopy reduction percentages of 70 to 90, and plant mortality greater than 90 percent for the cut stump and basal bark treatments. As suspected, fall foliage treatments have been superior to spring applications. Young trees of both species are more strongly affected by the herbicide treatments, compared to more mature specimens.

DEVELOPING METERED HERBICIDE INCISION TECHNIQUES TO CONTROL INVASIVE ARBOREAL AND SHRUB TARGETS IN THE PACIFIC BASIN. James Leary*; University of Hawaii at Manoa, Kula, HI (133)

Hawaii is the most isolated island ecosystem in the world and recent historical events of habitat loss and exotic species invasions have resulted in severe declines of the evolved native species. Today, there are many local, state and federal stakeholders who are managing significant portions of natural area as critical habitat, where overall management is dominated by activities in invasive weed control. These areas are often remote and difficult to traverse, and many of the major ecosystem modifiers are arboreal and shrub canopy species. The logistics of delivering resources to these remote infested areas is often a limiting factor to a satisfactory weed management operation. Thus, simple techniques for administering discreet lethal herbicide doses to large canopy specimens can greatly facilitate operational success. This starts with validated knowledge of optimized herbicide formulations that ensure consistent susceptibility of weed targets with the administration of an exact dose. The active ingredient triclopyr is the most utilized herbicide for individual plant treatments and typically provides acceptable results, but has also shown variability and failure as a treatment. Preliminary studies in Hawaii are investigating different active herbicide ingredients (i.e. Metsulfuron methyl, Imazapyr, Glyphosate, Aminopyralid and Aminocyclopyrachlor) to major weed targets in the Pacific Basin including: *Schinus terebinthifolius*, *Albizia molucca*, *Spathodea campanulata*, *Schefflera actinophylla*, *Psidium cattleianum* and *Rauvolfia vomitoria*. A basal incision point application (IPA) technique is being used for these studies where commercial herbicide concentrates (i.e. 0.24-0.48 kg ae/L) are directly applied to the exposed cambium created by clean incisions at the base of the arboreal target. Instead of a complete frill, incisions are equidistantly spaced and only made large enough to retain a 0.5-1.0 ml volume. This technical feature of the application is designed to reduce time-on-target and applicator fatigue. Utilizing full-concentrate formulations eliminates potential error in batch handling, but proper calibration is critical for optimizing the lowest effective dose. To ensure proper dose delivery a metered draw off syringe designed for veterinary vaccinations has been adopted and is proving to be an efficient and hygienic approach to herbicide delivery that can be deployed by field crews with nominal experience (including volunteers) for extended periods of time.

SEEDLING COOL SEASON GRASS RESPONSE TO AMINOCYCLOPYRACHLOR. Katie L. Conklin*, Rodney G. Lym; North Dakota State University, Fargo, ND (134)

Aminocyclopyrachlor is currently being developed for broadleaf and grass weed control in several areas, including pasture and rangeland. The purpose of this research was to evaluate aminocyclopyrachlor alone or with other herbicides on newly seeded pasture and rangeland grasses. Three cool season grass species, green needlegrass [*Nassella viridula* (Trin.) Barkworth], intermediate wheatgrass [Thinopyrum intermedium (Host) Barkworth & D.R. Dewey], and western wheatgrass [*Pascopyrum smithii* (Rydb.) A. Löve], were seeded separately on April 22, 2010 near Fargo, ND. Approximately 30 d after grass emergence aminocyclopyrachlor was applied alone or in combination with either chlorsulfuron, metsulfuron, or 2,4-D. Visual evaluations of grass injury were made 1, 2, 4, 6, and 8 wk after treatment (WAT) while weed control was evaluated 8 WAT. Western wheatgrass injury 8 WAT ranged from 77 to 98% when aminocyclopyrachlor was applied from 93 to 332 g ha^{-1}, respectively. Intermediate wheatgrass injury 8 WAT ranged from 39 to 97% as aminocyclopyrachlor rate increased. Green needlegrass injury 8 WAT did not exceed 48% regardless of aminocyclopyrachlor application rate. Broadleaf weed control was excellent at all rates and combinations of aminocyclopyrachlor. Control of Setaria spp. averaged only 73% with aminocyclopyrachlor alone at 93 or 111 g ha^{-1}, but control increased to 92 or 85% when applied with chlorsulfuron or metsulfuron, respectively. Aminocyclopyrachlor applied at 93 g ha^{-1} provided good weed control and may be suitable for the establishment of green needlegrass and intermediate wheatgrass, but not western wheatgrass, which was severely injured.

GORSE CONTROL AS A FUNCTION OF RATES, TIMING AND INTERACTION OF TRICLOPYR AND AMINOPYRALID. Kim Patten*, Chase Metzger; Washington State University Long Beach Research and Extension Unit, Long Beach, WA (135)

Gorse *(Ulex europaeus)*, a native of Europe, infests large areas of public and private lands in western Oregon and Washington. Thick infestations create serious fire hazards and cause ecological perturbations. One concern in controlling gorse on public lands is that ideal herbicide timing often coincides with peak public use and when staff is most busy. Research was conducted in 2009/2010 to assess efficacy of various herbicide treatments applied during the mid-winter, which is the off-season. Triclopyr-butotyl, with and without aminopyralid, was assessed as a function of herbicide rate and timing. Our first study compared the efficacy of a December (mid-winter) to spring (late March/early bloom) application of triclopyr-butotyl at 4.74 kg ae/ha with and without aminopyralid at 123 g ae/ha or 246 g ae/ha, or aminopyralid alone at 246 g ae/ha. Methylated seed oil was mixed at 1% concentration in all mixes and treatments applied at 465 l/ha. Gorse plants ranged from 0.5 to 1.5 m tall at application. Herbicide efficacy, per cent control, was rated in fall 2010. Control was better with spring applications than winter applications and better with triclopyr with or without aminopyralid than aminopyralid alone. However, there was an herbicide by timing interaction. Efficacy of the

December application of triclopyr was increased with the addition of aminopyralid, and was comparable to the spring application of triclopyr with or without aminopyralid. The results of a follow-up study that evaluated June-only timing were similar to the spring data, indicating no increase in control of gorse with triclopyr when aminopyralid was added.

IMPACTS OF VARIOUS TAMARISK (SALTCEDAR, *TAMARIX* SPP.) REMOVAL AND CONTROL METHODS ON PASSIVE RE-VEGETATION AND SECONDARY INVASIONS. Cameron Douglass*, Scott Nissen; Colorado State University, Fort Collins, CO (136)

The Arkansas River watershed, in southeastern Colorado, accounts for over 70% of the tamarisk infestation in Colorado. A large study has been established to determine how several common tamarisk removal methods affect subsequent understory re-vegetation. In addition to a large-scale trial directly comparing the impacts of chemical, mechanical, and biological removal methods, we are evaluating the influence of tamarisk canopies on aerially applied imazapyr retention and soil dissipation. Preliminary results have indicated that the average tamarisk canopy retained 74% ($P < .0001$) of aerially applied imazapyr, and that this retention significantly (75%, $P < .0001$) reduced soil residue levels beneath the canopy. We also have evidence indicating that soil dissipation underneath the canopy is occurring at a slower rate than dissipation in open areas. Soil residue levels one YAT varied, but in some samples imazapyr persisted at concentrations (up to 200 ppb) that are known to be phytotoxic to desirable plants. Imazapyr applications also resulted in significantly reduced plant species abundance (richness and basal cover) and diversity. Mechanical treatments, and in particular mulching using a Hydro-Axe, increased plant species abundance. In conclusion, our preliminary findings suggest that there is a higher capacity for desirable passive re-vegetation than was previously thought. These sites will be monitored for several years to provide a better understanding of the interaction between tamarisk removal methods and resulting plant species recruitment and re-establishment.

EFFICACY TRIALS FOR TOTAL VEGETATION CONTROL IN WESTERN WASHINGTON. Harvey A. Holt*[1], Galen M. Wright[2]; [1]Green Systems Analytics, LLC, Seattle, WA, [2]Washington Forestry Consultants, Inc., Olympia, WA (137)

Total vegetation control is a desired outcome for herbicide treatments on industrial sites such as railroads, substations, parking lots, storage areas, pumping stations, tank farms, and road shoulders. The residual nature of herbicide treatments used on these sites can exacerbate the development of herbicide resistance so the efficacy of new modes of action is a constant concern. Treatments were established at three railroad sites in western Washington and evaluated monthly from May to October, 2010. The traditional treatments that depend on inhibiting photosynthesis and ALS can be successfully enhanced by PROTOX and root inhibitors (flumioxazin and prodiamine), and the new auxin growth regulator (aminocyclopyrachlor).

CONTROL OF RUSSIAN-OLIVE THROUGH CUT STUMP AND BASAL BARK HERBICIDE APPLICATIONS. Ryan J. Edwards*, K. George Beck; Colorado State University, Ft. Collins, CO (138)

Cut-stump and Basal-bark field trials were conducted on Russian olive trees testing aminocyclopyrachlor (DPX-MAT 28 SL). For Cut-stump treatments, trees were cut down and herbicides applied using a backpack sprayer at 1 fluid ounce per inch of trunk diameter to the entire stump. Aminocyclopyrachlor was applied at 2.5, 5, 10 and 15% v/v and compared to 30% triclopyr ester, 20% triclopyr ester + 1% imazapyr, 10% aminocyclopyrachlor +1% imazapyr, and a no herbicide control. Basal-bark treatments were applied using a backpack sprayer at 1 fluid ounce per inch of trunk diameter, 6 inches above the soil surface. Herbicides were applied to either one side of the trunk (3-4 inches), or the entire trunk (greater than 4 inches). Aminocyclopyrachlor was applied at 5, 10 and 15% v/v and compared to 25% triclopyr ester, 20% triclopyr ester + 1% imazapyr, 10% aminocyclopyrachlor +1% imazapyr, and a no herbicide control. All treatments were mixed with Bark Oil Blue LT as a carrier. Both experiments were designed as a RCB, with nine replications (one tree per replicate). Visual control data were collected 1 year after applications, and data were analyzed by analysis of variance and means separated by LSD (α= 0.05). There were no statistical differences among Cut-stump treatments, but all treatments were different from the check. For Basal-bark, the 15% v/v solution of aminocyclopyrachlor was the most effective, while 30% v/v triclopyr ester + 1% v/v imazapyr was the least.

AMINOCYCLOPYRACHLOR: A NEW HERBICIDE FOR PASTURE AND RANGELAND WEED CONTROL. Craig M. Alford*[1], Jeff H. Meredith[2], James Harbour[3], Eric P. Castner[4], Susan K. Rick[5]; [1]DuPont Crop Protection, Lakewood, CO, [2]DuPont Crop Protection, Memphis, TN, [3]DuPont Crop Protection, Wilmington, DE, [4]DuPont Crop Protection, Weatherford, TX, [5]DuPont Crop Protection, Waterloo, IL (139)

Aminocyclopyrachlor, an exciting new class of auxin herbicide from Dupont, is under development for range, pasture and invasive weed control. In research trials conducted across the United States since 2005, aminocyclopyrachlor has demonstrated excellent activity on a number of important species such as thistles, leafy spurge, knapweeds, ironweed, and brush such as mesquite, and rubber rabbitbrush. Aminocyclopyrachlor has exhibited a number of positive stewardship attributes with very low impact to mammals and the environment.

AMINOCYCLOPYRACHLOR HERBICIDE MIXTURES FOR THE WESTERN US VEGETATION MANAGEMENT MARKET. Ronnie G. Turner[1], Stephen F. Colbert*[2]; [1]DuPont Land Management, Lakewood, CO, [2]DuPont Crop Protection, Escalon, CA (140)

Registration of four new vegetation management herbicides from DuPont is anticipated to occur in early 2011. The new products combine the proven efficacy of DuPont's sulfonylurea herbicides with the new active ingredient aminocyclopyrachlor. DuPont™ Plainview™ herbicide is a broad-spectrum bareground weed control product designed specifically to help utility and industrial site managers improve site safety. DuPont™ Viewpoint™ herbicide delivers broad-spectrum brush control for greater safety at utility sites and along roadways. DuPont™ Streamline™ herbicide was designed to help land managers maintain desired grasses without sacrificing brush control. DuPont™ Perspective™ herbicide controls invasive weeds and helps restore desirable grasses and more natural habitats.

WEED AND BRUSH MANAGEMENT IN PASTURE AND RANGELAND WITH AMINOCYCLOPYRACHLOR. James Harbour*[1], Jeff H. Meredith[2], Eric P. Castner[3], Susan K. Rick[4], Michael T. Edwards[5]; [1]DuPont Crop Protection, Wilmington, DE, [2]DuPont Crop Protection, Memphis, TN, [3]DuPont Crop Protection, Weatherford, TX, [4]DuPont Crop Protection, Waterloo, IL, [5]DuPont Crop Protection, Pierre Part, LA (141)

In research trials conducted in pasture and rangeland across the United States since 2005, aminocyclopyrachlor has demonstrated excellent activity on a number of important species such as thistles (*Circium* spp.), leafy spurge (*Euphorbia esula*), knapweeds (*Centauria* spp.), ironweed (*Vernonia* spp.), and brush such as mesquite (*Prosopis* spp.), and rubber rabbitbrush (*Chrysothamnus nauseosus*). Aminocyclopyrachlor has exhibited excellent weed control at low use rates and across a wide application window.

RANGELAND REVEGETATION REVISITED: ARE SHORT-TERM TRENDS INDICATIVE OF LONG-TERM OUTCOMES? Jane Mangold*[1], Matt Rinella[2], Erin Espeland[3], Jim Jacobs[4], Roger Sheley[5]; [1]Montana State University, Bozeman, MT, [2]USDA-Agricultural Research Service, Miles City, MT, [3]USDA-Agricultural Research Service, Sidney, MT, [4]USDA-Natural Resources Conservation Service, Bozeman, MT, [5]USDA-Agricultural Research Service, Burns, OR (146)

In recent decades, dozens of studies have attempted to re-introduce plant species into rangeland dominated by invasive plants. The re-introduced plants have proven capable of establishing, but because they are rarely monitored for more than a few years, it is unknown if they have a high likelihood of persisting and suppressing invaders for the long term. We periodically measured re-introduced species, invasive plants and other associated species for nine years at one site and 15 years at a second site in western Montana. At one site, three grass species re-introduced from seed maintained high densities for three or more years, but then all or nearly all individuals died. At the second site, three other grass species proliferated after remaining relatively sparse for six or more years. At least two of these three grasses greatly suppressed the dominant invader (*Centaurea maculosa*). For example, our most likely parameter estimate suggests *Thinopyrum intermedium* reduced *C. maculosa* biomass by 93% 15 years after seeding. These results show seeded species sometimes persist and suppress invaders for long periods, but short-term data cannot predict if, when, or where this will happen. In some cases, data from three and less years after seeding falsely suggested seeded species would persist. In other cases, data from as late as six years after seeding falsely suggested seeded populations would remain fairly small and not suppress the invader. Because short-term data are unreliable and long-term data are scarce, it remains unclear whether successfully established seeded populations have a high likelihood of persisting, growing, and reducing rangeland invaders for the long term. Additional long-term data are needed to identify effective traits, species and practices for revegetating invaded rangelands.

MANAGEMENT OF HARE BARLEY (*HORDEUM MURINUM* SSP. *LEPORINUM*) IN COOL SEASON GRASS PASTURES WITH AMINOPYRALID AND IMAZAMOX. Jessica L. Haavisto*, Gene Pirelli, Andrew G. Hulting; Oregon State University, Corvallis, OR (147)

Hare barley (*Hordeum murinum* ssp. *leporinum*) is a vigorous, cool season winter annual in the Poaceae family. It is an extremely successful invader of disturbed sites and has become globally distributed. It can be found in waste areas, intensely grazed locations and various range environments. Due to its robust early growth, hare barley is often an important forage component in pasture systems, but the awns that develop as the plant matures cause injury to the mouth, eyes, ears and the skin of livestock. In Oregon, hare barley is a weed management concern in perennial cool-season grass pastures. Using a RCB design with three replications, field experiments were conducted in established perennial grass pastures during 2008-2010 near Molalla, OR, to evaluate potential control of hare barley using labeled and experimental pasture herbicides. Aminopyralid, a currently labeled treatment for use in pastures in several western states, was applied in the fall at 0.12 kg ai/ha and 0.25 kg ai/ha. Imazamox was applied postemergence in the spring at 0.02 kg ai/ha and imazamox + MCPA ester was applied postemergence in the spring at 0.02 kg ai/ha and 0.16 kg ai/ha, respectively. All treatments included a non-ionic surfactant (NIS)at 0.25% v/v and the imazamox + MCPA treatment included urea ammonium nitrate (UAN) at 1% v/v. Visual evaluations of percent hare barley control and percent pasture injury were made at monthly intervals following application. Aminopyralid applications resulted in 83-89% control of hare barley with minimal pasture injury at 0.3%. Experimental treatments of imazamox and imazamox +MCPA as a spring post-emergent treatment resulted in 45-70% control of hare barley with acceptable levels of pasture injury, 30-40%. Fall applications of aminopyralid provided acceptable levels of hare barley suppression and imazamox + MCPA treatments showing effectiveness as well. However, risks of pasture injury have been documented to be more significant using this treatment.

THE BIOLOGY AND MANAGEMENT OF VENTENATA (*VENTENATA DUBIA*). Stephen M. Van Vleet*; Washington State University, Colfax, WA (148)

Ventenata grass (*Ventenata dubia*), commonly called wiregrass or hairgrass, is an invasive, introduced annual grass. Ventenata is highly invasive in bluegrass, alfalfa, small grains, pasture and rangeland. In the early spring of 2007, a research study was conducted on ventenata infested rangeland in Anatone, Washington, applying the herbicide imazapic at rates of 4 and 8 ounces per acre. The study was continued in the fall of 2008, using additional herbicides to determine and compare control potential. The spring 2007 applications of imazapic provided on average 68% control at the 4 ounce rate and 93% control at the 8 ounce rate. Fall 2007 applications at the 4 and 8 ounce rates provided 63% and 80% control, respectively. In the fall of 2008, imazapic applied at 4 and 8 ounce per acre rates provided 95% and 99% control, respectively. As for the comparison herbicides (tested in 2008 and 2009), flufenacet plus metribuzin (Axiom™) provided 36% control, while rimsulfuron (Matrix™) and sulfometuron methyl plus chlorsulfuron (Landmark XP™) provided 100% Ventenata control. Only slight seed head suppression of the perennial grasses was caused from fall applications of imazapic and rimsulfuron; however, sulfometuron methyl/chlorsulfuron caused 50-81% injury to perennial grass species.

EFFECTS OF SETHOXYDIM ON A SOUTH PUGET SOUND PRAIRE PLANT COMMUNITY. David H. Peter*, Timothy B. Harrington, and Warren D. Devine; USDA Forest Service, Olympia, WA (149)

No abstract submitted.

OPERATIONAL EFFICIENCIES OF HERBICIDE BALLISTIC TECHNOLOGY (A.I. TRICLOPYR) TARGETING MICONIA CALVESEN. James Leary*; University of Hawaii at Manoa, Kula, HI (150)

No abstract submitted.

PROJECT 2: WEEDS OF HORTICULTURAL CROPS

EFFECTIVE USE PATTERNS FOR HPPD HERBICIDES IN NON-TRANSGENIC CONSERVATION TILLAGE SWEET CORN. R. E. Peachey*[1], Rick A. Boydston[2]; [1]Oregon State University, Corvallis, OR, [2]USDA-ARS, Prosser, WA (089)

Weed control is still a challenge in non-transgenic sweet corn due to the suite of weeds present (including wild proso millet and triazine resistant species) and conservation tillage systems that are evolving to meet challenges of environmental stewardship and increasing input costs, mainly the rising costs of fuel and fertilizer. The HPPD herbicides tembotrione and topramezone are labeled and widely used, and have greatly improved the potential for one-pass POST weed control. But challenges still remain when using these herbicides in conservation tillage systems, notwithstanding potential crop injury when these herbicides are tankmixed with soil-applied herbicides such as s-metolachlor.

Experiments conducted from 2007 through 2010 evaluated weed control in strip tillage and conventional tillage corn with one-pass HPPD herbicide treatments, sweet corn tolerance to tank mixes of HPPD and chloroacetamide herbicides, and potential causes of injury. Experiments were located in the Columbia Basin near Prosser, WA and the Willamette Valley of OR. HPPD herbicides tank mixed with chloroacetamide herbicides and applied at V2-4 in 2007 damaged corn leaves, but the symptoms were transient and did not resemble symptoms commonly associated with chloroacetamide injury in sweet corn. In strip-tillage corn in OR in 2008, weed control was exceptional with topramezone plus s-metolachlor or dimethenamid-P but may have reduced corn yield by 20% or more at one of two experimental sites when applied at V5-6. In 2009 at trials near Prosser and at Corvallis, yield of both Coho and Basin varieties was reduced by 10 to 15% when topramezone and tembotrione were applied at V2. Yield of these two varieties was reduced by as much as 25% when water was poured over the corn plants before applying the tank mix of HPPD and chloroacetamide herbicide in 2010. And finally, HPPD herbicides had little to no effect on nutsedge in a strip-till field in 2010 unless tank mixed with bentazon or halosulfuron, but there was no significant injury to the corn and yield was not reduced. One-pass herbicide applications in sweet corn may require lower rates of chloroacetamide or HPPD herbicide when they are tank mixed, or possibly lower rates of the adjuvants typically used to enhance efficacy, but the precautions needed to limit injury may depend on corn variety, stage of growth, and soil and plant moisture when herbicides are applied.

WEED CONTROL FROM INDAZIFLAM APPLIED ALONE AND IN TANK MIXTURES WITH OTHER HERBICIDES IN PERENNIAL CROPS. Darren Unland*[1], Hank J. Mager[1], Ryan Allen[2]; [1]Bayer CropScience, Fountain Hills, AZ, [2]Bayer CropScience, Sacramento, CA (090)

Alion is a preemergence herbicide with the new active ingredient, indaziflam, Bayer CropScience has developed for use in perennial tree nut, fruit, and vine crops. Registration is currently under review and pending approval by EPA. Field trials have been conducted by Bayer CropScience, university, and private researchers across the United States in major fruit and tree nut production areas to evaluate weed control by indaziflam. In these trials 73 g ai ha-1 indaziflam (5 fl oz Alion per acre) provided effective residual control of the most common monocot and dicot weeds. Indaziflam alone provided insufficient control when applied postemergent to weeds. Tankmixtures of glufosinate plus indaziflam provided both postemergence and residual weed control. Residual weed control was similar or superior to rimsulfuron, flumioxazin, and oxyfluorfen. Excellent crop tolerance was observed in all of these trials.

INDAZIFLAM PERFORMANCE IN PACIFIC NORTHWEST PERENNIAL CROPS. Monte D. Anderson*; Bayer CropScience, Spangle, WA (091)

Efficacy trials conducted in 2007-2010 indicate that preemergent applications of indaziflam provided effective grass and broadleaf weed control in Pacific Northwest perennial crops. Trials conducted by Universities, private researchers, and Bayer CropScience included evaluations in apples, pears, cherries, grapes and filberts grown in WA and OR. Various rates of indaziflam, tank mixes with burndown herbicides, and combinations with other herbicides were evaluated for broader overall spectrum and resistance management. Final weed control assessments in these studies confirmed the broad spectrum and length of residual activity as well as the excellent crop tolerance from indaziflam. Upon registration (anticipated in 2011), indaziflam will be marketed for extended residual control of broadleaf and grass weeds in perennial crops as Alion™.

PYROXASULFONE FOR WEED CONTROL IN POTATOES. Pamela Hutchinson*, Brent Beutler, JaNan Farr; University of Idaho, Aberdeen, ID (092)

Two field research trials were conducted at the Aberdeen Research and Extension Center in 2010. The first included pyroxasulfone applied preemergence to weeds and potato at 0.106 or 0.213 lb ai/A alone or combined with flumioxazin; or pyroxasulfone at 0.213 lb/A plus pendimethalin at 1.0 or metribuzin at 0.5 lb ai/A. Treatments in the second trial were pyroxasulfone applied preemergence alone at 0.213 lb/A or with EPTC at 4.0, ethalfluralin at 0.75, or rimsulfuron at 0.023 lb ai/A. Nontreated weedy and weed-free controls were included in both trials for yield comparisons. Season-long common lambsquarters control by pyroxasulfone alone in either trial was less than 60 percent while control in the first trial was improved to 78, or 80, 100, or 100 percent by tank mixing the low rate with flumioxazin, or the high rate with flumioxazin, pendimethalin, or metribuzin, respectively. Tank mixing in the second trial with EPTC or ethalfluralin improved common lambsquarters control to 92 and 95 percent, respectively, however, control with pyroxasulfone plus rimsulfuron was only 62 percent. In general, season-long redroot pigweed and green foxtail control was greater than 90 percent regardless of treatment. Hairy nightshade control in the first trial was more than 95 percent while control in the second trial was 82 to 88 percent. Although there as a trend towards lower U.S. No. 1 and total tuber yields with the pyroxasulfone alone treatments compared with tank-mixture yields, all herbicide treatment yields were usually greater than nontreated weedy yields and not different than weed-free yields.

AMINOPYRALID INJURY TO POTATOES. Kevin B. Kelley*, Lloyd C. Haderlie; AgraServ, Inc., American Falls, ID (093)

Aminopyralid, an auxinic herbicide that is very effective on several broadleaf weeds, is commonly used in range and pastures. Potatoes are very sensitive to aminopyralid, and a number of off-target injury occurrences prompted this research. Potato response to aminopyralid was evaluated under several off-target scenarios: fall soil applied carryover, preplant drift, in season response to early and mid season drift events, and daughter tuber plant response to late season drift onto potato foliage. Picloram, dicamba, and clopyralid were included for comparison. Following fall soil carryover applications of aminopyralid, potatoes planted the following spring showed little to no injury early season, but injury increased as plants grew. Total yield was not significantly affected by fall applied soil carryover, but the highest rate (9 g ai/ha) resulted in a significant reduction in tuber quality (40% less US #1) compared to the untreated. A field use rate ranges from 53 to 123 g ai/ha. Spring preplant applications caused greater injury at lower rates than fall carryover applications, including early season injury, and resulted in significant yield losses (LSD P=0.1) at rates as low as 0.44 g ai/ha of aminopyralid. In season applications were made 2 weeks after emergence (WAE) and again 4 weeks later at row closure. Foliar injury was observed 1 to 2 weeks after both applications at all but the lowest rate (0.04 g ai/ha). The highest rate at both applications (44 g ai/ha) resulted in a significant total yield loss, and 4.4 g ai/ha applied at 2 WAE also resulted in a reduction of tuber quality. Late season simulated drift onto potatoes in 2009 resulted in foliar injury symptoms of plants grown from daughter tubers in 2010 beginning at emergence from rates as low as 0.44 g ai/ha, but symptoms were reduced as plants grew and there was no significant yield loss at this rate. A rate of 4.4 g ai/ha of aminopyralid in 2009 reduced both stand and yield in 2010. Preplant and in season applications of picloram caused similar levels of injury and yield loss at equivalent rates of aminopyralid. Growing out daughter tubers of potatoes is one of the most sensitive bioassays for picloram. Dicamba reduced yield when applied in season but not when applied preplant. Clopyralid caused less injury overall than the other herbicides and reduced yield when applied preplant but not when applied in season. Greater rates of clopyralid and dicamba were required to cause injury. In addition to yield losses, there were greater numbers of tuber defects in aminopyralid treated tubers from all treatment timings. These defects included growth cracks, knobs, folds, surface defects, and an unusual tuber defect involving a circular swelling around the eye resembling a bull's eye.

ORGANIC WEED CONTROL IN A NEWLY-ESTABLISHED VINEYARD. Callie S. Bolton*[1], Carol A. Miles[1], Mercy A. Olmstead[2], Timothy W. Miller[1]; [1]Washington State University, Mount Vernon, WA, [2]University of Florida, Gainesville, FL (094)

An organic vineyard was established in Mount Vernon, WA in 2009 to analyze the effectiveness of cover crops compared to tillage for weed control. Five treatments were applied to 'Pinot Noir Precoce' (PNP) and 'Madeleine Angevine' (MA) grapes during the first two years of establishment: 1) tillage between rows, hand-weeding in rows (standard), 2) ryegrass cover between rows and tillage with the Wonder Weeder in rows, 3) winter wheat cover crop, 4) winter pea cover crop, and 5) 2:1 winter wheat and winter pea respectively. MA produced more shoot growth than PNP in September 2010, with mean lengths of 123.8 and 93.6 cm, respectively. Grapevines measured 160.4 cm under Treatment 1, significantly longer than vines under

Treatment 2 (124.8 cm) or under the three cover crop treatments (from 82.3 to 91.2 cm). Weed biomass in September 2009 was maximized in Treatment 4 (10.8 $g \cdot m^{-2}$), significantly greater than under Treatments 1 and 3 (3.6 and 1.6 $g \cdot m^{-2}$, respectively). The greatest weed biomass in July 2010 was produced in cover crops (Treatments 3, 4, and 5), ranging from 7.9 to 12.6 $g \cdot m^{-2}$; by September, however, weed biomass did not statistically differ between treatments. In 2009, most weed biomass was from within the grape row rather than between the rows, but in 2010, most of the weed biomass was from between the rows. A total of 1.7-$hr \cdot ha^{-1}$ per person was required for plot maintenance in Treatment 1 for the two growing seasons, significantly longer than Treatment 2 (0.7-$hr \cdot ha^{-1}$) or cover crop treatments (0.9-$hr \cdot ha^{-1}$).

HERBICIDE COMBINATIONS FOR WEED CONTROL IN MATTED-ROW STRAWBERRIES. Timothy W. Miller*, Carl R. Libbey; Washington State University, Mount Vernon, WA (095)

June-bearing strawberry cultivars are grown in a perennial matted-row system in western Washington. Typically, establishment occurs in Year 1, followed by harvests in Years 2 and 3. If plants are still healthy, they may be kept beyond the normal two harvests. Since cultivation in the perennial bed is not possible, weeds within the rows after establishment are a major problem for producers. Sequential herbicide combinations to winter-dormant strawberries were tested over the last two years at Washington State University Mount Vernon NWREC in effort to find combinations providing season-long control of common winter annual weeds such as common chickweed. Split-block simazine at 1.1 kg ai/ha was applied in mid-December, followed by dormant-season, whole-plot treatments in mid-winter. Although 29% of the treatments in 2009 did not result in greater than 10% foliar injury by March, 83% of the products resulted in greater than 10% injury when applied in sequence with simazine, and four of those resulted in greater than 20% injury. By April, however, only strawberries treated with simazine + s-metolachlor and KSU 12800 with or without simazine were still showing greater than 10% injury. In 2010, strawberry foliar injury from most dormant-season herbicides in March was comparable to the 23% injury observed in nontreated strawberries. Injury was less than 10% by April for all treatments except KSU 12800. Common chickweed control was much enhanced by use of simazine in 2009, measuring 89 and 53% control with and without simazine, respectively, when averaged across dormant season treatments. In 2010, weed control was improved 15 to 22% when simazine was applied sequentially with dormant season herbicides. Fruit yield did not differ by herbicide treatment either year, and simazine also did not improve total yield. Average fruit weight was improved in 2009 by simazine treatment (16.7 and 14.8g/fruit for plants with and without simazine, respectively); fruit size did not differ in 2010.

IMAZOSULFURON (V10142) SOIL RESIDUES INJURES SUGAR BEET AND DRY BULB ONION. Joel Felix*, Joey K. Ishida; Oregon State University, Ontario, OR (142)

Field studies were conducted in 2010 in Ontario, OR to evaluate the response of direct-seeded dry bulb onion, sugar beet, and pinto bean to imazosulfuron soil residues 12 months after application to control weeds in potato. The studies followed randomized complete block design with three replications. Imazosulfuron was applied alone PRE at 224- and 450 g ai ha^{-1}, sequentially at 224 g ha^{-1} PRE and POST, or in tank mixture with s-metolachlor 1,060 g ha^{-1}. Very few onion plants emerged in plots previously treated with imazosulfuron at 224 g ha^{-1}, regardless of timing. Emerged onion plants were severely injured and never matured. No onions emerged from residues of imazosulfuron applied at 450 g ha^{-1}. Few sugar beet plants emerged from 224 g ha^{-1} but were severely stunted and never grew beyond the first set of leaves. There was no sugar beet emergence from imazosulfuron sequential applications, regardless of the rate and application timing. However, imazosulfuron residues did not affect pinto beans, which emerged and produced marketable yield similar to grower standard and nontreated treatments. The results suggest sensitivity of direct-seeded dry bulb onion and sugar beet to imazosulfuron residues 12 months after application, but not pinto beans.

EVALUATION OF METOLACHLOR AND DIMETHENAMID-P PRE-EMERGENCE ON DRY BULB ONIONS WITH ACTIVATED CARBON. Kevin V. Osborne*[1], Joel Felix[2], Joey K. Ishida[2]; [1]Oregon State University, Nyssa, OR, [2]Oregon State University, Ontario, OR (143)

Yellow nutsedge (*cyperus esculentus*) has become a threat to direct seeded onions throughout the Treasure Valley of eastern Oregon and southwestern Idaho and has the potential to devastate dry bulb onion yields if not controlled properly. S-metolachlor and dimethenamid-p are currently registered for application when plants are at 2 leaf stage. However, s-metolachlor and dimethenamid-p control yellow nutsedge best when applied prior to emergence. A field study was conducted in 2010 at the Malheur Experiment Station, Ontario, OR to evaluate the potential use of activated charcoal to neutralize PRE applied *s*-metolachlor and dimethenamid-p within the onion row and protect emerging plants from the herbicide effects. The study also evaluated the effect of simulated rain (1.27 cm) shortly after herbicide application but before onion emergence. The study followed a split-split-plot design with simulated rain (with and without) forming the main blocks into which activated charcoal and herbicide rates were imposed as sub and sub-sub-plots, repsectively. The study had four replications and the plot size was 4 rows of 55.9 cm wide beds each by 7.6 m length. A precision onion planter was modified to simultaneously apply 2.54 cm activated charcoal slurry band directly over the row in a single pass. Activated charcoal was applied at a rate of 28 kg/ha in 467 liters of water/ha. Pre-emergence *s*-metolachlor was applied at 1.07 or 1.42 kg ai/ha, while dimethenamid-p was applied sequentially at 0.55 kg ai/ha PRE and POST or 1.1 kg ai/ha PRE. The study included a grower standard treatment, which was comprised of pendimethalin at 1.07 kg ai/ha PRE followed by *s*-metolachlor at 1.42 kg ai/ha when onions were at 2-leaf stage. An untreated control was also included. Onion stand at 34 days after planting averaged 163,970 plants/ha when herbicides were applied without activated charcoal and followed by irrigation compared to 205,207 plants/ha with activated charcoal and irrigation. There also was a herbicide-by-irrigation interaction for onion plant stand. The presence of onion maggot (*Delia antiqua*) in the study area may have confounded the effect of irrigation and herbicides on onion stand. Onion stand was reduced when *s*-metolachlor was applied at 1 kg ai/ha and dimethenamid-p at 0.55 kg ai/acre followed by irrigation. Marketable onion yield for plots not treated with activated charcoal was reduced 11% relative to charcoal treated plots (43 T/ha). Onion yield was also influenced by the combined effects of charcoal and irrigation with marketable yield ranging from 32 T/ha to 51 T/ha. Yellow nutsedge control with *s*-metolachlor was not significantly different from the grower standard, mainly due to uneven distribution across the field. Dimethenamid-p provided significantly less control from all treatments. The results may also have been influenced by the weather conditions in 2010, which was cooler than normal. The results indicate that the use of activated charcoal may be a viable option for pre-emergence application of *s*-metolachlor and dimethenamid-p to directed seeded onion. However, more studies are needed to confirm these results.

NEW HERBICIDES OFFER NEW APPROACHES FOR WEED CONTROL IN DESERT TURFGRASSES. Kai Umeda*; University of Arizona, Phoenix, AZ (144)

Several new herbicide products have become available for use in desert turfgrasses recently or will soon be registered. Aminocyclopyraclor, marketed as Imprelis, has exhibited varying levels of efficacy against dandelion, burclover, black medic, wild celery, and mat chaff-flower at rates ranging from 0.075 to 0.15 lb a.i./A. Imprelis is safe on overseeded perennial ryegrass but is injurious to bermudagrass. Indaziflam, marketed as Specticle, is very effective in giving preemergence and very early postemergence control of Poa annua in dormant bermudagrass. Indaziflam showed a rate response with 0.067 lb a.i./A providing near complete control of P. annua and acceptable control achieved with 0.031 lb a.i./A. Flumioxazin, soon to be marketed as Sureguard is not yet registered for turf use, has been effective for preemergence control of P. annua in dormant bermudagrass. Fall applications of flumioxazin at 0.38 lb a.i./A were very effective against P. annua; however, rates as low as 0.19 lb a.i./A inhibited overseeded ryegrass turf establishment. Flazasulfuron is marketed as Katana for use in turfgrass for controlling purple nutsedge in bermudagrass with sequential applications at 0.047 lb a.i./A. It is also effective for use as a transition-aid herbicide to eliminate overseeded cool-season grasses from bermudagrass in the spring at rates from 0.0078 to 0.035 lb a.i./A. In dormant bermudagrass, it has exhibited efficacy in removing clumpy ryegrass and P. annua. Celsius is a three-way combination product that contains thiencarbazone, iodosulfuron, and dicamba. At product rates of 2.5 to 4.0 oz/A, it gave effective postemergence broadleaved winter weed control plus activity against P. annua and clumpy ryegrass in dormant bermudagrass.

RESPONSE OF FOUR SWEET CORN HYBRIDS TO WEED MANAGEMENT LEVEL. Rick A. Boydston*[1], Martin M. Williams[2]; [1]USDA-ARS, Prosser, WA, [2]USDA-ARS, Urbana, IL (145)

Weed suppressive ability and tolerance to weeds were evaluated among four sweet corn hybrids that were previously characterized as differing in competitive ability. Field trials were conducted in 2009 and 2010 at Prosser, WA and in 2010 at Urbana, IL. Hybrids ‘Code128’ and ‘Legacy’(more competitive) and ‘Spring Treat’ and ‘Sugar Buns’ (less competitive) were grown under two weed management levels; 1) rotary hoed once and cultivated once and 2) rotary hoed twice and cultivated twice. Weed- free plots of each hybrid were included. Final leaf area per plant of Spring Treat and Sugar Buns averaged only 57% of Code 128 and Legacy. In late season, the two more competitive hybrids allowed 5 and 21% of photosynthetically active radiation (PAR) to penetrate through the canopy whereas 20 and 39% of PAR was transmitted through the canopy of the less competitive hybrids in 2009 and 2010, respectively. Final weed biomass was least in Code 128 averaging 136 to 243 g/m2 and greatest is Spring Treat averaging 310 to 330 g/m2 in 2009 and 2010, respectively. As weed density increased, Code 128 and Legacy maintained a greater portion of their weed-free yield than the less tolerant hybrids, Sugar Buns and Spring Treat. Selection of hybrids with greater competitive ability could be a valuable weed management tool particularly where weed control options are limited, such as in organic production systems.

PROJECT 3: WEEDS OF AGRONOMIC CROPS

TAKING THE E OUT OF ET. Robert N. Klein*; University of Nebraska, North Platte, NE (096)

Nebraska is now number one in the acres of irrigated farmland. The state moved to number one in 2007 replacing California. Average precipitation decreases 1 inch for every 25 miles from east to west across the state. Droughts are frequent in the High Plains and Nebraska records show 21 drought periods of 5 or more years in length in the years from 1220 to 1952. Nebraskans are always concerned about a drought and a depleting Ogallala aquifer that is forcing farmers to find more water efficient ways to produce crops. Some land that is now irrigated may have to return to rainfed or limited irrigation. Also, a large number of cropland acres in the High Plains will always be rainfed. The winter wheat fallow system was developed to compensate for the low precipitation in the high plains. Fallowing with tillage that buried most crop residues was replaced with tillage which left residues on the soil surface. Residue on the soil surface helps protect the soil from wind and water erosion. This stubble mulch lets more rain and snow soak into the soil to increase the soil water thus increasing efficiency. The crop residue also reduced soil temperatures to reduce evaporation of water from the soil. Winer wheat residue reduces weed density and improves weed management with herbicides. Crop Water Use (Evapotranspiration - ET) for irrigated corn in the High Plains ranges from 60 to 70 cm for fully watered corn. Up to 35% of this water use is from evaporation. Research has shown that the evaporation in fully irrigated corn can be reduced to as low as 15% of the ET with crop residues. This saving in E in ET plus saving 2.5 to 5.0 cm of soil water with the elimination of tillage reduces the irrigation water needs as much as 16 cm. Cropping practices for rainfed such as ecofallow and skip-row increase the success of crops grown using these systems. These practices are also being adopted by irrigators to increase crop water efficiency. This paper will discuss how to be successful with these water saving systems.

PENOXSULAM CONTROL OF (*CONYZA* SP.) BIOTYPES IN CALIFORNIA. Monica Sorribas*[1], Marcelo L. Moretti[2], Anil Shrestha[2], Richard K. Mann[3], Garrick W. Sthur[4], Marc Fisher[5]; [1]Dow AgroSciences LLC, Indianapolis, IN, [2]California Fresno State University, Fresno, CA, [3]Dow AgroSciences, Indianapolis, IN, [4]Dow AgroSciences, Fresno, CA, [5]Dow AgroSciences LLC, Fresno, CA (097)

Pindar™ GT is a premix formulation of penoxsulam (Tangent™), an ALS (acetolactate synthase) inhibitor (HRAC Group B) herbicide developed by Dow AgroSciences and registered by EPA in 2009 for use in tree nut crops and oxyfluorfen (Goal Tender®), a PPO (protoporphyrinogen oxidase) inhibitor (HRAC Group E). Pindar GT is a dual mode of action herbicide product that when applied during the winter dormant and/or spring period provides excellent residual and contact control of susceptible winter annual and spring/summer weeds in tree nuts including *Malva* spp. (Mallow species), *Erodium* spp. (Filarees), *Amsinckia* spp. (Fiddlenecks), *Calandrinia ciliata* (Redmaids), *Amaranthus* spp. (Pigweeds), *Senecio vulgaris* (Common groundsel), *Sonchus* spp. (Sowthistles), *Oenothera* spp. (Primroses) and glyphosate susceptible and resistant *Conyza canadensis* (Marestail/Horseweed) and *Conyza bonariensis* (Fleabane) among other broadleaf weeds and common key grasses present in tree nut orchards. Pindar GT was registered by EPA in August 2010 and multiple State registrations including California were approved during the summer and spring of 2010.

In light of the increasing problematic spread of Glyphosate resistant *Conyza* spp. in tree nuts and other tree fruit crops in Fresno and San Joaquin Valley in California, a field trial was conducted in 2008 at the Dow AgroSciences Western Research Center in Fresno, California to determine the efficacy of Tangent (penoxsulam) on both species at different weed stages. Greenhouse trials were conducted in 2010 to determine the efficacy of Pindar GT (penoxsulam+oxyfluorfen) versus other residual commercial herbicides to control different Conyza spp. biotypes in pre-emergence and at different post-emergence weed stages at the Western Research Center in Fresno, California. Results showed that Pindar GT at 3 pt/ac (35 gai/ha Penoxsulam+ 1680 gai/ha Oxyfluorfen) delivered pre-emergence and post-emergence control at different weed stages of different *Conyza* spp. populations. Additional research is in progress to extend Pindar™ GT testing to other glyphosate resistant populations.

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PYROXSULAM PERFORMANCE ON WHEAT IN CALIFORNIA AND ARIZONA. Jesse M. Richardson*[1], Marc Fisher[2], Deb Shatley[3], Monica Sorribas[4], Roger Gast[4]; [1]Dow AgroSciences, Hesperia, CA, [2]Dow AgroSciences LLC, Fresno, CA, [3]Dow AgroSciences, Lincoln, CA, [4]Dow AgroSciences, Indianapolis, IN (098)

Pyroxsulam is an effective herbicide for the control of key grass weeds and a wide range of broadleaf weeds in winter and spring wheat, including Durum. Field studies were conducted with pyroxsulam (liquid oil dispersion formulation) in 2010 over a wide range of growing conditions, and against diverse weed species in California, Arizona and New Mexico. In these studies, pyroxsulam was compared to a number of herbicides, including mesosulfuron, fenoxaprop and pinoxaden. From the standpoint of grass weed control, pyroxsulam provided similar efficacy to mesosulfuron, fenoxaprop and pinoxaden against wild oat. Against Italian ryegrass, pyroxsulam was superior to fenoxaprop and pinoxaden, but similar to mesosulfuron. Against littleseed canarygrass, pyroxsulam was superior to all three. For broadleaf weed control, pyroxsulam was superior to fenoxaprop and pinoxaden against wild mustard, bur clover, purple vetch and tansymustard, but similar to mesosulfuron. Against nettleleaf goosefoot, pyroxsulam provided superior efficacy to all three comparison herbicides. In assessments up to 30 days after application, pyroxsulam was slightly more injurious to wheat than mesosulfuron, fenoxaprop and pinoxaden, but this effect was not detected at later assessments. Where broadleaf weed pressure was high, pyroxsulam generally resulted in higher yields than the comparison herbicides. Pyroxsulam will be sold in California and Arizona under the trade name Simplicity™.

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State restrictions on the sale and use of Simplicity™ apply. Consult the label prior to purchase or use for full details. Always read and follow label directions.

EFFICACY OF A NEW HIGHER CONCENTRATION PYROXSULAM WG FORMULATION FOR WINTER WHEAT. Kevin D. Johnson*[1], Daniel C. Cummings[2], Joe Yenish[3], Harvey Yoshida[4], Neil A. Spomer[5], Gary A. Finn[6], Marcin D. Dzikowski[7]; [1]Dow

AgroSciences, Barnesville, MN, [2]Dow AgroSciences, Perry, OK, [3]Dow AgroSciences, Pullman, WA, [4]Dow AgroSciences, Richland, WA, [5]Dow AgroSciences, Brookings, SD, [6]Dow AgroSciences, Indianapolis, IN, [7]Dow AgroSciences, Munich, Germany (099)

Effective grass control in wheat has always been difficult to obtain without risking injury to the crop. This has become increasingly more difficult as Group 1 resistance has developed in some of the most important grass weeds. Pyroxsulam containing herbicides have demonstrated excellent control of many tough to control grass and broadleaf weeds while still providing excellent crop safety and rotational flexibility. Pyroxsulam herbicides are effective in controlling many of the toughest grass weeds in both winter and spring wheat, including but not limited to Italian ryegrass (*Lolium multiflorum*), wild oat (*Avena fatua*), and downy brome (*Bromus tectorum*), including Group 1 resistant biotypes. For use in winter wheat, a 7.5% wettable granule formulation (WG) of pyroxsulam was registered in 2008, containing a 1:1 ratio with a safener, cloquintocet. During the 2009 and 2010 field seasons, we compared the currently sold formulation of pyroxsulam to a more concentrated WG formulation, containing 13.1% pyroxsulam, also in a 1:1 ratio with cloquintocet. Evaluations were conducted for control of several of the toughest to control grass weed species in winter wheat. Over the two years no differences in bioactivity or crop safety were observed between the two formulations of pyroxsulam.

BROADLEAF WEED CONTROL IN WHEAT AND BARLEY WITH FLORASULAM PLUS FLUROXYPYR. Harvey Yoshida*[1], Roger Gast[2], Monte Weimer[2], Marcin Dzikowski[3]; [1]Dow AgroSciences, Richland, WA, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, Munich, Germany (100)

Multi-year studies were conducted in the U.S. over 2008 - 2010 to evaluate the premix combination of florasulam plus fluroxypyr for postemergence broadleaf weed control in wheat and barley. The premix formulation, sold under the name Starane® Flex by Dow AgroSciences, is a suspo-emulsion liquid containing a 20:1 ratio of fluroxypyr-meptyl (ae) and florasulam (ai). The labeled rate of florasulam at 987 mL formulated product per hectare (5 g ai/ha of florasulam plus 100 g ae/ha of fluroxypyr) resulted in excellent control of kochia (*Kochia scoparia)*, wild buckwheat (*Polygonum convolvulus)*, wild mustard (*Sinapis arvensis*), prickly lettuce (*Lactuca serriola)*, catchweed bedstraw (*Galium aparine*), redroot pigweed (*Amaranthus retroflexus*), volunteer sunflower (*Helianthus annuus*), and Russian thistle (*Salsola iberica*). The combination of florasulam (Group 2) plus fluroxypyr (Group 4) provides advantages such as broad spectrum broadleaf weed control, short crop rotational flexibility and resistance management.

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MANAGEMENT OF ITALIAN RYEGRASS WITH PYROXASULFONE IN WINTER WHEAT. Siyuan Tan*[1], Christopher R. Bond[1], Steven J. Bowe[1], Rex A. Liebl[1], Yoshihiro Yamaji[2], Hisashi Honda[2], Toshihiro Ambe[3]; [1]BASF Corporation, Research Triangle Park, NC, [2]Kumiai America, White Plains, NY, [3]Kumiai Chemical Industry, Tokyo, Japan (101)

Pyroxasulfone is a new selective herbicide under development for residual control of grass and broadleaf weeds in wheat production. Field research trials have been conducted across the USA from 2005 to 2009 to evaluate Italian ryegrass control and wheat safety from different application timings including preplant, preemergence, and postemergence. Rate ranges of

pyroxasulfone from 25 to 250 g ai/ha have been tested for different application timings. Studies indicate that pyroxasulfone provides excellent control of Italian ryegrass and some other winter annual weeds with flexible application timing and long-lasting efficacy. No or little crop response was observed from most of the weed-free trials. These field trials show that pyroxasulfone can be an effective management tool for Italian ryegrass and other grass and broadleaf weeds in winter wheat.

A NEW FLUCARBAZONE-SODIUM + CLOQUINTOCET-MEXYL COMBINATION FOR SPRING AND WINTER WHEAT. Chad J. Effertz*; Arysta LifeScience, Velva, ND (102)

Flucarbazone-sodium has been used effectively as a postemergent grass herbicide in cereal crop production since 2001. Historically, flucarbazone-sodium's selectivity to wheat was managed by limiting the stage of growth at application, restricting tankmix partners, and adjuvant use. Recently, Arysta LifeScience has investigated flucarbazone-sodium in combination with the wheat safener cloquintocet-mexyl. Everest 2.0 is a 419 g ai/l liquid suspension concentrate formulation containing flucarbazone sodium + cloquintocet-mexyl. Cloquintocet-mexyl offers flucarbazone-sodium increased crop selectivity, in turn allowing more flexibility in its commercial use. Flucarbazone-sodium crop injury under stress conditions or late postemergence applications is reduced by greater than half when in the presence of cloquintocet mexyl, while grass control is unaffected by the presence of the safener. Averaged over trials, flucarbazone-sodium provided 92-94% control of wild oat (*Avena fatua*) when applied alone or in combination with safener. With greater crop selectivity, more aggressive approaches can be taken to control difficult grassy weeds, which include using flucarbazone-sodium at 30 g ai/ha in combination with tribenuron-methyl and with surfactants containing a nitrogen source.

UTILIZATION OF PROPOXYCARBAZONE APPLIED PREEMERGENCE FOR THE CONTROL OF BROME SPECIES IN WINTER WHEAT. Steven R. King*[1], Mary D. Paulsgrove[2], Charlie Hicks[3], Kevin B. Thorsness[4], Tate Castillo[5], Mike C. Smith[4]; [1]Bayer CropScience, Huntley, MT, [2]Bayer CropScience, Raleigh, NC, [3]Bayer CropScience, RTP, NC, [4]Bayer CropScience, Fargo, ND, [5]Bayer CropScience, Larned, KS (103)

In the United States, downy brome (*Bromus tectorum*) and Japanese brome (*Bromus japonicus*) are becoming two of the most troublesome and difficult to control weeds in winter wheat (*Triticum aestivum*). Increased no-tillage production practices, warmer winters, and limited herbicide choices have facilitated the increase in bromus species populations. The herbicide propoxycarbazone is labeled for postemergence (POST) applications in winter wheat for the control of bromus species. Propoxycarbazone can be applied at 30-45 g ai/ha in the fall or spring. Sequential treatments of 30-45 g ai/ha applied in the fall may be followed by an additional 15-30 g ai/ha in the spring. The maximum use rate of propoxycarbazone in one year is 60 g ai/ha. Herbicidal activity in weeds is due to root and foliar absorbtion of the active ingredient and propoxycarbazone offers both contact and residual control. Currently, propoxycarbazone can be applied to wheat from crop emergence up to but before jointing. In 2009 and 2010, research trials were conducted to determine the efficacy of propoxycarbazone applied preemergence (PRE) or postplant preemergence (PPRE) in winter wheat for the control of bromus species. Propoxycarbazone rates ranged from 15-45 g ai/ha applied either PRE or PPRE alone in the fall. Sequential treatments of propoxycarbazone at 30 g ai/ha applied in fall followed by 30 g ai/ha in the spring were also evaluated. Propoxycarbazone treatments were compared to 14.7 g ai/ha of flucarbazone applied PRE or PPRE in the fall. Winter wheat injury from any treatment applied either PRE or PPRE did not exceed 10%. Downy brome control with 15 g ai/ha of propoxycarbazone applied in the fall was similar to that provided by 14.7 g ai/ha of flucarbazone. Downy brome control was increased 15 and 27 percentage points when propoxycarbazone was applied at 30 and 45 g ai/ha PRE, respectively, compared to 15 g ai/ha. Sequential propoxycarbazone treatment generally resulted in greater than 80% downy brome control and was typically the highest yielding treatment. Submission of the section 3 label to the EPA for the application of propoxycarbazone as a preemergence treatment in winter wheat is pending. Utilization of this use pattern is planned for the fall of 2011.

RELATIVE COMPETITIVENESS OF SPRING CROPS IN EASTERN WASHINGTON DRYLAND ORGANIC SYSTEMS. Misha R. Manuchehri*, E. P. Fuerst, Ian C. Burke, Dennis Pittmann; Washington State University, Pullman, WA (104)

Weed control in certified organic grain production in Eastern Washington presents many challenges. Spring crops, in particular, are weak competitors against weeds and often fail due to weed pressure. In May of 2010 an organic spring crop trial was initiated near Pullman, WA. The study addressed the relative competitiveness of six spring crops (barley, wheat, lentils, garbanzos, and peas) against oats. The experiment was a randomized complete block design with strip plots. There were four replications of treatments. Main plots included each crop planted at two different seeding rates (a recommended and a doubled rate) and subplots were two oat density treatments (88 kg/ha and 22 kg/ha) and a weed free control. The growth and development of crops and weeds were measured by stand counts, biomass, and yield. Crop stand counts for barley, wheat, and lentils increased when seeding rates were doubled, but due to recruitment, stand counts were similar for wheat and barley by 47 days after planting. Garbanzo, lentil, and pea stand counts were not affected by seeding rate or recruitment. Barley and wheat biomasses were greater than total weed biomass for each crop, while broadleaf crop biomass was less. Barley and wheat yields decreased as oat density increased whereas oat presence in the broadleaf crops resulted in a complete yield loss. Doubled seeding rates increased barley and wheat yields. Barley and wheat were the most competitive while the broadleaf crops were poor competitors.

PYRASULFOTOLE AND BROMOXYNIL WEED CONTROL PERFORMANCE IN GRAIN SORGHUM IN 2010. Brian L. Olson*[1], Curt Thompson[2], Phillip Stahlman[3], Pat Geier[3], Nathan Lally[4], Alan Schlegel[5], Doug Shoup[6], Gary Cramer[7], Kent Martin[8]; [1]Kansas State University, Colby, KS, [2]Kansas State Unviversity, Manhattan, KS, [3]Kansas State University, Hays, KS, [4]Kansas State University, Manhattan, KS, [5]Kansas State University, Tribune, KS, [6]Kansas State University, Chanute, KS, [7]Kansas State University, Wichita, KS, [8]Kansas State University, Garden City, KS (105)

Pyrasulfotole and bromoxynil is a relative new herbicide combination that has the potential to provide effective postemergence weed control of problematic weeds in grain sorghum. Fortunately, this herbicide combination also has the potential to control various groups of herbicide resistant weeds (triazine, ALS, and glyphosate). Broadleaf weed control in grain sorghum continues to be challenging with limited options available, and weed resistance to those options occurring. The second year of field experiments evaluating two application timings of a prepackaged mixture of pyrasulfotole and bromoxynil (1:8 ratio) plus atrazine alone, and in combination with 2,4-D ester or dicamba for grain sorghum tolerance and weed control were conducted near Tribune, Manhattan, Garden City, Colby, Topeka, Wichita, and Hays, KS in 2010. Pyrasulfotole and bromoxynil at 244 g/ha was tank mixed with atrazine at 560 g/ha only or in combination with 2,4-D ester at 140 g/ha or dicamba at 140 g/ha. Herbicide treatments were applied postemergence to 2 to 6-leaf (early) and 7 to 10-leaf (late) sorghum. Crop response and weed control were evaluated visually. Sorghum injury ratings at all locations ranged from 0 to 30% injury 5 to 14 days after application for the pyrasulfotole and bromxoynil treatments. Unlike 2009, the addition of 2,4-D ester or dicamba to pyrasulfotole and bromoxynil + atrazine did not consistently reduce sorghum injury compared to pyrasulfotole and bromoxynil + atrazine alone. At the six locations harvested, all pyrasulfotole and bromoxynil + atrazine treatments yielded similarly to the atrazine + bromoxynil treatments. As for weed control, the highest level of control observed on palmer amaranth, redroot pigweed, tumble amaranth, common sunflower, ivyleaf moningglory, kochia, puncturevine, was consistently achieved across sites with the early application of pyrasulfotole and bromoxynil + atrazine treatments when weeds were typically 1 to 4 inches in height. Weed control generally decreased with the later application of pyrasulfotole and bromoxynil + atrazine treatments when weeds were typically 6 to 9 inches in height. For example, control for palmer amaranth was 96% when averaged across all sites and pyrasulfotole and bromoxynil + atrazine treatments for the early application and 86% for the late applications. Puncturevine control was also reduced with an average of 94% control observed across all sites and pyrasulfotole and bromoxynil + atrazine treatments for the early application, while 73% was observed for the late applications. Similar to 2009, the 2010 results indicate that grain sorghum has adequate tolerance to postemergence applied pyrasulfotole and bromoxynil + atrazine regardless of the tank mix partner evaluated in these experiments. Excellent control of several problems weeds is an indication of the enhanced value the herbicide could bring to a weed control program in grain sorghum. However, weed size is important in order to consistently observe high levels of weed control.

DISSIPATION AND SOIL INTERACTION OF PYROXASULFONE AND S-METOLACHLOR. Eric P. Westra*[1], Dale Shaner[2], Philip Westra[3]; [1]Colorado State University, Fort Collins, CO, [2]USDA/ARS, Fort Collins, CO, [3]Colorado State University, Ft. Collins, CO (106)

Pyroxasulfone and s-metolachlor soil interactions were evaluated in field dissipation studies and in lab experiments which were used to calculate Kd values (herbicide bound to soil/herbicide in solution) across multiple soils. Field dissipation studies were repeated at 2 locations in northern Colorado during 2010 in sunflowers to compare dissipation between pyroxasulfone and s-metolachlor over the growing season. The field dissipation studies consisted of 3 replications with pyroxasulfone applied at 0.28 kg ai/ha, and S-metolachlor at 1.67 kg ai/ha. Three soil samples per plot per sampling time were collected in 30 cm zero-contamination tubes from each plot. The soil samples were extracted with toluene prior to use of a G.C. mass spectrometer to quantify herbicide concentrations. Compared to the 2009 dissipation study, the 2010 growing season received higher precipitation which resulted in faster dissipation of both herbicides compared to 2009. Second year field dissipation studies highlight the importance of soil moisture and its effects on dissipation rates for both herbicides. Between 2009 and 2010 growing season soil moisture increased at both sites which resulted in a reduced half-life for both herbicides which would suggest shorter residual control under soil conditions with increased moisture. Across 20 soils s-metolachlor had the highest Kd values which ranged from 0.34 to 22.4, pyroxasulfone had the lowest, and dimethenamid was in the middle although closer to pyroxasulfone values. Kd values showed that when compared to s-metolachlor and dimethenamid, greater amounts of pyroxasulfone are found in the plant available water compared to being bound to the soil and organic matter

PENDIMETHALIN APPLICATION TIMINGS FOR WEED CONTROL IN GRAIN SORGHUM. Randall S. Currie*; Kansas State University, Garden City, KS (107)

Early preemergence applications of pendimethalin in sorghum are only labeled east of the Mississippi river and in a few states and areas adjacent to the Missouri river as well as the state of Arizona. This work was conducted to explore the possibility of expanding the range of this label. To produce a robust weedy grass population, the entire plot area was seeded to winter wheat blended with green foxtail seed in the fall of 2006. In 2007 after wheat harvest, the entire plot area was kept free of broadleaf weeds with applications of 2, 4-D and dicamba as needed. In 2008, the area was fallowed with light tillage and applications of 2, 4- D as needed to produce a dense stand of green foxtail. The entire plot area was planted to winter wheat in the fall of 2008. In 2009 on May 17th the wheat was terminated with a 0.8 kg ai/ha application of glyphosate 30 days prior to planting sorghum. Sorghum was planted without tillage on June 9th at a rate of 99,000 kernels /ha. Preemergence applications were applied immediately after planting followed by a 25 mm sprinkler irrigation to insure uniform emergence. Treatments included preemergence applications of dimethenamid + saflufenacil at 0.9 + 0.04 kg/ha plus 1.1 kg/ha atrazine or 1 kg/ha pendimethalin applied to 30 cm or 3 to 4-leaf or spike stage sorghum. For comparison, conventional treatments included preemergence applications of dimethenamid + saflufenacil + atrazine at 1.7 + 0.04 + 1 kg/ha or S-metolachlor + atrazine at 1.3+ 1.1 or saflufenacil at 0.04 kg/A. Several permutations of 2, 4-D tank mixed with metsulfuron or carfentrazone or atrazine plus bromoxynil were also applied. Experimental design was a randomized complete block with 4 replications. Within 6 days of any herbicide application, 25 mm over head irrigation was applied to insure herbicide incorporation. Sorghum was irrigated as needed to simulate a good dryland crop for this region. Foxtail and crabgrass were the predominate weed species and no postemergence broadleaf compound performed well. Low rates of atrazine in these postemergence treatments produced measureable albeit poor control on both grass species. All preemergence grass control compounds produced greater than 90% control. Treatments with spike applications of pendimethalin produced no injury as indexed by visual observation, and plant height. In contrast, treatments containing pendimethalin applied to 30 cm sorghum had significant height reductions compared to the control and spike treatments of pendimethalin. Tank mixes followed by spike applications of pendimethalin had the highest grain yield. This yield was significantly higher than some standard treatments. These results only represent one location and one year but strongly suggest that further work is needed on the timing and use of pendimethalin in grain sorghum.

POSTEMERGENCE GRASS AND BROADLEAF WEED CONTROL IN QUIZALOFOP AND SULFONYLUREA HERBICIDE TOLERANT SORGHUM. Robert N. Rupp*[1], Eric Castner[2], James Harbour[2], Keith Johnson[2], Case Medlin[2], David Saunders[2]; [1]DuPont Crop Protection, Edmond, OK, [2]DuPont Crop Protection, Wilmington, DE (108)

Postemergence control of grasses in sorghum has been identified as a highly prioritized research need by sorghum producers. To meet this need, two new herbicide tolerance traits are under development by DuPont that will enable postemergence control of grass weeds in sorghum. The two separate traits were first identified by researchers at Kansas State University and confer tolerance to quizalofop and sulfonylurea herbicides. In 2010, DuPont and University researchers evaluated one-pass postemergence and two-pass preemergence followed by postemergence herbicide programs for grass control in grain sorghum. Data will be presented supporting the use of quizalofop and sulfonylurea herbicides in grain sorghum containing the tolerance traits as new tools for postemergence grass control across the United States. Data will also be presented showing that SU tolerant sorghum has tolerance to residues of ALS herbicides in the soil which may allow for shortened rotational crop intervals following applications of herbicides such as chlorsulfuron and pyrithiobac sodium. Seed products with the tolerance traits will be available for sale pending development by seed companies. DuPont Crop Protection herbicides for use on the tolerant sorghum are being evaluated and will be available for sale pending EPA registration.

INHERITANCE OF EPSPS GENE DUPLICATION AND GLYPHOSATE RESISTANCE IN PALMER AMARANTH. Darci A. Giacomini*[1], Todd Gaines[2], Sarah M. Ward[1], Philip Westra[3]; [1]Colorado State University, Fort Collins, CO, [2]University of Western Australia, Perth, Australia, [3]Colorado State University, Ft. Collins, CO (109)

Glyphosate resistance in Palmer amaranth is a major concern for farmers and weed managers. Previous research has shown resistance to be due to increased copy number of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene through gene amplification, but the stability of this resistance trait is unknown. We used qPCR to determine relative EPSPS copy numbers of F1 progeny from crosses between glyphosate resistant and susceptible Palmer amaranth. Crosses included susceptible by resistant, resistant by susceptible, and resistant by resistant, creating twenty F1 populations. EPSPS gene copy number was determined for at least ten plants from each of these F1 populations. Preliminary data have shown a wide spread of copy numbers for the majority of F1 populations, indicating unstable transmission of copy number, with some populations exhibiting transgressive segregation. One S x R population had very low copy number in all but one individual, suggesting the influence of either apomixis or maternal effects. However, subsequent genotyping of the F1s and parents of this population ruled out apomixis as a cause of similar copy numbers. Initial results have also shown a strong correlation between high copy number and level of resistance (determined by shikimate disc assay), as was expected. More research on the EPSPS gene is needed to investigate how glyphosate resistance transmission occurs across generations at the molecular level. However, our data are consistent with EPSPS gene amplification via transposition of a mobile genetic element.

TRIBENURON ENHANCED CONTROL OF YELLOW FOXTAIL (SETARIA PUMILA) WITH FLUCARBAZONE. Alicia E. Hall*, Kirk A. Howatt; NDSU, Fargo, ND (151)

Tribenuron is a sulfonylurea herbicide used to control broadleaf weeds. In previous research, tribenuron decreased grass control when tank mixed with a grass herbicide that inhibits the ACC-ase enzyme, such as a fenoxaprop. The objective of this research was to determine if tank mixing tribenuron with flucarbazone, an ALS inhibiting herbicide for grass control, would also result in decreased yellow foxtail control. Flucarbazone at 20 to 25 g ha^{-1} and tribenuron at various rates were applied alone and in combination to two- to three-leaf yellow foxtail in studies near Fargo, ND. Treatments were applied with a backpack sprayer with Turbo Teejet 11001 tips delivering 80 L ha^{-1}. Visual evaluations of yellow foxtail control were recorded 14 and 28 days after treatment (DAT). In one study, flucarbazone control of yellow foxtail was 6 and 11 percentage points greater 14 and 28 DAT, respectively, with tribenuron than when flucarbazone was applied alone. In another study, tribenuron added to flucarbazone improved yellow foxtail control by 5 percentage points 28 DAT compared to flucarbazone alone. A third study showed yellow foxtail control was similar between flucarbazone applied with and without tribenuron. These studies demonstrated that improved yellow foxtail control with tribenuron occurred but was not consistent. However, an overall trend of improved yellow foxtail control when tribenuron was added to flucarbazone has been observed versus the antagonistic relationship of tribenuron and ACC-ase inhibiting grass herbicides.

ANNUAL BLUEGRASS (POA ANNUA) MANAGEMENT IN ESTABLISHED GRASSES GROWN FOR SEED WITH INDAZIFLAM, PYROXASULFONE AND METHIOZOLIN. Andrew G. Hulting*, Daniel W. Curtis, Barbara J. Hinds-Cook, Carol Mallory-Smith; Oregon State University, Corvallis, OR (152)

Annual bluegrass (*Poa annua*) invades established grasses grown for seed in OR causing significant production and economic challenges for grass seed growers. Field experiments were conducted from 2007-2010 to determine the potential for using fall- applied applications of indaziflam, pyroxasulfone and methiozolin to control annual bluegrass in established perennial ryegrass and tall fescue grown for seed. A range of application rates of these three products were compared to current industry standards including applications of flufenacet+metribuzin. Annual bluegrass control, crop injury and crop yield were evaluated each year. Indaziflam applications at rates ranging from 12-50 g ai/ha resulted in excellent annual bluegrass control (greater than 90%), but injured the perennial ryegrass and tall fescue. However, the tall fescue was more tolerant to indaziflam than the perennial ryegrass. Applications rates of 12-25 g ai/ha of indazaiflam once during the life of the grass seed stand may be appropriate to manage annual bluegrass. Indaziflam applications over multiple years may reduce the life of the stand, particularly perennial ryegrass stands. Pyroxasulfone applications also resulted in excellent annual bluegrass control (greater than 90 %) and were less injurious to both tall fescue and perennial ryegrass than indaziflam applications. Application rates ranging from 50-100 g ai/ha resulted in little crop injury and no yield loss. Applications of methiozolin up to 1000 g ai/ha resulted in little crop injury and good to excellent control of annual bluegrass. However, control of annual bluegrass with methiozolin was less consistent than with indaziflam and pyroxasulfone. These studies suggest that the active ingredients indaziflam, pyroxasulfone and methiozolin appear to provide adequate annual bluegrass control as well as crop safety when applied to established perennial ryegrass and tall fescue. Additional trials are ongoing to build needed efficacy and crop safety data sets with these compounds should industry choose to pursue uses of these materials in grasses grown for seed.

ALTERNATIVE HERBICIDES FOR DIURON IN CARBON SEEDED PERENNIAL RYEGRASS (LOLIUM PERENNE) GROWN FOR SEED. Daniel W. Curtis*, Barbara J. Hinds-Cook, Andrew G. Hulting, Carol Mallory-Smith; Oregon State University, Corvallis, OR (153)

Annual bluegrass (*Poa annua*) contamination in grass grown for seed is a major production challenge to producers with significant economic ramifications. In Oregon, diuron applied preemergence over newly-planted seed rows protected with a narrow band of activated carbon has been the standard production practice for the past three decades to control annual bluegrass. However, annual bluegrass has developed resistance to diuron in many grass seed fields in the Willamette Valley. Previous research by these authors has documented that indaziflam and pyroxasulfone can provide excellent annual bluegrass control with preemergence applications to carbon seeded perennial ryegrass. A study conducted in 2008-09 confirmed that pyroxasulfone applied at 50 g ai/ha could be used with the carbon seeding technique and produce seed yields statistically equivalent to a diuron standard. In 2009-10, a study with indaziflam applied at 32 g ai/ha provided excellent annual bluegrass control with acceptable crop safety. An industry study in 2009-10 indicated that rimsulfuron was effective for controlling annual bluegrass in perennial ryegrass and that the carbon seeding technique provided good crop safety. Therefore, in the fall of 2010, four studies were initiated with the objective of evaluating annual bluegrass control and perennial ryegrass injury resulting from inadaziflam, pyroxasulfone and rimsulfuron applied as preemergent broadcast applications over perennial ryegrass seeded with a 2.54 cm wide band of activated carbon applied at 336 kg/ha over the rows. Three studies are located at the Oregon State University Hyslop research farm near Corvallis, Oregon, and one study is located in a cooperator's field near Jefferson, Oregon. All studies are randomized complete block designs with four replications. Initial results indicate that indaziflam applied at rates of 12 to 24 g ai/ha is controlling 92 to 97 % of the annual bluegrass with visual crop injury ratings of 10 to 35 %. Pyroxasulfone applied at rates of 25 to 100 g ai/ha is controlling 78 to 100 % of annual bluegrass with visual crop injury ratings ranging from 10 to 30 %. Rimsulfuron applied at rates ranging from 35 to 71g ai/ha is controlling 70 to 90 % of the annual bluegrass with crop injury ratings of 0 to 30 %. These studies suggest that the active ingredients, indaziflam, pyroxasulfone and rimsulfuron appear to provide adequate annual bluegrass control as well as crop safety necessary for replacement of diuron for annual bluegrass control in the carbon seeded perennial ryegrass production system. These four studies will be harvested and yields will be compared with diuron standard treatments included in the studies. Further experimentation will be conducted to refine application rates to minimize the potential for crop injury.

ANALYZING WEED SEED BANK DATA USING RANDOM FOREST REGRESSION.
Rachel Unger*[1], Ian C. Burke[1], David R. Huggins[2]; [1]Washington State University, Pullman, WA, [2]USDA-ARS, Pullman, WA (154)

Understanding how crop rotation, soil characteristics, and terrain influence the weed seed bank helps identify field-related factors that contribute to greater weed pressure. A multi-year cropping systems study in a no-till regime with six different three year rotations of spring wheat – winter wheat – alternative crop rotation (winter or spring plantings of barley, canola, or pea) was initiated in 2001 on the Washington State University Cook Agronomy Farm near Pullman, WA. Intensive sampling of the weed seed bank was done in the summer of 1999, before the crop rotations were implemented to establish a baseline to allow an understanding of how the weed species composition and abundance change over time. A second sampling was completed in the spring of 2007. Nonmetric multidimensional scaling (NMS) ordinations was used to examine compositional differences in the weed seed bank community among rotations over the two sampling intervals. Due to low weed abundance, only two-thirds of the field site was analyzed using NMS. Over the area analyzed, wild oat and common lambsquarters abundance decreased while Italian ryegrass and mayweed chamomile increased. The data were then analyzed using Random Forest Regression to attempt to address the entire field. Between 15.87% and 22.2% of the variation in the appearance of Italian ryegrass was explained by elevation, global irradiation, flow direction, flow accumulation, and specific catchment area. Terrain, environmental, and soil attributes were not contributing factors for the distribution of the remainder of the weed species, confirming the results of the NMS ordinations.

BROADLEAF WEED CONTROL IN FIELD CORN WITH PREEMERGENCE FOLLOWED BY SEQUENTIAL POSTEMERGENCE HERBICIDES. Richard N. Arnold*, Michael K. O'Neill, Kevin A. Lombard; New Mexico State University ASC, Farmington, NM (155)

Research plots were established on May 10, 2010, at New Mexico State University's Agricultural Science Center at Farmington, New Mexico, to evaluate the response of field corn (var. Pioneer PO751HR) 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 0.3%. The experimental design was a randomized complete block with three replications. Individual plots were four, 34 in rows 30 ft long. On May 10, field corn was planted with flexi-planters equipped with disk openers. Preemergence treatments were applied on May 12 and were immediately incorporated with approximately 0.75 in of sprinkler applied water. Sequential postemergence treatments were applied on June 28 when field corn was in the 6^{th} to 8^{th} leaf stage with weed heights averaging approximately 8 to 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 6. All preemergence and preemergence followed by sequential postemergence treatments gave excellent control of redroot and prostrate pigweed, black nightshade, and common lambsquarters except the weedy check. The preemergence application of Integrity applied at 13 oz/A gave poor control of Russian thistle when rated on July 6.

BENCHMARK STUDY: FOUR YEARS LATER TRENDS IN WEED SPECTRUM, POPULATION DENSITY, AND GROWER PERCEPTIONS ON GLYPHOSATE RESISTANCE. Robert G. Wilson*; University of Nebraska-Lincoln, Scottsbluff, NE (164)

The Benchmark Study was initiated in 2006 and involves 156 producers in the states of Iowa, Illinois, Indiana, Mississippi, Nebraska, and North Carolina to assess the impact of weed management strategies on the sustainability of glyphosate-based crop production systems. Producers were randomly selected and provided a 16 ha field which was divided in half, the producers continued their weed management program on half of the field and a scientist at each university used their expertise to recommend herbicide resistance management practices. Fields selected for the study in 2006 had a minimum of a three-year field history in glyphosate-resistant (GR) cropping systems. Fields were divided into three categories: 1) a single continuous GR crop, 2) a rotation of two GR crops, and 3) a GR crop rotated with a non-GR crop. Forty observation sites were established in each field and at each site the soil seedbank was sampled and weed density assessments by species; before or at planting; before the first postemergence herbicide application; 2 weeks after the last postemergence herbicide treatment; and before harvest for a total of 125,000 observations over 4 years. Academic weed control recommendations included much greater herbicide diversity including increased use of residual herbicides compared to tactics practiced by growers. Academic recommendations reduced the population density of problematic weeds (horseweed (*Conyza canadensis* (L.) Cronq.), common waterhemp (*Amaranthus rudis* Sauer), and giant ragweed (*Ambrosia trifida* L.)) before and after postemergence glyphosate applications. Weed control recommendations made by academics increased weed control costs from $14 to $25 per hectare but the overall economic return for grower and academic sections of the field were similar. Grower perceptions on GR weeds have changed in the past 5 years. Growers reported increased use of specific management methods such as tillage and the use of post-applied and residual herbicides to manage GR weeds. Growers in the southern U.S. were more aware of GR weeds and were employing specific actions to manage problematic weeds compared to growers in other regions. The prevalent sources for acquiring information on weed resistance were farm publications (57%), dealers/retailers (30%), university extension (27%), other farmers (16%), and the internet (3%).

PALMER AMARANTH BIOTYPE RESPONSE TO HPPD INHIBITING HERBICIDES. Curtis R. Thompson*, Nathan Lally, Dallas E. Peterson; Kansas State University, Manhattan, KS (165)

Palmer amaranth infests crop fields across the state of Kansas and remains one of the more difficult weed problems in Kansas crop production. During the summer of 2009, Palmer amaranth was not controlled in a Bayer field sorghum demonstration in Stafford County with pyrasulfotole & bromoxynil 1:8 ratio applied at 246 g/ha. During September, Palmer amaranth seed collections were made from the pyrasulfotole & bromoxynil treated area, R1, and from the remainder of the field, R2. A known susceptible (S) source of Palmer amaranth was produced near Manhattan, KS. Greenhouse experiments were conducted to evaluate Palmer amaranth response to pyrasulfotole & bromoxynil at several rates, field use rates of atrazine, isoxaflutole, isoxaflutole&thiencarbazone methyl 2.5:1, mesotrione and tembotrione. All herbicides were mixed with crop oil at 1% v/v and applied to 7 to 10 cm Palmer amaranth. Early screening suggested 7 to 11 times more pyrasulfotole & bromoxynil was required to control the R1 and R2 collections 50% compared to the susceptible standard. Tembotrione at 92 g/ha injured R1 and R2 85 to 90% 28 DAT and when tank mixed with 1.12 kg/ha atrazine the R1 and R2 collections were controlled 100%. Isoxaflutole at 105 g/ha injured R1 and S 60 and 100% 28 DAT and when mixed with 1.12 kg/ha atrazine control was 68 and 100%. Isoxaflutole & thiencarbazone methyl at 129 g/ha injured R1 and S 64 and 100% when applied alone or when mixed with 1.12 kg/ha atrazine. Mesotrione at 105 g/ha injuryed R1 and S 34 and 90% 28 DAT and when mixed with 1.12 kg/ha atrazine injury was 78 and 100%. Palmer amaranth is a diecious species make reciprocal crosses with S and R1 plants. F1's treated with pyrasulfotole & bromoxynil at 246 g/ha survived indicating that the resistance is nuclearly inherited. Collections R1 and R2 were not controlled with field use rates of pyrasulfotole & bromoxynil, isoxaflutole, isoxaflutole & thiencarbazone methyl, mesotrione, or atrazine. Previous years use of mesotrione and atrazine in corn fields in the area have likely contributed to the resistance of the R1 and R2 collections. The field use rates of tembotrione tank mixed with atrazine controlled the R1 collection 100%. Further work is underway to characterize this resistance.

GLYPHOSATE RESISTANT KOCHIA IS PREVELANT IN WESTERN KANSAS. Phillip W. Stahlman*, Patrick W. Geier; Kansas State University, Hays, KS (166)

The presence of glyphosate resistance in four populations of kochia in western Kansas was confirmed in 2007. The populations were dispersed more than 100 km apart and were considered to have developed resistance independent of each other. A few additional reports of lack-of-control of kochia with glyphosate in other regions were received in 2008 and 2009 and the number of such reports escalated dramatically in 2010. An extensive driving tour and unscientific field survey in the fall of 2010 confirmed the presence of uncontrolled kochia in many corn, soybean, and fallow fields throughout the western one-third of Kansas that had been sprayed with glyphosate alone or in mixture with other postemergence herbicides. Seed was collected from 17 kochia populations dispersed throughout the region that had survived spraying operations. Glyphosate dose-response trials are being conducted to determine if the sampled populations are indeed resistant to glyphosate as suspected. If resistance is confirmed, then glyphosate-resistant kochia is prevalent throughout western Kansas.

HERBICIDE OPTIONS FOR CONTROL OF GLYPHOSATE RESISTANT KOCHIA. Andrew R. Kniss*[1], Phillip W. Stahlman[2], Patrick W. Geier[2], Robert G. Wilson[3], Gustavo M. Sbatella[3], Philip Westra[4], Michael J. Moechnig[5], Richard M. Cole[6], Jeffrey M. Tichota[7]; [1]University of Wyoming, Laramie, WY, [2]Kansas State University, Hays, KS, [3]University of Nebraska-Lincoln, Scottsbluff, NE, [4]Colorado State University, Ft. Collins, CO, [5]South Dakota State University, Brookings, SD, [6]Monsanto, St. Louis, MO, [7]Monsanto, Centennial, CO (167)

Field studies were initiated at 5 locations in Kansas, Nebraska, Colorado, Wyoming, and South Dakota in 2010 as part of a regional effort to determine best management practices for glyphosate-resistant kochia. Three herbicide treatments were chosen for each of four major crops grown in this region and for wheat stubble fallow. Treatments were developed with the goal of controlling kochia without the use of glyphosate. A glyphosate treatment and an untreated check were also included for a total of 17 herbicide treatments. At each site, the treatments were applied in an area with a heavy natural kochia population in the absence of crop competition so that all herbicides could be evaluated in a single trial. Kochia control was estimated visually 2 to 4 weeks following the final herbicide application. Kochia biomass was then collected from 1 m^2 of each plot to evaluate biomass reduction from each treatment. Kochia control with glyphosate was lowest at the Kansas field site; glyphosate-resistant kochia has not been confirmed in any of the other states where these studies took place, and thus this result was not surprising. When locations were combined for analysis, corn and soybean herbicide treatments controlled kochia at least 92%, and no significant differences were observed among the herbicide treatments within these two crops. Wheat and fallow herbicide treatments controlled kochia 75 to 92%. Sugarbeet herbicide programs controlled kochia 40 to 51%. Corn and soybean herbicides reduced biomass by 96%, wheat and fallow herbicides reduced kochia biomass 82 to 85%, and sugarbeet herbicides reduced kochia biomass by 34%.

MON63410 EFFICACY AND WEED CONTROL IN SUGAR BEET. Don W. Morishita*[1], Joel Felix[2], J. Daniel Henningsen[1], Joey K. Ishida[2], Donald L. Shouse[1]; [1]University of Idaho, Twin Falls, ID, [2]Oregon State University, Ontario, OR (168)

MON63413 is an encapsulated acetochlor formulation being evaluated for crop tolerance and weed control in sugar beet. Studies were conducted in 2009 and 2010 near Kimberly, ID and Ontario, OR. Experimental design at both locations was a randomized complete block with four replications. Sugar beet was planted April 24, 2009 and April 15, 2010 at Kimberly (‘BTS26RR14’) and April 15, 2010 at Ontario (‘BTS27RR10’) on 56-cm rows with 11.4 cm seed spacing. Herbicides were applied with a CO_2-pressurized bicycle wheel plot sprayer at Kimberly calibrated to deliver 140 L/ha and with a CO_2-pressurized backpack sprayer at Ontario calibrated to deliver 112 L/ha. Major weeds at both locations included redroot pigweed (AMARE), common lambsquarters (CHEAL), kochia (KCHSC), annual sowthistle (SONOL), and barnyardgrass (ECHCG). Other weeds that were either at one location or appeared only one year included hairy nightshade (SOLSA), common mallow (MALNE) and green foxtail (SETVI). Acetochlor was applied at 1.26 and 2.52 kg ai/ha pre-emergence (Pre) followed by (fb) two glyphosate postemergence (Post) applications and Post in combination with glyphosate at 0.84 kg ae/ha. At Kimberly, crop injury and weed control were evaluated 17 and 98 days after the last application (DALA) in 2009 and 7, 18, and 91 DALA in 2010. Crop injury and weed control were evaluated 14 and 49 DALA at Ontario in 2010. The two center rows of each plot were harvested October 1, 2009 and October 12, 2010 at Kimberly and on October 16, 2010 at Ontario. No injury was observed at any of the early evaluations at either location or year. In 2009 at Kimberly, CHEAL, AMARE, SONOL, MALNE, and SETVI control with glyphosate alone was less than acetochlor applied Pre at 1.26 or 2.52 kg ai/ha as well as glyphosate + dimethenamid-P. Control of KCHSC and ECHCG was not significantly different with all herbicide treatments and ranged from 94 to 100%. At Kimberly in 2010, weed control with all herbicide treatments ranged from 90 to 100%. Weed control ratings in this study were very consistent, thus significant differences were observed between 97 and 100%, although these were not considered biologically significant. At Ontario, CHEAL, AMARE, KCHSC, SOLSA, ECHCG, and SONOL control ranged from 95 to 100% with no differences among any of the herbicide treatments. Sugar beet yield in 2009 at Kimberly ranged from 96to 108 MT/ha among herbicide treatments. The untreated control yielded 13 MT/ha. In 2010 at Kimberly, the untreated control yielded 4 MT/ha and ranged from 63 to 81 MT/ha among the herbicide treatments. Dimethenamid-P at 1.1 kg ae/ha + glyphosate at 0.84 kg ae/ha applied at the two-leaf stage fb glyphosate alone had the only yield (63 MT/ha) that was significantly lower than the two highest yielding treatments. One of those two treatments was glyphosate at 0.84 kg ae/ha fb dimethenamid-P + glyphosate. At Ontario, sugar beet yield of the untreated control was 45 MT/ha and the herbicide treatments ranged from 103 to 114 MT/ha. At this location, glyphosate alone applied two times at 0.84 kg ae/ha had the highest numerical yield and was significantly higher than five other herbicide treatments. Estimated recoverable sugar yield at all three site-years followed the same pattern as root yield.

INFLUENCE OF WEED EMERGENCE COHORTS ON SUGARBEET YIELD. Prashant Jha*, Josefina Garcia; Montana State University, Huntley, MT (169)

Field experiments were conducted in 2010 at the Southern Agricultural Research Center in Huntley, MT, to determine the influence of weed emergence timing on sugar beet yield. Glyphosate-resistant sugar beet variety 'BTS 36RR50Pro200' was planted in 61-cm wide rows at a seeding rate of 123,500 seeds/ha. Seeds of individual weed species were seeded in a 10-cm band on either side of a sugar beet row in each plot (3 m wide by 10 m long). The experiment was conducted in a split-plot design with four replications. The main plot factor included four different weed species (common lambsquarters, wild buckwheat, redroot pigweed, and velvetleaf) and a weed-free treatment, which was established by hand-weeding throughout the growing season. The subplot factor included three weed emergence cohorts. Cohort 1 comprised of weeds that were seeded immediately after sugar beet planting and emerged at the VE to V1 (emergence to one-leaf) stage of sugar beet. Cohort 2 comprised of weeds that were seeded at the cotyledon stage of sugar beet and emerged at the V3 to V4 (three- to four-leaf) stage. Cohort 3 comprised of weeds that were seeded at the two-leaf stage of sugar beet and emerged at the V6 to V7 (six- to seven-leaf) stage. Weed cohorts were established by thinning the emerged plants to obtain a uniform density of 4 plants/m of row. Weeds that emerged beyond the 10-cm band centered over a row were removed by hand-weeding. Data on plant height and leaf number were recorded at 14 d interval for weeds and sugar beet in each plot. Weed biomass and seed production were recorded at maturity. Percent light interception (PAR) reaching the top and bottom of the crop canopy was measured bi-weekly. Sugar beet and weeds were harvested from the center row of each plot. Sugar beet root yields were recorded and six sugar beet roots from each plot were randomly sampled to estimate the sugar (sucrose) yield. Data were subjected to ANOVA using PROC MIXED in SAS. Means were separated using Fisher's protected LSD test at α = 0.05. Among all weed cohorts, cohort 1 was the most competitive. Common lambsquarters, redroot pigweed, velvetleaf, and wild buckwheat produced greater biomass in cohort 1 than in cohort 2 or 3; however, differences were not significant between cohort 2 and 3. Velvetleaf, redroot pigweed, and wild buckwheat produced 586, 15888, and 485 seeds/plant, respectively, in cohort 1 compared with 112, 8238, and 82 seeds/plant, respectively, in cohort 2. Weed seed production by cohort 2 and 3 did not differ except for common lambsquarters and redroot pigweed, and was 21724 and 8238 seeds/plant, respectively, in cohort 2 compared with 1924 and 766 seeds/plant, respectively, in cohort 3. Compared to the weed-free treatment, sugar beet root yield (averaged over weed species) was reduced by 37% from cohort 1, which was higher than the 20 to 25% yield reductions from cohort 2 and 3. In conclusion, weeds that emerge from planting to the V1 stage of sugar beet need greater attention for management; however, late cohorts that emerge until the V7 stage could significantly contribute to weed seed bank additions and sugar beet yield reductions. This study indicates that multiple applications of glyphosate (alone or tank-mixed with other herbicides) concomitant with weed emergence timings will be needed to prevent weed control failures in glyphosate-resistant sugar beet.

PROJECT 4: TEACHING AND TECHNOLOGY TRANSFER

HERBICIDE RESISTANCE EDUCATION AND TRAINING MODULES SPONSORED BY WSSA. Jill Schroeder*[1], Wes Everman[2], Les Glasgow[3], David Shaw[4], John Soteres[5], Jeff Stachler[6], Francois Tardif[7]; [1]New Mexico State University, Las Cruces, NM, [2]Michigan State University, Lansing, MI, [3]Syngenta Crop Protection, Greensboro, NC, [4]Mississippi State University, Starkville, MS, [5]Monsanto Company, St. Louis, MO, [6]North Dakota State University and University of Minnesota, Fargo, ND, [7]University of Guelph, Guelph, ON (156)

Grower and agrichemical retailer herbicide resistance education and training and has been identified as a critical path in advancing the adoption of proactive best management programs to delay or mitigate the development of herbicide resistant weeds. Universities, private sector companies, crop commodity groups, and other groups have all been active in developing and distributing training materials to growers and the agricultural community at large. In February 2010, a proposal was made and accepted by the WSSA Herbicide Resistant Plants Committee (E12) and the special task force on Herbicide Resistance Education (S71) to form a team of public and private sector weed scientists (see list of authors) to review current web-based herbicide resistance training modules, with the intent to update and modify these modules as appropriate. The broad goals of the effort are to: (1) provide the most up-to-date information on causes and best methods for managing resistance, (2) increase consistency of basic messages to growers and retailers, (3) demonstrate to the public a unified public and private sector message of a science-based approach to managing resistance, and (4) increase incorporation of herbicide resistance training into formal certification programs such as the Certified Crop Advisor program. The team is developing five modules around the following questions: (1) Why is proactive resistance management important? (2) How do herbicides work and what is herbicide site-of-action? (3) What is herbicide resistance? (4) How do I identify resistance to herbicides? , and (5) How do I manage resistance? In addition, the team, in cooperation with other weed scientists and agronomists, is developing a separate module to address the specific issue of the impact of resistance management practices on conservation tillage. Each of these modules will be developed in multiple formats (web-based training, PowerPoint slides, and videos). The modules will be made available to all who wish to use them and will be maintained and freely distributed by the WSSA. WSSA will also work with grower organizations and others to develop and distribute these materials.

PROGRAM EVALUATION: HOW TO INCREASE KNOWLEDGE GAINED AND MEASURE KNOWLEDGE RETAINED. Wendy V. Hamilton*; New Mexico State University, Las Cruces, NM (157)

Are you using the most appropriate method of evaluation for your program clientele? Do you know if your clientele are learning all they can from your programs? Targeted evaluation methods, the pros and cons of use, and the questions to ask will be discussed.

ATTEMPTS TO OVERCOME POOR EFFICACY FROM LARGE SPRAY DROPLETS. Kirk A. Howatt*; NDSU, Fargo, ND (158)

Previous research demonstrated that 2,4-D and paraquat efficacy can decline dramatically as the droplet size range becomes larger than medium. This resulted in less control by as much as 60%. Experiments were established near Casselton, Fargo, and Langdon, ND, to evaluate the influence of several aspects of more typical producer applications on these previous results. For weed seedlings less than 6 cm tall, 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. Formulation of 2,4-D affected the magnitude of spray quality effect, with amine formulation resulting in amaranth (*Amaranthus cruentus* L.) control as much as 25 percentage points lower with coarse compared with medium spray. Several cereal broadleaf tank mixes and premixes at labeled field rates demonstrated less control, as much as 28 percentage points depending on herbicide and species, with very coarse spray quality compared with medium quality. Additional control through wheat competition was not achieved even when full rates of fenoxaprop plus clopyralid and fluroxypyr were used. Control of wild oat (*Avena fatua* L.) was 97% compared with 87% and of wild mustard (*Sinapis arvensis* L.) was 97% compared with 42% for medium and very coarse spray patterns, respectively.

ACIDIC AMMONIUM SULFATE (AMS) REPLACEMENT ADJUVANTS - ABERRANT OR ACTIVE? Rich Zollinger*; North Dakota State University, Fargo, ND (159)

Studies were conducted in 2009 and 2010 in North Dakota, Nebraska, Kansas, and Illinois to evaluate weed control from glyphosate (no adjuvant formulation) applied with commercial acidic AMS replacement (AAR) adjuvants in distilled water and water with 1000 ppm hardness. Commercial AAR adjuvants were compared to AMS plus nonionic surfactant (NIS). Most AAR adjuvants contain monocarbamide dihydrogensulfate (urea plus sulfuric acid) which will reduce spray water pH to approximately 2. This low pH is below the pKa of most herbicides and causes herbicides to carry a neutral charge which minimizes bonding with antagonistic cations in hard water. AAR adjuvants may contain other ingredients to enhance activity, such as phosphate esters and ethoxylated tallow amine. In the absence of hard water, many AAR adjuvants enhanced weed control from glyphosate similar to AMS + NIS; however, in hard water weed control from most AAR adjuvants was less than AMS + NIS. AAR adjuvants were applied at 0.5% and 1% v/v and AMS was applied at 8.5 lb/100 gallons of water. Nitrogen enhances most postemergence herbicides even in the absence of antagonistic cations. By comparing rates, AAR adjuvants provided much less nitrogen (from urea) than AMS. This research shows that many AAR adjuvants can partially overcome some antagonism from hard water by lowering spray solution pH but do not supply an adequate amount of nitrogen to optimize glyphosate activity.

PROJECT 5: BASIC BIOLOGY AND ECOLOGY

EPIGENETIC ALTERATION OF RAPID RESPONSES TO ENVIRONMENTAL FLUCTUATION AND PHENOTYPIC VARIATION OF ALLIGATOR WEED. Gao Lexuan*, Yang Ji; Fudan University, Shanghai, Peoples Republic (110)

Alternanthera philoxeroides (alligator weed) is an invasive weed that can colonize both aquatic and terrestrial habitats. Individuals growing in different habitats exhibit extensive phenotypic variation but little genetic differentiation in its introduced range. The mechanisms underpinning the wide range of phenotypic variation and rapid adaptation to novel and changing environments remain uncharacterized. In this study, we examined the epigenetic variation and its correlation with phenotypic variation in plants exposed to natural and manipulated environmental variability. Genome-wide methylation profiling using methylationsensitive amplified fragment length polymorphism (MSAP) revealed considerable DNA methylation polymorphisms within and between natural populations. Plants of different source populations not only underwent significant morphological changes in common garden environments, but also underwent a genome-wide epigenetic reprogramming in response to different treatments. Methylation alterations associated with response to different water availability were detected in 78.2% (169/216) of common garden induced polymorphic sites, demonstrating the environmental sensitivity and flexibility of the epigenetic regulatory system. These data provide evidence of the correlation between epigenetic reprogramming and the reversible phenotypic response of alligator weed to particular environmental factors.

EVALUATION OF HERBICIDE ABSORPTION AND TRANSLOCATION IN EURASIAN WATERMILFOIL AND SAGO PONDWEED. Joseph D. Vassios*, Scott Nissen; Colorado State University, Fort Collins, CO (111)

The invasive species Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) and hydrilla (*Hydrilla verticillata*) are submersed species that are found across much of the United States.

Both of these species are perennial, but exhibit an annual growth habit, forming dense mats that can impact water quality. An ongoing series of experiments have been examining herbicide absorption and translocation in these species using radiolabeled herbicides. Herbicides evaluated include fluridone, penoxsulam, and triclopyr. For the first experiments, translocation to the roots was examined following herbicide exposure in the water column. Plants were treated with 10 ppb fluridone, 10 ppb penoxsulam, or 1 ppm triclopyr plus radiolabeled herbicide. Plants were then harvested over a 192-hour time course. Experiments were also conducted to examine translocation to shoots following root exposure to the same three herbicides. Plants each received 200,000 dpm of radiolabeled herbicide, and were harvested over a 192-hour time course. Upon completion of all experiments, plants were harvested, dried, oxidized, and radioactivity quantified using liquid scintillation spectroscopy. Overall, herbicide absorption by EWM was two to four times greater than hydrilla. Shoot to root translocation of all herbicides was relatively limited with 97% and 87% or greater remaining in the shoots for EWM and hydrilla, respectively. For both species, triclopyr showed the greatest absorption over the 192-hour time course. Following root exposure, fluridone absorption was greatest, but translocation to shoots was greater for penoxsulam and triclopyr (approximately 20%).

RESPONSE OF RIPARIAN PLANT COMMUNITIES TO KNOTWEED TREATMENTS. Shannon M. Claeson*[1], April Boe[2]; [1]USDA Forest Service, Olympia, WA, [2]The Nature Conservancy, Olympia, WA (112)

Invasive knotweed varieties (Japanese, Bohemian and Giant) are a threat to riparian habitats because they reduce plant species diversity by establishing dense knotweed monocultures. Multiple years of intensive surveys and chemical treatments are required to control the establishment and aggressive spread of this invasive plant. The Nature Conservancy has been treating knotweed along river corridors in the Chehalis Basin of Washington State since 2004. Given the cost and effort required to control knotweed, and other invasive plants, it is useful to characterize riparian areas with natural native seed regeneration, as well as plant recolonization capabilities. Control efficacy studies typically measure the amount of knotweed reduced with treatment, but not the resulting plant community after treatment. The objective and assumed outcome of these restoration efforts is a return to a native plant assemblage. To examine this assumption, we measured the diversity and composition of plant species in riparian areas treated for knotweed and areas that never had knotweed. We present plant community composition results from four streams 2 to 6 years after initial knotweed treatment.

DO CHILLING REQUIREMENTS LIMIT SOUTHWARD SPREAD OF RUSSIAN-OLIVE (*ELAEAGNUS ANGUSTIFOLIA*) IN WESTERN NORTH AMERICA? Kimberly R. Guilbault*[1], Cynthia S. Brown[1], Jonathan M. Friedman[2], Patrick B. Shafroth[2]; [1]Colorado State University, Fort Collins, CO, [2]US Geological Survey, Fort Collins, CO (113)

Russian olive (*Elaeagnus angustifolia* L.), an exotic tree that is now a dominant species along rivers in western North America, has an apparent southern boundary running through southern California, Arizona and Texas. We carried out a controlled experiment to investigate whether lack of cold temperatures at the southern limit may prevent the accumulation of sufficient chilling and inhibit dormancy loss of vegetative buds, potentially constraining its distribution.

We took a terminal bud cutting from 34 naturalized adult trees in Loveland, CO and 34 Russian olive saplings in Fort Collins, CO, at 12 dates throughout the winter of 2009-2010, representing

12 different chilling treatments. Cuttings were placed into tap water and forced in a greenhouse. We also moved one whole unpruned sapling into the greenhouse at the same time that cuttings were taken. Therefore, we had three different bud sources of Russian olive in our experiment: Adult Cuttings, Sapling Cuttings and Whole Saplings.

Results suggest that the chilling requirement for bud-break is partly responsible for the southern range limit. Percentage bud break decreased when chilling dropped below values typical of the southern range limit. Although, the chilling requirement for Whole Saplings (631 Chill Units), Adult cuttings (848 Chill Units) and Sapling cuttings (848 Chill Units) is less than the average chilling at the southern range limit (948 Chill Units), in 17-65% of the years from 1980-2000, the chilling accumulated at a site near the southern range limit (El Paso, TX) would lead to a 10% or more decrease in bud-break. The potential decline in growth could have large fitness consequences for Russian olive trees.

ADDING IMAZAPYR TO IMAZAMOX AFFECTS EFFICACY BUT NOT TRANSLOCATION IN FERAL RYE. Michael Ostlie*[1], Philip Westra[2], Dale Shaner[3]; [1]Colorado State University, Fort Collins, CO, [2]Colorado State University, Ft. Collins, CO, [3]USDA/ARS, Fort Collins, CO (114)

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. Temperature can play an important role in herbicide efficacy, particularly in metabolized herbicides such as imazamox. Imazapyr was added to imazamox to discern if this combination would be more effective than imazamox alone at equal total active ingredient. A ^{14}C translocation experiment and greenhouse experiment were carried out to investigate this issue. Imazamox movement in the plant was similar whether imazapyr was present or not. Imazapyr movement was greater and more rapid than imazamox. At the whole plant level, adding imazapyr to imazamox was always equal to or better than imazamox alone, under different temperature regimes and in different formulated ratios. Imazamox activity appeared to have a temperature correlation whereas imazapyr did not. This indicates addition of imazapyr may be better for feral rye control in late fall and early spring where low temperature can occur for extended periods in some areas of the country.

WEED COMMUNITY AND COMPETITIVE LOAD FOLLOWING 12 YEARS IN A GLYPHOSATE-RESISTANT CROPPING SYSTEM. Nevin C. Lawrence*[1], Andrew R. Kniss[1], Gustavo M. Sbatella[2], Robert G. Wilson[2]; [1]University of Wyoming, Laramie, WY, [2]University of Nebraska-Lincoln, Scottsbluff, NE (115)

A long-term field study was conducted near Scottsbluff, NE from 1998 to 2009 to identify weed-shifts in response to glyphosate-resistant cropping systems. The study was designed as a split-split plot RCBD where the whole plot factor was crop rotation, the split plot factor consisted of glyphosate use patterns, and the split-split plot factor was presence or absence of a PRE herbicide. Glyphosate use patterns ranged from treatments receiving no glyphosate to continuous, exclusive use of glyphosate. In 2010 weeds were allowed to establish without herbicide treatment or crop competition and then counted. To interpret the weed density counts, a competitive index of each weed species as if it was in competition with corn, dry bean, and sugarbeet was used to calculate the competitive load for the weed spectrum resulting from historical treatments. The previous crop rotation had no effect on competitive load regardless of the crop index used. For the corn competitive index, treatments utilizing a PRE herbicide, or continuous use of glyphosate at 840 g ae ha^{-1} resulted in the lowest competitive load. For both the dry bean and sugarbeet competitive indices, the use of a PRE herbicide significantly decreased the competitive load, regardless of glyphosate use history. Continuous use of glyphosate at 840 g ae ha^{-1} resulted in the lowest competitive load of any glyphosate use history for both the sugarbeet and dry bean indices; however there was no statistical difference between this treatment and alternating glyphosate applications with conventional herbicides when using the sugarbeet index.

THE ROLE OF SOIL MICROBIAL COMMUNITIES IN MEDIATING WEED-CROP INTERACTIONS. Fabian Menalled, Zachariah J. Miller*; Montana State University, Bozeman, MT (116)

Mechanistic understanding of processes by which crops and weeds affect each other provides the foundation for effective management strategies. While resource competition has been a dominate paradigm of plant interactions, recent work in natural systems is increasingly demonstrating the importance of alternate mechanism, plant-soil biota feedbacks (PSF), where interactions among plant species are mediated through effects of plant species on soil microbial communities. However, in agricultural systems, effects crop and weed species on abundance and composition of soil microbial communities (SMC) and how SMC feedback to affect crop and weed growth have not been explored. Furthermore, while fertilization and tillage are known to alter the diversity and function of SMC, the impacts of these management practices on PSF is unknown. To investigate the effects on PSF on crop-weed interactions, we conducted a greenhouse experiment in which biomasses of four crop species were compared following treatments of weed and crop species grown in monoculture in soils that had been inoculated with SMC's from agricultural sites, non-agricultural sites, or sterilized controls. The results demonstrate that the nearly half of the impacts of weeds on crop growth are mediated through PSF, that effects of PSF differ among plant species, and that these effects are altered by agricultural practices.

GROWTH AND ARTEMISININ ACCUMULATION IN ARTEMISIA ANNUA IN EASTERN WASHINGTON. Heather Malone*, Ian C. Burke, William Pan; Washington State University, Pullman, WA (117)

Artemisia annua L. (sweet wormwood), a member of the Asteraceae family, produces the antimalarial sesquiterpene lactone endoperoxide, artemisinin. Artemisinin (ART) is effective for the malaria causing parasite, *Plasmodium* spp. and some cancers. Malaria has developed a resistance to most drugs currently used, making artemisisin one of the last known modes of treatment and leading to high worldwide demand. However, to date, artemisinin cannot be produced in large amounts synthetically due to its complex structure, requiring extraction from *A. annua*. As yields of artemisinin are very low (0.01%-0.80%), development of new cultivars and understanding the biosynthesis and conditions influencing artemisisin yield are essential. The objective of the study was to examine the growth and development of *A. annua* in eastern Washington to identify production practices that will maximize biomass accumulation and ART yield. *A. annua* was transplanted on three dates, May 10, June 10, and June 16, 2010, at Central Ferry, WA. At anthesis, plants transplanted on May 10 reached a mean height of 142 cm (+/-

2.1) with 674 g (+/- 49.2) of dry biomass accumulation. Compared to the last planting date, June 16 with a mean height of 117 cm (+/- 2.4), and dry biomass was also lower, at 357 g (+/- 28.5). In addition, at anthesis a total of 572 g/HA (+/- 103.9) of ART can be harvested. Planting early in the season resulted in the largest accumulation of biomass and height, and as a consequence, achieved the highest ART yield, when compared to the last planting date.

LONGER TERM RESPONSE OF IN-SITU NON-TARGET NATIVE PLANTS & RHIZOMATOUS NOXIOUS WEEDS TO IMAZAPIC. Peter M. Rice*; University of Montana, Missoula, MT (118)

Imazapic (0.188 lb a.e./A + MSO 1 qt/A) was applied once in the fall and on two sequential years in the fall at two sites with difference abundances of sympatric leafy spurge (*Euphorbia* esula) and dalmatian toadflax (*Linaria dalmatica*). Control of leafy spurge canopy cover was 86 to 97% for the first year post-spray. Treating leafy spurge with imazapic in two sequential years did not increase the absolute level of canopy cover control but did extend the duration of a high level of suppression. Spraying reduced leafy spurge frequency of occurrence, but the remaining resprout frequency was quite high and sufficient to probably allow leafy spurge to eventually re-dominate the sites. Spraying twice did reduce leafy spurge frequency of occurrence to a low level. Imazapic provided acceptable control of dalmatian toadflax where its initial abundance was low and the site was proportionately much more dominated by leafy spurge. However the dalmatian toadflax actually increased after spraying relative to the no-spray controls on the second site where dalmatian toadflax had a higher absolute abundance and was proportionally more similar to the leafy spurge abundance. Competition between post-spray resprouts of dalmatian toadflax and leafy spurge were determining the relative responses of the two targets. Leafy spurge is more susceptible to imazapic, and when dalmatian toadflax is well established and vigorous the toadflax benefits from the suppression of the leafy spurge. The sequentially sprayed twice treatments released spotted knapweed (*Centaurea stoebe*) from competition with imazapic susceptible species. The imazapic treatments suppressed sulfur cinquefoil (*Potentilla recta*), but the level of control was not high enough to recommend imazapic as an efficacious herbicide for sulfur cinquefoil. First year post-spray declines in perennial grass canopy cover corresponded to observed and known imazapic visual injury symptoms. These symptoms consisted of reduced culm height and suppressed flowering. Perennial grass recovery was obtained by the second year post spray, but there were only limited net gains in perennial grass production. Species richness was fully restored within 2 to 3 years after spraying imazapic once. Additional reduction in competition from spraying twice allowed complete species richness recovery in the second year after cessation of the treatments. Imazapic did not reduce non-target forb canopy cover on the more diverse site. On the less diverse site with much less initial non-target forb canopy, the non-target forb canopy cover was fully recovered in the second year after ending spraying. Decreaser species strongly outnumbered increaser species in the first year post-spray once or twice at both sites. However the principal community level effect of spraying was to alter the intensity of competitive interactions between the numerous individual species. Previously scarce resources, most importantly soil moisture in these somewhat xeric environments, were now available allowing many species population abundance shifts. The opportunities for establishing individual new plants were further enhanced by reductions in accumulated litter and creation of bare soil safe microsites. The ratio of increaser species to decreaser species improved greatly starting in the second year post-spray. The number of increaser species came into approximate balance with the number of decreaser species. The target weeds, both the forb weeds and the annual grasses, generally remained decreasers. Statistically significant native forb increasers included fringed sage (*Artemisia frigida*), yarrow (*Achillea millifolium*), and hairy golden aster (*Chrysopsis villosa*). Native forbs exhibiting tolerance, that is no change in abundance, included silky lupine (*Lupinus sericeus*), low larkspur (*Delphinium bicolor*), arrowleaf balsamroot (*Balsamorhiza sagittata*), and fuzzytongue penstemon (*Penstemon eriantherus*). Imazapic provides an efficacious but more selective option for suppression of leafy spurge than picloram when conservation of desirable plant species is an important management goal.

CHARACTERIZING SITE CONDITIONS RESULTING FROM SUPPRESSIVE APPLICATIONS OF GLYPHOSATE AND IMAZAPYR TO ABANDONED MONTANE RANGELANDS FOR REFORESTATION IN HAWAII. James Leary*[1], Jeremy Pinto[2], Anthony Davis[3], Mike Robinson[4]; [1]University of Hawaii at Manoa, Kula, HI, [2]USDA Forest Service, Moscow, ID, [3]University of Idaho, Moscow, ID, [4]Department of Hawaiian Home Lands, Hilo, HI (119)

On the Island of Hawaii, a recent history of the windward slope on Mauna Kea (1500-2500 m) includes deforestation, exotic forage species introductions, and active grazing management over the last 150 years. Today, a new history is being scheduled to restore critical native plant communities across 1000's of hectares. Despite being in a tropical climate, this high elevation landscape experiences frost temperatures during the winter months, which inhibits planting of native seedlings at the wettest time of the year and poses a conundrum for only planting during the summer when soil moisture is a serious limitation. Following ungulate removal, the unchecked naturalized forage communities are the next greatest impediment to successful restoration. Moisture limitation is presumably exacerbated by the exotic occupants consisting of C4 (Pennisetum clandestinum) and C3 (Anthoxanthum odoratum and Holcus lanatus) grasses. A simple replicated experiment was installed to characterize the efficacy of herbicide applications in suppressing these resident grass communities as well as determine the effects the suppression treatments have on soil moisture availability. In May 2010, a replicated experiment was installed with glyphosate and imazapyr applied as individual treatments in 10 x 6 m plots at 1.12 and 0.56 kg ae/ha, respectively, and compared to an untreated control. Each plot was installed with soil moisture and temperature sensors (Decagon Devices, Inc. Pullman, WA) buried at 5 and 20 cm depths and coupled to data loggers programmed to record hourly. As expected, glyphosate showed observable symptoms of sod desiccation and profile reduction early (90 DAT), while the imazapyr treatment was less pronounced. However, both herbicide treatments were recorded with higher volumetric soil moisture levels (m^3/m^3, $P<0.01$) at a 5 cm depth compared to the untreated control, but were not significantly different between herbicide treatments. Furthermore, soil moisture was higher at the 20 cm depth, than at the 5 cm depth across all of the treatments, including untreated. Temperature data showed higher diurnal fluctuation at the 5 cm depth than at 20 cm. Our initial data analyses, suggest early suppression of competitive grasses attributing to an increase in soil moisture. Treatment affects are expected to shift over time due to differences in suppressive longevity between glyphosate and imazapyr. We will present trends of this data to include time points at 180 and 270 DAT. The ability to determine intervals of increased moisture retention resulting from suppressive pre-plant herbicide applications can be exploited for optimizing planting schedules post-treatment.

CAN THE COMPETITIVE LOAD INDEX BE USEFUL IN SEED BANK ANALYSIS? Gustavo M. Sbatella*[1], Robert G. Wilson[1], Andrew R. Kniss[2]; [1]University of Nebraska-Lincoln, Scottsbluff, NE, [2]University of Wyoming, Laramie, WY (120)

Long term studies present the unique possibility to monitor the impacts of weed management practices over weed populations. Changes in the dynamics of soil seed banks are often reported as variations in the total weed seeds. In addition the effects of herbicides programs are frequently evaluated by the number of weeds present two weeks after the last post emergence herbicide application. The analysis of total seed numbers in soil seed banks or the number of plants present after the last application can sometimes be misleading, particularly if the weed populations are shifting to more competitive species. The Competitive Load (CL) is used to describe the total competitive effect of a weed population. The CL is estimated based on the Competitive Index (CI), which is used to measure the relative competitiveness of a weed compare to a crop. The CI was used to determine its potential value in the analysis of long term weed management practices over weed populations. The CI was applied to weed seed bank data and to weed densities counts determined two weeks after the last post emergence herbicide application, from a long term study. The study was conducted between 1998 and 2009 at Scottsbluff, NE, to evaluate glyphosate induced weed shifts in a glyphosate resistant crop rotation. The use of the CL in seed bank analysis helped reflect changes in the potential competitiveness of the weed populations present in the soil seed bank. This advantage was minimized when the number of species present in the seed bank was reduced. The CL proved to be more promising when applied to weed densities determined after the last herbicide application. The CL increased through time with all herbicide treatments, suggesting changes in the species composition of the weed populations.

RESEARCH ON MECHANISMS OF GLYPHOSATE RESISTANCE IN KOCHIA. Philip Westra*[1], Andrew Wiersma[2], Jan Leach[2], Phillip Stahlman[3], Amar Godar[4], Jason Waite[4], Kassim Al Khatib[5], Chris Preston[6]; [1]Colorado State University, Ft. Collins, CO, [2]Colorado State University, Fort Collins, CO, [3]Kansas State University, Hays, KS, [4]Kansas State University, Manhattan, KS, [5]University of California, Davis, CA, [6]University of Adelaide, Adelaide, Australia (121)

Greenhouse and outdoor glyphosate dose response research by Kansas State University and Colorado State University weed scientists has documented the existence of multiple kochia populations that are no longer controlled by commercial, labeled rates of glyphosate. The increased level of glyphosate resistance observed is generally in the range of 3 to nearly 5 fold, depending on the sensitivity of the susceptible population used for comparison. A Colorado State University 2010 screening of over 10,000 kochia plants at 750 and 1250 grams ae/ha consistently yielded a proportion of plants that survived these rates. Research at KSU documented no significant difference in glyphosate uptake and translocation among 2 resistant and 2 susceptible kochia populations. In 2010, there was an increase in the number of field sites in Kansas and Colorado where suspected glyphosate resistant kochia was reported. Plants grown from seed from these sites are being tested to determine if glyphosate resistance is present in these kochia populations. Molecular techniques were used at Colorado State University to successfully extract DNA for the EPSPS enzyme in 3 susceptible and 3 glyphosate resistant plants. The gene region of interest around proline 106 was sequenced to evaluate whether or not a mutation is present. Real time PCR will be used to investigate whether glyphosate resistant kochia plants exhibit any level of gene amplification similar to what was documented in Palmer amaranth by CSU weed scientists. Additional research will also evaluate whether some form of glyphosate sequestration is responsible for resistance in kochia.

GLYPHOSATE RESISTANT CREEPING BENTGRASS: SAME SONG SECOND VERSE.
Carol Mallory-Smith*; Oregon State University, Corvallis, OR (122)

Creeping bentgrass (*Agrostis stolonifera*) is a perennial, obligate outcrossing species mainly used on golf courses. Glyphosate resistant (Roundup Ready) transgenic creeping bentgrass was developed by Scotts Company and Monsanto. While still a regulated article, it was planted in Oregon and Idaho for seed production. In Oregon, about 160 ha were planted in Central Oregon near Madras. After swathing but before combining, a wind storm moved panicles from the fields. The fields were removed from production in 2003. Because the transgenic creeping bentgrass was still a regulated article, all transgenic creeping bentgrass plants were required to be found and destroyed. Seven years after the removal of the fields, transgenic creeping bentgrass plants are still being found near the Madras fields. In Idaho, production fields were planted in Canyon County under notification in 2003 and 2004 and under permit in 2005 and 2006. It is not clear why there was a change from notification to permit for the production but a permit is more restrictive than a notification. According to Scotts Company, the size of the fields, the harvest dates, and the years the fields were removed are considered to be confidential business information. The fields likely were harvested in either 2005 or 2006 or both. Transgenic creeping plants were found in Canyon County after the fields were removed from production. In October 2010, the presence of transgenic creeping bentgrass was confirmed in Malheur County in Oregon. Transgenic creeping bentgrass was never planted in Malheur County but Canyon County is just across the Snake River. The plants are likely the result of seed movement from the Idaho sites possibly on trucks or other equipment. The transgenic creeping bentgrass has spread along irrigation canals, ditches, and roadsides. It also has been found in pastures and production fields. The transgenic creeping bentgrass is still a regulated article. There were no mitigation plans for gene movement in place for either the Madras or the Canyon County sites. There are no herbicides presently labeled that are permitted to be used along the water ways that are effective for controlling established glyphosate resistant creeping bentgrass. The failure to consider creeping bentgrass biology, ecology, production practices, and control options led to the erroneous opinion provided by the Weed Science Society of America stating that Roundup Ready creeping bentgrass would not be a problem and could be controlled by other herbicides. The major issue not addressed in the opinion was that lack of herbicides that can be used near water ways where the most used and effective herbicide is glyphosate. The authors failed to consider the potential for gene flow during seed production which is very different than what would occur in a turf situation. This example of transgenic creeping bentgrass provides insight into the complexity of preventing gene flow, the inadequacy of the monitoring requirements, and the difficulty in retracting a gene once it is released let alone determining how far the transgene has moved.

SEASONAL EMERGENCE OF KOCHIA IN THE CENTRAL GREAT PLAINS.
Phillip W. Stahlman*[1], Patrick W. Geier[1], Johanna A. Dille[2], Tyler W. Rider[2], Jarrett D. Riffel[1], Randall S. Currie[3], Philip Westra[4], Robert G. Wilson[5], Gustavo M. Sbatella[5], Andrew R. Kniss[6], Richard M. Cole[7]; [1]Kansas State University, Hays, KS, [2]Kansas State University, Manhattan, KS, [3]Kansas State University, Garden City, KS, [4]Colorado State University, Ft. Collins, CO, [5]University of

Nebraska-Lincoln, Scottsbluff, NE, [6]University of Wyoming, Laramie, WY, [7]Monsanto, St. Louis, MO (123)

The timing and duration of weed emergence influence the ability to implement timely and effective control practices. Emergence patterns of kochia populations in cropland and non-cropland was monitored in 2010 at sites in Colorado {Fort Collins (irrigated and dryland cropland)}, Kansas {Garden City (cropland), Hays (cropland and non-cropland), Ness City (non-cropland), and Stockton (non-cropland)}, Nebraska {Mitchell (non-cropland) and Scottsbluff (cropland)}, and Wyoming {Langley (non-cropland)}. Quadrats (1 m^2) were marked in which weekly observations of emergence were documented and emerged seedlings removed by hand or sprayed with glyphosate. Observations were initiated as early as March 15, 2010 and continued through July 30, 2010 or until no new emergence was seen on consecutive observation dates. Total season population densities varied among locations and ranged from as few as 10 to almost 332,000 seedlings/m^2. Earliest observed emergence was in Kansas soon after March 15, while first observations in Wyoming and Nebraska occurred around April 8. Between 70 and 95% of the kochia seedlings had emerged between the first two observations across all locations. The combination of high seedling emergence very early in the season emphasizes the need for early weed control. However, the high number of seedlings that appear in the second flush (between 5 and 30% of the total population) emphasizes the need for extended periods of early-season kochia management.

EDUCATION & REGULATORY SECTION

Symposium: Use of New Technology by Weed Science Educators

THE VIRTUAL FIELD DAY (VFD): WEB-BASED VIDEO PRESENTATIONS THAT EXTEND TO A BROADER AUDIENCE. James Leary*; University of Hawaii at Manoa, Kula, HI (160)

When organizing field days, it is often very difficult to schedule a date that accommodates all of our stakeholders. Thus, it is important for land grant institutions to be able to transfer technology and information through a diversity of media and while you can't replace the on-site experience of a field day, we do have the ability with newer technologies to simulate the occasion through the Virtual Field Day (VFD). The VFD is a concept for archiving events with an edited streaming video format that can be made available on your website or even on video sharing websites such as youtube.com. While it still has yet to be institutionalized by our peers we have moved forward to continue developing this platform. Since April of 2010, we have uploaded fourteen VFD presentations on our "Hawaiirrea" youtube channel with over 1:12 hours of edited footage and 4,334 views from global stakeholders. This presentation will highlight the simplicity of the latest hardware and software necessary to be fully operational with uploading VFD presentations.

EDUCATIONAL VIDEOS: A WAY TO DO MORE WITH LESS. Joseph M. DiTomaso*; University of California, Davis, CA (161)

Many weed scientists find themselves in a dilemma with regard to providing adequate weed science training to land managers, licensed pesticide applicators, growers, and practitioners within their states and communities. The rise in demand for weed related education, concomitant with the increased demands on time, reductions in the total number of weed scientists, and limited budgets has made it more difficult to provide the necessary training at the numerous educational programs being offered. One potential solution to this problem is the development of distance learning education through online sources. The advantages to this approach is reduced travel expenses and time, as well as the ability to utilize multiple experts for a particular topic, employ props and laboratory or field situations to demonstrate principles and practices in weed management, and reach a larger number of individuals. Such an approach does not come without some disadvantages, particularly the cost involved in producing online educational tools and the loss of interpersonal communication through face-to-face contact. At the University of California, we have begun to develop a series of teaching videos on several topics related to weed science. This is facilitated through the Weed Research and Information Center (wric.ucdavis.edu). The initial emphasis is on training videos to support the Master Gardener program. This includes three videos covering weed identification, principles of weed control, and weed control techniques. Subsequent to these, other potential topics can include calibration techniques, aquatic weed control in small ponds, control strategies for species troublesome weeds, organic weed control techniques, and managing herbicide resistance. Shorter segments can be produced and included on youtube.com. Ultimately, our goal is to provide continuing education credits on timely and important weed science related topics at a cost that may sustain our ability to continue developing additional videos.

WEB-LOGS (BLOGS) AS AN EXTENSION TOOL: EXPERIENCES OF A NOVICE BLOGGER. Brad Hanson*[1], David A. Doll[2]; [1]Univ. of California, Davis, Davis, CA, [2]University of California, Merced, CA (162)

Web logs (blogs) are internet-based communication tools that occupy a gap between static web sites and social media platforms. Many early blogs were essentially online diaries or journals maintained by individuals with fairly high technical abilities. In recent years, however, the development of user-friendly, low cost blogging tools have made this form of electronic communication much more accessible to a broader range of users. Typically, blog owner(s) update their blog content on a regular basis and the information is available to anyone who subscribes (such as through an RSS feed) or is directed to a post by an internet search engine. One major benefit that blogs have compared to conventional newsletters or static websites is the ability of the readers to interact with the author through online comments; this clearly has potential as an extension outreach tool. In June 2009, The Almond Doctor blog (http://www.thealmonddoctor.com) was initiated to evaluate the extension outreach potential of this tool and was followed in October 2010 with the UC Davis Weed Science blog (http://ucanr.org/blogs/UCDWeedScience). Although blogs can take many forms, we have taken a relatively informal and conversational approach and provide weekly postings on news, announcements, and current research related to the focus areas. The content is updated on a weekly basis in order to provide a balance between topical relevancy and time commitment for the blogger and the reader. In many ways, these blogs are similar to extension newsletters, but have several key benefits including: low cost to update content each week, the ability to respond quickly to current events and issues, interaction of the reader with the blogger, and searchable, archived content that is accessible at anytime online. Additionally, other multimedia material (documents, photos, videos, etc) can be uploaded or embedded within the blog, the blog can be linked to other blogs or webpages, and the blog can be used in conjunction with other social media tools which include Twitter and Facebook. Finally, online extension tools provide the ability to track page hits, the number of readers, and repeat visitors through analytical tracking software (eg. GoogleAnalytics). These data allow assessment of the perceived value of the blog and its impact within the targeted audience. For example, the Almond Doctor blog was read by approximately 125 individuals per week six months after it was started and this increased to 425 and 600 per week after twelve and eighteen months, respectively. Similarly, UC Davis Weed Science had about 15 page views per week after one month and increased to 150 page views per week by the fourth month. In our cases, content is not always developed solely for the blog; instead many postings are also used for newsletter or popular press articles, proceedings papers, or extension presentations. We occasionally use the blogs as incubators for topics to be covered in more depth in a later posting or another published format. Overall, our experience suggests that blogs are an effective way to reach extension clientele and provide a regularly updated profile for research and extension programs. The development of user-friendly and inexpensive or free software has made blogging relatively straight forward for users with moderate technical abilities. The use of blogs as extension tools has the potential to become more important in the future as our audiences become more technologically capable and as time and resources for conventional extension efforts are reduced.

SEARCHABLE DATABASE: WEB-BASED ACCESS TO RESEARCH INFORMATION. Marvin D. Butler*, Rhonda R. Simmons; Oregon State University, Madras, OR (163)

The Central Oregon Agricultural Research Center serves an area of high-value vegetable and grass seed crops on irrigated acreage. Research results are documented in annual reports, copies of the reports are distributed annually, and hard copies from 1953 to the present are archived in the branch station library. University peers, industry representatives, crop consultants, growers and others have reason to search back through these reports looking for information to answer a current question related to specific research topics. The idea of an electronic searchable database for these annual research reports was pursued to provide easy access to this information based on key words. A summer college student employee was assigned to the project. Reports were separated into individual, single-sided pages that were scanned into PDF files and assigned names. A Faculty Research Assistant familiar with much of this research identified the key words for each report and created consistency in the use of these words to describe key elements of the research and author identification. Working with a technology education development specialist on campus, an Excel spreadsheet was developed to provide an organizational template for the reports that could be used by search engine software. Website visitors can now access research reports using the search engine feature, by crop and research topic areas, or by going to the electronically archived annual reports. The searchable database is being used by a wide range of website visitors as an effective tool to access research information generated at the Central Oregon Agricultural Research Center.

SYMPOSIUM: *Ventenata dubia* – EMERGING THREAT TO AGRICULTURE AND WILDLANDS?

VENTENATA BIOLOGY AND DISTRIBUTION IN THE PACIFIC NORTHWEST. Pamela Pavek*[1], John Wallace[2], Timothy Prather[2]; [1]NRCS Plant Materials Center, Pullman, WA, [2]University of Idaho, Moscow, ID (124)

In the last two decades ventenata [*Ventenata dubia* (Leers) Coss.] has spread rapidly along transportation corridors, in pasture, hay land, range and Conservation Reserve Program (CRP) fields throughout the Pacific Northwest. Data collected in 2008 from a survey sent to Natural Resources Conservation Service (NRCS) field staff and an 800 km traverse through eastern and central Washington, northeastern Oregon and northern Idaho revealed ventenata grows in areas receiving 35 to 112 cm annual precipitation at elevations ranging from 10 to 1800 m. It is most commonly found on south-facing slopes and in shallow, rocky clay or clay-loam soils that are saturated or inundated in early spring. However, it can also be found on other aspects and soil types. In areas with disturbance such as grazing, ventenata appears to be displacing desirable vegetation. In undisturbed areas it may be replacing desirable vegetation as growth is hindered by old age, disease, or lack of nutrients, and may be preventing desirable vegetation from reproducing by occupying open niches. Ventenata is a winter annual grass in the Aveneae tribe that has a shallow root system, one to few tillers and produces 15 to 35 seeds per plant. Ventenata seed has a bent and twisted awn which, similar to wild oat (*Avena fatua* L.) "unwinds" when it becomes wet and drills the seed into the soil. Seed typically germinates in the fall about 2 weeks after downy brome (*Bromus tectorum* L.). Similarly, ventenata produces seed heads in the spring 2 to 4 weeks after downy brome. Greenhouse experiments indicate vernalization is necessary for seed head production. Ventenata seed has little or no innate dormancy, however dormancy may be induced if seeds are exposed to cold temperatures. Seed placed in a germinator at 18 C with 10 hours of light began germinating on Day 4 and achieved 85% germination by Day 26. Seed chilled for 5 days at 1 C prior to being placed in germinator began germinating on Day 9 and reached a maximum of 30% germination on Day 68. Seed chilled for 10 days at 1 C began germinating on Day 31 and reached a maximum of 35% germination on Day 64. In soil, seed may be viable for only 1 or 2 years. Seed in packets buried at 2 cm and 8 cm at two sites had an average germination of 82% and 80%, respectively, after 1 month and 0% germination after 6 months. After 1 year there was one germinating seed (at 2 cm depth) indicating there may be a small amount of variability in dormancy. Grazing and mowing ventenata are not effective management options. If the plant is grazed or cut when soil moisture is available it will regrow from within the same tiller and produce viable seed. Depletion of soil moisture is typically a trigger for seed head production, and during this phase the plant has high silica content (~2.7%) which causes it to become unpalatable to livestock and difficult to mow or swath. Fire is also not an effective management option; survey respondents reported in areas where fires have occurred, ventenata is more prevalent. Ventenata is of ecological concern because it may impair the functions and productivity of grassland systems.

PRODUCING TIMOTHY HAY AND MANAGING FOR THE IMPACTS OF *VENTENATA*. Bill Fountain*; Fountain Ranch, Cusick, WA (125)

The export market for Timothy hay has been $200 to $215 per ton for the last several years. Ventenata has matured at the optimal time for Timothy harvest and even small amounts in a bale can cause its rejection for export. The domestic market is $70 to $100 per ton so losses because of ventenata can be as high as $145 per ton. It is possible to avoid rejection by harvesting early but unstable weather during June can make early harvest risky. Optimal timing for Timothy coincides with ventenata maturity and ventenata stems are difficult to cut, requiring sharpened sickles and ground speed must be slow. Seeds spread throughout the field during harvest, quickly infesting a field even with small initial infestations. Once well- infested and Timothy production is reduced, the field must be plowed in June and cultivated through the summer and occasionally, a glyphosate application is made during the fallow period. The field is then re-seeded either in the fall or the next spring. Normally, Timothy is not harvested during its first year and ventenata is not detected but during the second or third year some ventenata usually is detected. Once detected, the field likely will need to be reseeded in two years. We have tried several herbicides in test plots that include metribuzin that must be applied before ventenata is 2 inches tall but results were erratic. Sulfosulfuron is effective but crop injury ranges from no damage to 50% damage with damage seen when Timothy had sprouted in the fall and the growing season was unusually wet. Aminopyralid has been effective as a preemergent at the high end of the label rate but we are not able to sell for export. Challenges continue for hay production and we are still needing to work towards additional options for management of ventenata.

VENTENATA CONTROL IN TIMOTHY HAY AND KENTUCKY BLUEGRASS GROWN FOR SEED. Traci Rauch*, John Wallace, Donn Thill; University of Idaho, Moscow, ID (126)

Ventenata is an annual grass weed that is difficult to control especially in hay and grass seed crops including Kentucky bluegrass and timothy. Few grass herbicides are registered for use in Kentucky bluegrass, while none are registered in timothy. Studies were established near Plummer, ID in Kentucky bluegrass and near Potlatch and Gifford, ID in timothy to evaluate weed control and crop injury with various grass herbicides over the growing season. The experimental design was a randomized complete block with four replications and included an untreated check. In Kentucky bluegrass, ethofumesate, pendimethalin, metolachlor, terbacil, pyroxsulam and flufenacet/metribuzin alone or combined with terbacil, primisulfuron, and oxyfluorfen controlled ventenata 74 to 100%. Flufenacet/metribuzin at the high rate injured Kentucky bluegrass 29%, but injury was greatest with pyroxsulam at 80%. In timothy at Potlatch, triasulfuron, sulfosulfuron, terbacil, rimsulfuron, and flufenacet/metribuzin alone or combined with sulfosulfuron or triasulfuron reduced ventenata stand 90% or greater compared to the untreated check. Timothy stand height and seed head formation were reduced 26 to 35% and 10 to 25%, respectively, by rimsulfuron, terbacil and sulfosulfuron at the high rate. At Gifford, ventenata control in timothy was 90% or greater with metolachlor, ethofumesate, diclofop, primisulfuron, oxyfluorfen plus diuron, pyroxsulam, and flufenacet/metribuzin alone or combined with terbacil, flucarbazone, diclofop, aminopyralid, sulfosulfuron, and primisulfuron. Timothy injury was 14 to 21% with flufenacet/metribuzin alone or combined with terbacil, diclofop, sulfosulfuron, and primisulfuron. Dry forage hay weight did not differ among treatments and from the untreated check.

REHABILITATING *VENTENATA* INFESTED RANGELANDS USING HERBICIDES IN CONJUNCTION WITH BUNCHGRASS SEEDINGS. Marvin D. Butler*; Oregon State University, Madras, OR (127)

Ventenata (*Ventenata dubia*) is an annual grassy weed that degrades range and wild lands of the Pacific Northwest. Research was established in 2008 on the Warm Springs Reservation and consisted of two sites, one where bluebunch wheatgrass remained despite significant populations of ventenata, and a second nearby location where few bunchgrasses remained. Treatments at the two locations consisted of herbicides-only and herbicides followed by planting of different bunchgrass species. In the spring of 2009 herbicide-only applications provided 100 percent control of ventenata in the herbicide-only plots. The following season residual efficacy for the four herbicides dropped to 60 and 68 percent for imazapic plus glyphosate or imazapic alone, 73 percent for rimsulfuron and 81 percent for sulfometuron plus chlorsulfuron. Where six bunchgrasses species were planted directly following herbicide application of imazapic alone or with glyphosate, a moderate stand of Sherman big bluegrass, Sandberg's bluegrass and intermediate wheatgrass were established in the spring of 2009. Stand establishment in the sulfometuron plus chlorsulfuron and rimsulfuron treated plots planted during the fall of 2009 was strong for Sandberg's bluegrass and Sherman big bluegrass, and moderate for smooth brome and intermediate wheatgrass. Differences in stand establishment during the spring of 2009 and 2010 were likely due to spring precipitation, and timing and duration of cattle present in the plots.

CHEMICAL CONTROL OF *VENTENATA* IN THE PALOUSE PRAIRIE. Ian C. Burke*[1], Randall E. Stevens[2]; [1]Washington State University, Pullman, WA, [2]Palouse Conservation District, Pullman, WA (128)

The Palouse prairie ecosystem is endangered and the remnants are being further degraded by downy brome and ventenata. Four studies were conducted to evaluate herbicide effects on Palouse prairie plant communities and downy brome and ventenata control. Species richness in pyroxsulam, diclofop, and propoxycarbazone treatments were similar, 5.0, 4.4, and 4.4 species respectively, indicating these treatments were the least injurious to the native plant population. Pyroxsulam, sulfosulfuron, and imazapic plus glyphosate treatments reduced alien grass richness to 0.9, 0.8, and 0.8 species, respectively, compared to 1.8 for the nontreated areas. Imazapic plus glyphosate and sulfosulfuron reduce alien grass cover 73% and 69% respectively, and were similar in control to pyroxsulam, chlorsulfuron, and diclofop. Control of downy brome was 87% or greater with sulfosulfuron and imazapic plus glyphosate. Ventenata control was 77% or better by diclofop, sulfosulfuron, pyroxsulam, and imazapic plus glyphosate. Treatments of diclofop, sulfosulfuron, pyroxsulam, and imazapic plus glyphosate were the most effective herbicides for downy brome and ventenata control and the safest on the native plant community.

MANAGEMENT OF *VENTENATA* IN PASTURE AND CRP. John Wallace*, Timothy Prather; University of Idaho, Moscow, ID (129)

Ventenata is able to establish in a wide range of habitats in the Inland Northwest including pasture, rangelands and grass hay. Extension outreach programs suggest that among these habitats, natural and managed perennial grass systems including grassland prairies, pasture, and Conservation Reserve Program (CRP) are increasingly impacted by ventenata and are in need of applied research to develop management techniques. In the Palouse Prairie, ventenata is one of the primary weeds impeding restoration efforts of prairie remnants. In pasture systems, small-farm owners have seen forage yields decline as much as 75% following ventenata invasion. In CRP, ventenata's displacement of resource-conserving vegetative cover has made compliance of maintenance requirements difficult and has negative impacts on the wildlife habitat objectives of the program. Initial extension-directed research efforts have concentrated on identifying herbicide control options across a range of production systems. The objective of these efforts was to identify appropriate application rates and timings of labeled products that achieve high levels of ventenata control while minimizing injury to desirable grasses in each production system. Few products are labeled for annual grass control in non-agronomic commodity systems and fewer are labeled specifically for ventenata control. In 2006-2008, field studies were conducted in ventenata-infested grassland where bluebunch wheatgrass and Idaho fescue were the primary perennial grasses. Applications of imazapic at 1.75 oz ae/A and sulfosulfuron at 0.75 oz ai/A applied in late fall, following ventenata germination (<1" tall), resulted in high levels of control (>90%) and less than 50% growth suppression of perennial grass. Subsequent studies showed that high levels of ventenata control could be achieved with imazapic + glyphosate or terbacil applications applied in late fall to emerged ventenata seedlings. Terbacil applications resulted in less injury to perennial grasses in comparison to imazapic + glyphosate. Another study was conducted in 2007-2009 in a pasture comprised of bearded wheatgrass, meadow foxtail, smooth brome and Sandberg bluegrass. Plots were located in areas of low (<25%), medium (40-60%) and high (>75%) ventenata foliar cover. Imazapic was applied at 1.1 oz ai/A in the spring and NPK fertilizer (160 lb N/A) was applied as a split application to sub-plots. Significant injury to perennial grasses was observed. Fertilizer-only applications resulted in increases to perennial grasses 15 MAT comparable to increases observed in herbicide-only plots in both medium and high ventenata cover plots. Inferences from comparisons between fertilizer and herbicide treatments across varying levels of ventenata cover were somewhat conflicted by herbicide injury to perennial grasses, but results indicate that management targeted towards nutrient pools and cycling may be critical to development of integrated control strategies in perennial grass systems. Sulfosulfuron has been demonstrated as effective for ventenata control but little is known about the effect of sulfosulfuron on emerging or emerged perennial grass seedlings. In 2010, a greenhouse study was initiated to determine the effect of sulfosulfuron on 11 perennial grasses commonly found in CRP, pasture or grassland plantings. These grasses were planted into six rates of sulfosulfuron, ranging from 0 to 0.75 oz ai/A. Initial results indicate that intermediate and bluebunch wheatgrass are generally tolerant across the range of sulfosulfuron rates, whereas grass yields decline significantly at low rates of sulfosulfuron across all other species including bromes, bluegrass and timothy suggesting a limited choice of grasses can be used for reseeding if sulfosulfuron has been applied recently. Management of ventenata continues to be a challenge but a fertilization program linked to herbicide application will contribute to a ventenata decision tool to assist farmers and ranchers.

CLASSIFICATION OF ANNUAL VERSUS PERENNIAL GRASSES IN RANGELANDS; A FIRST STEP TOWARDS A LANDSCAPE DECISION TOOL. William B. McCloskey*[1], Timothy Prather[2], Larry W. Lass[2]; [1]University of Arizona, Tucson, WA, [2]University of Idaho, Moscow, ID (130)

Ventenata dubia is one of a complex of weedy annual grasses that infest rangelands as well as pastures, CRP and hay fields. Detecting annual grasses and other weeds from perennial grasses on rangelands presents a significant challenge. This challenge may be addressed by using remotely sensed data to develop landscape level decision tools for making weed control and plant community rehabilitation decisions. Decision tools are being developed that utilize plant cover as one component. Hyperspectral data (126 bands in visible and infrared wavelengths) of the Canyon Grasslands in northern Idaho between Grangeville to south of Riggins, ID along the

Salmon River were collected using an aircraft mounted instrument. The hyperspectral data from a small accessible area of the grasslands were subjected to an unsupervised classification and compared to an initial set of ground referenced polygons containing different vegetation types collected at the site; this initial classification did not successfully distinguish degraded areas with annual grass and broadleaf weeds from areas with desirable perennial grasses. Additional polygons containing different types of vegetation were collected at various accessible sites on the landscape using a handheld GPS-GIS unit and used to develop signature files. These signature files were in turn used to develop a supervised classification of the landscape that was able to distinguish to some degree between different vegetation types. Further cycles of collecting ground referenced data and developing signature files can be used to refine the landscape classification. Making larger scale plant community improvements on public lands can be driven by major disturbances such as fire when resources are made available for recovery after fire. Classifying rangelands by categories of annual grass cover would allow implementation of decision tools across the landscape scale needed to assist in making informed decisions on where to spend resources after fire.

SYMPOSIUM: Ecological Effects of Invasive Plants

ECOLOGY AND MANAGEMENT OF INVASIVE SPECIES: A CONCEPTUAL FRAMEWORK. Dean E. Pearson*, Yvette K. Ortega; USDA Forest Service, Missoula, MT (170)

Biological invasions present unique management challenges. When exotic species invade native systems, they can shift the system out of its natural equilibrium dynamic and launch it onto a new trajectory defined by the invader's impacts – the invasion trajectory. Understanding biological invasions in light of the invasion trajectory is crucial to effective invasive species management. Although management practices such as chemical and biological control offer powerful tools that can alter the invasion trajectory, they rarely extirpate the invasive species and return the system to its historic state. Moreover, much like in human medicine, management tools can have potentially negative side effects that can exacerbate the problem. Thus, effective invasive species management requires understanding the invasion trajectory and how management tools alter the trajectory so we can balance side effects to ensure that management actions improve system conditions. Here, we present a conceptual framework for understanding, studying, and managing biological invasions. We provide examples from an ongoing research program on spotted knapweed (*Centaurea stoebe*) to illustrate the importance of determining the invasion trajectory in order to predict the community-level impacts of the invader over time and provide a baseline for evaluating the efficacy of management actions. We discuss how applying this approach can provide managers with the necessary knowledge to make informed decisions that will maximize efficacy and minimize side effects of management actions.

ECOLOGICAL EFFECTS OF INVASIVE PLANTS ON FOREST ECOSYSTEMS. Timothy B. Harrington*[1], Mike Newton[2]; [1]USDA Forest Service, Olympia, WA, [2]Oregon State University, Corvallis, OR (171)

Non-native, invasive plants pose a serious threat to many of the ecological characteristics of forest ecosystems, including their biodiversity, productivity, and resilience to disturbance.

Natural disturbances, integral to the sustainability of forest ecosystems, often facilitate plant invasions by removing physical and environmental barriers that tend to slow or prevent plant spread. Among disturbance types, wildfire is perhaps the greatest facilitator of plant invasions because it often creates extensive openings in otherwise dense forest canopies, enabling shade intolerant and relatively non-competitive plant species to gain a foothold and reproduce. Localized disturbances associated with waterways and roads provide corridors for widespread transport and distribution of invasive plants. Disturbances associated with forest management, such as thinning and clearcut harvesting, alter habitat sufficiently to promote establishment of aggressive invaders, such as Scotch broom and Himalayan blackberry, as well as less aggressive invaders like English holly. Some invasive plants alter growing conditions to favor their long-term dominance. Scotch broom typically invades forest sites of lower productivity where it out-competes conifer species, such as Douglas-fir, and alters soil chemistry to promote its own regeneration at the expense of native species. Japanese knotweed typically invades natural openings within riparian forest ecosystems where it creates a dense shade that essentially eliminates regeneration of all other woody and herbaceous species. When compared to native riparian woody species, knotweed retains more of its sequestered nitrogen, has poor rooting characteristics that destabilize streambanks, and is capable of regenerating from stem and root fragments that are carried downstream during flooding. Most invasive plant species have a weakness in their life cycle or growth habit, such as seeds that have specific germination requirements or seedlings that are susceptible to smothering or drought. These weaknesses can be exploited with management strategies that eliminate germination sites (e.g., retention of logging debris after forest harvesting), delay flowering and seed production (e.g., application of selective herbicides), or accelerate site occupancy by a dominant native species (e.g., seeding of native grasses or planting of large tree seedlings at close spacing). Where localized eradication of invasive plants is desired, intensive efforts can be applied as “quarantine” reaches of roads or streams or buffers where virtually all sources of incoming seeds or plant fragments of target species are eliminated.

IMPACT OF INVASIVE PLANTS ON RANGELAND AND GRASSLAND ECOSYSTEMS.

Joseph M. DiTomaso*, Guy B. Kyser; University of California, Davis, CA (172)

The most important invasive plants of rangelands have long been known to significantly compromise the economic viability of livestock production systems through reductions in forage quality and quantity, negative effects on animal health and increased cost of managing and producing livestock. In addition, invasive plants can reduce recreational activities and land values. Estimates of the financial impact of invasive plants in rangelands exceed $2 billion a year. Invasive plants can also dramatically affect wildlife and plant diversity by altering wildlife forage and habitat and competitively excluding many important native plants. While there are thousands of species that ecologist might define as invasive in rangelands and grasslands, the most problematic of these (perhaps 10%) change the biotic or abiotic character, condition, form or nature of natural ecosystems, including rangelands. They do this through several mechanisms, including aggressively competing for limited resources (light, water and nutrients), donating limiting resources (e.g., nitrogen) that facilitates invasion of other ruderal weedy species, promoting fires or erosion, and accumulating litter, salt, or heavy metals that prevent establishment of desirable species. Examples of each of these mechanisms will be discussed, with emphasis on invasive plants in western US rangelands and grasslands.

SPOTTED KNAPWEED AND SONGBIRDS: UNDERSTANDING THE NATURE OF INVADER IMPACTS. Yvette K. Ortega*, Dean E. Pearson; USDA Forest Service, Missoula, MT (173)

While negative impacts of exotic plant invasions on native plants have been studied extensively, relatively little is known about consequences of associated habitat changes for animals, including songbirds. We studied savannas in western Montana that were either dominated by native vegetation or invaded by spotted knapweed. We found that knapweed invaded sites had reduced prevalence of native plants and insects representing important food resources for ground-foraging songbirds like chipping sparrows. Indeed, chipping sparrows nesting in knapweed invaded habitat showed delayed breeding and reduced fecundity, effects frequently associated with low food availability. Knapweed invaded habitat also had higher turnover of breeding adults among years and reduced prevalence of older versus yearling males, which in turn, impacted song learning and the maintenance of local song traditions. Our research demonstrates that invasive plants can have complex and far reaching impacts on animals by affecting food chains. These pathways of impact must be elucidated in order to understand the implications of plant invasions and evaluate the efficacy of mitigation and restoration measures.

IMPACT OF SPARTINA AND ITS CONTROL IN WILLAPA BAY, WA ON MIGRATORY SHOREBIRD FORAGING. Kim Patten*[1], Carol O'Casey[2]; [1]Washington State University Long Beach Research and Extension Unit, Long Beach, WA, [2]Washington State University, Long Beach, WA (174)

Outside its native range, *Spartina* is an aquatic noxious weed in estuaries throughout the world. Over the past 50^+ years it has spread over many thousands of acres of tidal mudflats in Puget Sound, Grays Harbor and Willapa Bay (WB), WA and San Francisco Bay, CA. Species most threatened by *Spartina* have been the 30 species of shorebirds along the Pacific Flyway that rely upon the intertidal mudflats for food and shelter during annual migrations. The Audubon Society lists the invasion of WB by *Spartina* as the second most critical threat to shorebird habitat in the nation. Delays in initial control efforts due to regulatory constraints and lack of effective chemical or mechanical control tools resulted in exponential expansion of *Spartina* in WB between 1990 and 2003. By 2003, ~ 5,000 ha of the most-preferred shorebird habitat of Willapa Bay, sheltered upper tidal mudflats, had become almost contiguous *Spartina* meadows. In 2004, the control effort for *Spartina* was switched from mechanical control and chemical control with glyphosate to imazapyr (1.68 kg ai/ha). A multi-million dollar annual control effort by federal, state and county agencies over the past 6 years has killed all but a few remaining isolated *Spartina* plants. Long-term shorebird monitoring studies, from 2003 to 2010, have been conducted in WB at sites where prime shorebird habitat was replaced with *Spartina* meadows. There was no bird usage (of any species) in *Spartina* meadows. Following control, shorebird usage of affected tideflats increased dramatically for four years and then levelled off (mean range 400 to 1000 shorebird/ha/10 min). This rapid recovery of vast tracts of prime habitat is one of the most successful restoration projects for shorebirds in modern history. Owing to *Spartina*-induced increase in tidal elevations, there has also been a succession of native marsh species (*Salicornia*, *Triglochin* and *Spergula)* more than 400 m out into previously vacant mudflats. This potentially permanent conversion of mudflat to salt marsh could have negative implications for shorebird habitat.

MICROBIAL ENHANCED COMPETITIVE ABILITY (MECA): BACTERIAL ENDOPHYTES CONTRIBUTE TO INCREASED GROWTH RATE, DEFENSE AND ALLELOCHEMICALS IN AN INVASIVE PLANT. Marnie E. Rout*[1], Thomas H. Chrzanowski[2], Thomas H. DeLuca[3], William E. Holben[1], Ragan M. Callaway[1]; [1]University of Montana, Missoula, MT, [2]University of Texas, Arlington, TX, [3]Bangor University, Bangor, Wales (175)

Invasive plants can profoundly alter ecosystem processes. Plant attributes like growth rates, morphology, novel defense and allelopathic compounds have been documented in many invasive species. While these characteristics are considered plant-regulated, our work with the invasive grass *Sorghum halepense* shows microbial symbionts significantly contribute to many of these invasive traits. Using culture and molecular approaches, we found that the plant harbors a suite of bacterial endophytes within the rhizomes including N_2-fixers, iron siderophore producers, phosphate solubilizers, and organisms capable of producing plant-growth hormones. In combination with these microbial partners, invasive *Sorghum* creates a soil environment with increased plant-available forms of nitrogen, phosphorus and potassium, in addition to altering several other soil biogeochemical cycles. Using a novel antibiotic approach, we manipulated the bacterial endophytes within the rhizomes and found these symbionts significantly increased plant biomass and altered resource allocation supporting more rhizomatous growth. Plants with endophytes had increased production of allelochemicals and significantly inhibited growth of *Schizachyrium scoparium*, a native prairie grass frequently displaced by *Sorghum*. When endophyte loads were restricted, the competitive effects of *Sorghum* on *S. scoparium* were removed. Plants with endophytes also had increased production of dhurrin, an anti-herbivory compound found in the leaves. These results suggest microbial interactions significantly contribute to *S. halepense* invasions by promoting many invasive characteristics of the grass, including growth rate, allelochemical production and plant defense compounds. Harboring bacterial endophytes might be an underlying mechanism contributing to the profound alterations to ecosystem processes observed in many plant invasions.

IMPACTS OF EXOTIC PLANTS OF NATURAL AREAS: METHODS AND OUTCOMES OF EXPERIMENTAL RESEARCH. Tanya C. Skurski*, Bruce D. Maxwell, Lisa J. Rew; Montana State University, Bozeman, MT (176)

Over 1,000 plant species have been reported as invasive in natural areas of the United States, and many of these cause substantial ecological and economic impacts. However, the broad spectrum of exotic plant species and the extent of invasions preclude comprehensive control and necessitate evaluation of species and population impacts to help prioritize management. We reviewed the literature for all exotic plant impacts research from 2001 to 2010 with the goal of synthesizing both the methods and findings of experimental research. Here we present the results of U.S.A. and Canadian studies. Overall we found 75 experimental impact studies conducted across 24 states and 2 Canadian provinces. Most experiments (57%) examined impacts on individual species, followed in descending order by impacts on community structure, ecosystem properties, and ecosystem processes. The research examined 76 exotic species; with C_3 annual grasses (20%) and perennial forbs (17%) the most frequently studied growth forms. Approximately half of all experiments were carried out in constructed communities, either in the field or greenhouse. Of the experiments conducted in natural systems, hardwood forests and grasslands were the predominant community types. Exotic plants caused a decrease in response variables in 39%, an increase in 12%, and had no significant effect in 49% of all experiments. Of the negative impacts, community properties (particularly plant and arthropod abundance and composition) were the most frequently affected, and ecosystem processes the least. Annual forbs led to disproportionately more and C_3 annual grasses disproportionately fewer negative impacts relative to their frequency across all experiments. Impacts were context-specific, varying among different exotic and native species, as well as environmental conditions. Experimental results indicate that factors such as shading and interference from litter were more often the mechanisms underlying impacts than competition for resources, which may have implications for some management situations. While methodologies are improving, future studies that examine impacts across multiple sites and address the effects of other interacting factors will strengthen our understanding of the consequences of exotic plant establishment and assist in developing effective management strategies.

DO NOT FIDDLE WHILE ROME BURNS: DIRECTING RESEARCH TO ADDRESS MANAGEMENT AND POLICY. Sarah H. Reichard*; University of Washington, Seattle, WA (177)

Non-native invasive species are an increasing problem in wildland ecosystems. As global trade expands and new markets are established, the rate of introduction has accelerated and unexpected pathways have arisen. The impacts of many species are still being discovered and the discoveries surprise even seasoned biologists. While many biologists direct their research towards work that can be applied to solutions, that is not always the case. Biologists working with broad-based teams can identify problems in management and policy to find answers. They should also be willing to ensure that their research is delivered to those that need the answers, even if it includes using methods that may not be traditional for many scientists.

DISCUSSION SESSIONS

Project 1 Discussion Session: Weeds of Range and Natural Areas

Moderators: James Leary, University of Hawaii and Lars Baker, Fremont County Weed & Pest

Topic: *Extending Invasive Weed Management with Novel Technologies and Collaborative Applied Research Networks*.

The discussion section dealt with two topics. The first was introduced by Nathan Korb of the Nature Conservancy in Helena, Montana who summarized research that TNC has been doing on the economic benefits of Early Detection and Rapid Response. The result of this work is in progress and will be released later this spring. Copies will be made available to all in attendance. The computer model reflects weed species distribution, rate of spread and control efficacy for leafy spurge and spotted knapweed at several TNC properties in Montana. Of greatest interest in the dramatic difference between weed control efforts that target the leading edge of the infestation and those that focus on the large visible and often easy acres in the center. The discussion then moved to the technologies that are in common use to map weeds across wide spread landscapes. It was observed that most weed mapping efforts are carried out with the less expensive units. They have an advantage of low price and simplicity of use. However, the more expensive units that allow for data logging allow for easier collection of data which does have value for research. They were equally accurate from the stand point of returning to the infestation. There was some disappointment expressed that more recognition was not given to ongoing EDRR efforts throughout the western states and that since the development of the "Fire Model" by Steve Dewey, the concept is well accepted. It should be noted, however; that ignoring the large visible patches of weeds is not possible. Without a visible effort on weeds in plain view, enforcement programs are crippled and when resources are limited, many weed programs rely heavily on regulatory efforts. So, in spite of obvious benefits to EDRR, weed control efforts are frequently hampered in their ability to pursue them.

The second topic of the day was introduced by Tim D'Amato under the title "Western Invasive Plant Network" envisioned as a collaboration between land managers and university research where the problems faced by the land managers might become the priority of researchers and the products of the research are communicated widely to land managers. This has been the traditional role for the university extension service, but shrinking budgets in most western states have resulted in a significantly reduced extension presence in the area of weed management. Similar networks are found in the Midwest and it was proposed that WSWS sponsor the Western Invasive Plant Network (WIPN). The hope is that a wide area network for the dissemination of standardized weed management could improve weed management throughout the western states. The idea has merit, but is complicated by the great variety of cropping systems, differences in weed species, soils and climate, and the resources and programs of different states. It was suggested by Dr. Scott Nissen that Colorado might try to establish a pilot project to serve as a model for WSWS consideration next year in Reno. A committee was formed of Scott Nissen, Steve Sauer, Steve Ryder, Jane Mangold and Mary Halstvedt, with Tim D'Amato acting as chair.

A short discussion was held about the management duties for the section. Todd Neel, National Park Service, Marblemount, WA, volunteered for the role of Chair Elect. He was elected by popular acclamation. The discussion section adjourned at 5:00 PM.

2011 Chair:
James Leary
University of Hawwaii at Manoa
3050 Maile Way
310 Gilmore Hall
Honolulu, HI 96822
808-956-9268
leary@hawaii.edu

2011 Chair-Elect:
Lars Baker
Fremont County Weed & Pest
450 N. 2nd Street, Room 325
Lander, WY 82520
307-332-1052
larsbaker@wyoming.com

2012 Chair-Elect:
Todd Neel
Exotic Plant Management Specialist
North Coast-Cascades Network
North Cascades National Park
7280 Ranger Station Road
Marblemount, WA 98267
todd_neel@nps.gov

Discussion Section Attendees:
David Peter, dpeter@FS.FED.US; Tim D'Amato, tdamato@larimar.org; Dale Shanar, dale.shanar@ars.usda.gov; Casey Cisnaros, ccisneros@larimar.org; Jim Harbour, james.d.harbour@usa.dupont.com; Steve Ryder, steve.ryder@ag.state.co.us; Todd Neel, Todd_Neel@nps.gov; Dan Campbell, dan_campbell@nps.org; Travis Bean, bean@email.arizona.edu; Travis Ziehl, TZiehl@tcweed.org; Jim Olivrez, jolivarez@msn.com; Edison Hidalgo, hidalgo@gmail.com; James Leary, leary@hawaii.edu; John Wallace, jwallace@uidaho.edu; Vincent Jansen, vjansen@tnc.org; Steve Sauer, ssauer@bouldercounty.org; Scott Nissen, scott.nissen@colostate.edu; Cini Brown, Cynthia.s.brown@colostate.edu; Roy Brunskill, roy.brunskill@kingcounty.gov; Kim Patten, pattenk@wsu.edu; John Brock, john.brock@asu.edu; Becky Brown, becky.n.brown@gov.bc.ca; Harvey Holt, holth@purdue.edu; Guy Kyser, gbkyser@ucdavis.edu; Tanya Harrison, tanyaharrison@ctuir.org; Larry Lass, llass@uidaho.edu; Tom Getts, tomgetts@lamar.colostate.edu; Marvin Butler, marvin.butler@oregonstate.edu; Peter Rice, peter.rice@umontana.edu; Celestine Duncan, weeds1@wildblue.net; Jane Mangold, jane.mangold@montana.edu; Jim Sebastian, jseb@lamar.colostate.edu; Sandya Rari Kesoju, keso4900@vandels.uidaho.edu; Bob Finley, rfinlry@dteworld.com; Bobby Goeman, goeman@larimer.org, Mary Halstvedt, mbhalstvedt@dow.com; Sarah Ketchum, sarah@wallowaresources.org; Lars Baker, larsbaker@wyoming.com; and Nathan Korb, nkorb@TNC.ORG.

Project 2 Discussion Section: Weeds of Horticultural Crops

Moderator: Steve Young, University of Nebraska

Topic: *Are weed scientists meeting grower needs for weed control in specialty cropping systems?*

Steve Young opened the discussion. In the current economic climate, universities and agencies are making drastic cuts to reduce budgets and meet spending limits. Once again, agriculture has been targeted due to under representation in legislative and other public bodies. Some groups have put forth the idea of possibly cutting entire agricultural colleges; something that would never have been proposed, let alone mentioned, just a decade ago. In the face of the many societal demands, there is mounting pressure to meet state spending limits by cutting entire programs in colleges and universities. Nothing is being held sacred, which raises the question of the importance of any specific field of study, including agriculture and more specifically weed science.

It is well-recognized that weed science plays a critical role in crop production and this fact has largely gone unnoticed by the general public. On the side of the growers, both large and small, weed scientists should have broad-based support from those who make their living in production agriculture. But, is this really the case? In eastern Washington, one of the biggest vegetable producing companies in the Pacific Northwest has decided to diversify and produce organically grown carrots, onions and peas. Several smaller growers across the state already in organic production have developed weed control practices with limited support.

The weed science community may need to re-think how to strengthen ties with those it most desperately needs and has faithfully served since the beginning of the land grant institution, especially as the public becomes more disconnected with its agrarian base, yet demands more environmentally-friendly production practices. Are weed scientists meeting the needs of the grower, both in terms of production research and extension education? We already know what the legislature thinks, but what do the growers think?

Steve suggested (with broad agreement) that state budget shortages will be problematic for the foreseeable future. Industry funding on the rise but government funding is steadily declining. Inputs are rising and yields are stable, thus rate of net return is decreasing. Food service suppliers are adding sustainability and environmental statements to their core values. The objective of this discussion session is to hear from growers about their weed control practices and identify the gaps where stronger ties could be made for greater advocacy and support of university weed science programs.

Bill Fleury, a farmer from the Camas Prairie of Northern Idaho, discussed his views of the relationship between researchers and growers. In addition to his direct experience as a grower, he has been involved in a number of agricultural commodity boards and agricultural advocacy groups. He indicated that growers in the Pacific Northwest want and need extension. He strongly supports cooperation between extension and growers and encourages extension researchers to reach out to progressive growers for help. Many times he has issues but has no idea what is truly happening and thinks extension can help with some of these situations. Education of EPA and consumers may be an important part of extension. "Sustainability" slowly replacing "organic". The session closed with attendees questioning Bill Fleury about his views and experiences on various aspects of the interactions among growers and agricultural researchers.

The discussion closed with a vote for chair-elect for the Horticultural Crops Section in 2012. Hank Mager (Bayer Crop Science) will be chair for the 2012 meeting in Reno. John Roncoroni (University of California Cooperative Extension) was elected as chair-elect for 2012 and will rotate to the chair position for the 2013 meeting in San Diego.

2011 Chair:
Brad Hanson
University of California, Davis
Dept. of Plant Science, MS-4
One Shields Ave.
Davis, CA 95616
530-752-8115
bhanson@ucdavis.edu

2011 Chair-Elect:
Hank Mager
Bayer CropScience
14422 N. Prickly Pear Court
Fountain Hills, AZ 85268
hank.mager@bayer.com

2012 Chair-Elect:
John Roncoroni
Univ. of Calif. Coop. Ext. Napa County
1710 SOSCOL Ave. Suite 4
Napa, CA 94559-1315
jaroncoroni@ucdavis.edu

Discussion Session Attendees: Bill Fleury, John Roncoroni, Gene Dawson, Hank Mager, Rick Boydston, Rich Zollinger, Kai Umeda, Pam Hutchinson, Bill Cobb, Joel Felix, Ed Peachey, Rich Affeldt, Brad Hanson, Steve Young

Project 3 Discussion Section: Weeds of Agronomic Crops

Moderators: Andy Hulting, Oregon State University and Chad Asmus, BASF Corporation

Topic: *Defining grass weed management research and extension priorities in cereal grain-based cropping systems.*

We began the discussion by addressing some "big picture" issues for the group by trying to define who we are and what we do as weed scientists as part of the Agronomic Crops Group. This immediately led to a discussion about how to get by with less funding for research. The idea was proposed that weed scientists lobby commodity groups for grower-based funding of weed research. Commodity group funding of public-sector research apparently varies by country and state, with some states more actively involved than others. In Canada, for example, commodity groups and government split the costs of research funding 50/50. It was emphasized that weed scientists need to lobby commodity groups for funding, since the status quo is for commodity groups to wait for a problem to become severe before they approach weed scientists for support. In other words, weed scientists need to improve on becoming more proactive vs. reactive. There was a concern about the possible control of commodity groups over a researcher's direction and focus if the researcher became too dependent on them for funding, but there already is a precedent for researchers to accept industry funds in exchange for focused research. Consequently, there should be little problem for weed scientists to accept some level of commodity funding as well. Such studies could easily become too narrowly focused on just weed control, however, and it was stressed that an overall "systems" approach must also be studied and maintained (i.e. the influence of tillage, fertility, crop rotation, etc. on weed control).

The focus of the discussion then shifted to determining research priorities for the group. The question was then raised about the absence of weed biology/ecology studies and the over-abundance of resistance management studies in graduate student research. This led to a discussion about how to garner more interest in weed science among graduate and undergraduate students. It was agreed that there was a trend among undergraduate courses to be more laboratory based and not field based, which resulted in an increased number of graduate students without field agronomy experience. Interest in graduate level weed science must begin with a strong undergraduate program where students are exposed to excellent opportunities that are associated with weed science. The future relevancy of weed science depends on successful undergraduate and graduate programs.

The next discussion topic focused on strengthening partnerships between the public and private sector. There had been comments made during the meeting that some in private industry were having difficulty finding public researchers to work with. Some public researchers in the group, however, mentioned that they were already stretched too thin and actually had the problem of having too much of a research workload. Upon further investigation it was discovered that the shortage of public researchers was in the area of new herbicide development, when potential herbicides were still numbered compounds more than two years from commercial launch. This was due to the sensitivity of the work and the confidentiality that is required by the private researcher. Such secrecy and exclusivity that is required by the private cooperator is often at odds with the public researcher's supervisors who believe in the full disclosure of public research. History has proven it to be very difficult for the slow moving beaucracies of both public institutions and private industry to come to an agreement on such sensitive research in a timely manner. By contrast, there were no perceived problems from either the public or private sector in researching compounds that were either commercially available or were within two years of commercial launch. Essentially, there must be a high level of trust between the researcher and industry which can only be cultivated over time.

The discussion again returned to trying to define research and extension priorities in cereal based cropping systems. Andy Hulting introduced the group to the WERA-077 "Invasive Weeds in Wheat" working/discussion group, which has open membership and the goal of providing long-term guidance for research and extension efforts and peer collaboration. Individuals may contact Ian Burke, Washington State Univ., (2011 Chair) or Joe Armstrong, Oklahoma State Univ., (2012 Chair Elect) about participating in the next meeting of this group which will be held prior to the 2012 WSWS meeting in Reno. One other area of research interest that was discussed dealt with the sustainability and stewardship of Clearfield® wheat cropping systems in an effort to thwart weed resistance. Such research would also have to include rotational cropping system studies in addition to herbicide evaluation, and would require the collaboration with researchers in other fields of expertise. This necessitates having multiple authors/disciplines contributing to cropping system projects.

Finally, Joe Armstrong was nominated and elected to serve as Chair Elect. Chad Asmus will be the 2012 Chair.

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

2012 Chair:
Chad Asmus
BASF Corporation
2301 Bristol Ln.
Newton, KS 67114
Phone: 316-251-5514
chad.asmus@basf.com

2012 Chair-Elect:
Joe Armstrong
Oklahoma State University
Department of Plant and Soil Sciences
368 Agricultural Hall
Stillwater, OK 74078-6028
Office Location: 279 Agricultural Hall
Phone Number: 405-744-9588
FAX Number: 405-744-5269
joe.armstrong@okstate.edu

Discussion Section Attendees:

Name	Affiliation
Connor Ferguson	Oklahoma State University (undergrad)
Alan Helm	Colorado State University
Ken Sapsford	University of Saskatchewan
Siyuan Tan	BASF Corporation
Josett Hackett	Hackett Ag Consulting
Jean Dawson	Private Consultant
Randall Currie	Kansas State University
Andrew Kniss	University of Wyoming
Darren Unland	Bayer CropScience
Stuart Turner	Turner and Co., Inc.
Andrew Hulting	Oregon State University
Daniel Curtis	Oregon State University
Chad Asmus	BASF Corporation
Frank Young	USDA-ARS, Pullman
Mary Paulsgrove	Bayer CropScience

Another three individuals attended but did not record their names/affiliations.

Project 4 Discussion Section: Teaching and Technology Transfer

Moderator: Wendy Hamilton, New Mexico State University

Topic: *How effective are knowledge gain evaluations?*

The discussion session was held on Wednesday, March 9, which had approximately 14 people in attendance, and was moderated by Wendy Hamilton (Extension Evaluation Specialist, NMSU). Wendy was our invited presenter and prior to discussion provided a lecture on "Program Evaluation: How to Increase Knowledge Gained and Measure Knowledge Retained".
To start the discussion, Wendy Hamilton provided background information on the importance of defining the program goals in order to design evaluations that help obtain information with regard to the learning objectives. Many in attendance had used evaluations, and expressed the important of evaluations in improving their programs. As a result many benefits and issues were brought up and discussed. One of the discussed topics was the importance of designing questions in evaluations. The group talked about the benefits of knowing the audience in formulating the questions. The moderator emphasized on avoiding yes or no questions, asking two questions in one, and instead utilizing a range of answers to generate more information. Questions that generate qualitative data (e.g. work performance) are usually not very relevant, but in some cases they can be used to support quantitative data. The group also talked about the importance of support from universities and institutions to help design and implement accurate evaluations for their programs. Although few universities provide evaluation support from experts, those institutions with no program evaluation support can acquire support from their local American Evaluation Association.

Other topics that were discussed include: pre- and post-evaluations, long term evaluations, use of one standard evaluation for different programs, conducting evaluations via email, the use of disclaimers in evaluations, the impact of fatigue on evaluation results, audience age groups, importance of program evaluation in the performance evaluations, the use of press release to show program impact, and the possibility to get immediate feedback from audience with the use of text messages.

Finally, Kelly Murray Young was nominated and elected to serve as chair for Project 4 in 2013. Gustavo M. Sbatella will be the 2012 Chair.

Chair 2011:
Jamshid Ashigh
New Mexico State University
Department of Extension Plant Sciences
P.O. BOX 30003-MSC 3AE
Las Cruces, NM 88003
575-646-2888
jashigh@nmsu.edu

Chair 2012:
Gustavo M. Sbatella
Post Doctoral Research Associate
Panhandle Research and Extension Center
4502 Avenue I
Scottsbluff, NE
Phone: 308-632-1231
gsbatella2@unl.edu

Chair 2013:
Kelly Murray Young
University of Arizona, Maricopa County Coop. Ext.
4341 East Broadway Road
Phoenix, AZ 85040-8807
Phone: 602-827-8200 ext.319
kyoung@arizona.edu

Discussion Section Attendees:
List of attendees not submitted

Project 5 Discussion Session: Basic Biology and Ecology

Moderator: Kevin Kelley, AgraServ

Topic: *The Future of Invasive Species Research*

Brian Meglor started discussion by stating that he worked with land managers and that they were interested in the issue of novel or synthetic landscapes. Land managers wonder if it is feasible to restore to natives species or if a series of beneficial or synthetic landscapes could be developed (i.e., a new ecosystem) that would be more resistant to invasion by undesirable species. If a state transition has occurred due to invasion/degradation, landscape changes may not be reversible to the original native state. The example of crested wheatgrass as a benign introduced species was mentioned and the comment was made that it is not cost effective to revegetate with natives. The idea would be to introduce "benign" species that were sufficiently aggressive to get established but not so aggressive as to overrun the landscape and remaining natives. Another comment made was that with climate change and the redistribution of flora world-wide, it may be impossible to manage back to the original flora.

It was noted that NRCS Plant Materials Program has switched to developing native species seed production and the preservation of resources and that the BLM has the Seeds of Success program to collect, conserve and develop native plant materials for stabilizing, rehabilitating and restoring lands in the United States. Commercial native seed production uses the NRCS seed as "Foundation seed" for commercial production.

Tanya Skurski asked: what are the ecosystem services that we want performed by a landscape? These might include carbon storage and watershed functions among others and are likely to be context or location specific. What can we live with and what ecosystem functions do we need? She also voiced the need for the development of research methods for studying the impact of invasive or exotic species and gave an example of greenhouse studies of individual pairs of species to determine outcomes. She also brought up the idea that multiple tropic levels need to be considered as a network and that the impacts of invasive species are localized. Others commented that the National Park Service is trying to preserve native flora but others such as the BLM are more interested in function. Andrew Kniss brought up the concept of social accounting as a way assign value to ecosystem services provided by ecosystems. Frank Dugan made the point that there is a need for process driven models of ecosystem function or services in order to understand what makes "it all go".

Another topic of discussion was the role of endophytes/mycorrhiza in invasion processes. It was noted that this topic has received increased research interest in the last decade, is still largely descriptive with regard to the fungi involved and is topic of interest to members of Ecological Society of America and Botanical Society of America. This lead to a discussion about the need to encourage young people to cross the "divide" between basic and applied research and increase interactions with other societies such as the ESA, BSA and American Phytopathological Society. The Wildlife Society is also interested in invasive species and it was noted that diverse expertise is need. Land managers want local plant biotypes for revegetation but are afraid to make mistakes; their decision need to be defensible and they feel that they don't have enough information to make informed decisions. It was noted that agricultural systems are not plant communities in the sense of natural systems but rather are simplified systems and that herbicides are not just agronomic tools but can be used to achieve ecological goals. There was also recognition that the survey and detection of invasive plants in range and natural systems is limiting progress in managing invasive species and that citizen detection and recognition of invasive species and volunteer efforts in collaboration with Fish & Wildlife, BLM, Forest Service and NRCS (which has EQIP funds for vegetation control) is very important.

Sarah Ward introduced the use of molecular biology to study the history of invasions and the idea that genomics work will inform the management of invasive species. The basic idea was that if the mechanisms of invasions were known and what functions were important, than the use of molecular biology to study the genes involved might lead to management insights. However, until we know the mechanisms involved we won't know what the possible management insights might be. Molecular techniques have been useful for targeting biological controls and can be used for detection; examples discussed included mussels, carp and identification of invasive biotypes of Phragmites from native biotypes. The idea of using pollen trapping including sampling pollen from bees to detect invasive species was also brought up in the context of this discussion.

The session closed with a discussion/vote for chair-elect; Sarah Ward (Colorado State University) will serve as Chair-Elect for the Basic Biology and Ecology Section in 2012 and will rotate to the Chair position for the 2013 meeting in San Diego. Bill McCloskey (University of Arizona) will serve as the Chair for the 2012 meeting in Reno.

Chair 2011:
Kevin Kelley
AgraServ
2565 Freedom Lane
American Falls, ID 83211
208-226-2602
kevin@agraserv.com

Chair 2012:
William B. McCloskey
Unversity of Arizona
School of Plant Sciences
Tucson, AZ 85721
520-621-7613
wmcclosk@cals.arizona.edu

Chair 2013:
Sarah Ward
Colorado State University
Department of Soil and Crop Sciences
Fort Collins, CO 80523-1170
970-491-2102
Sara.ward@colostate.edu

Discussion Section Attendees:
Wendy DesCamp, wdescamp@agr.wa.gov; Randall S. Currie, rscurrie@ksu.edu;

Frank Dugan, fdugan@wsu.edu; David Heimer, david.heimer@dfw.wa.gov; Nina Klypin, niklypin@nmsu.edu; Kevin Kelley, kevin@agraserv.com, Andrew Kniss, akniss@uwyo.edu; Bianca Assis Barbosa Martins, babmartins@yahoo.com.br; Bill McCloskey, wmcclosk@cals.arizona.edu; Brian A. Meglor, bameglor@uwyo.edu; Elena Sanchez, elena.sanchez@oregon.state.edu; Sarah Ward, sarah.ward.@colostate.edu; Tanya Skurski, tskurski@gmail.com; Tiffany Wax, twax@wsu.edu.

WESTERN SOCIETY OFWEED SCIENCE NET WORTH REPORT

April 1, 2010 through March 31, 2011

ASSETS	
Cash and Bank Accounts	
Certificate of Deposit from Money Market	43,843.49
Checking	40,163.23
Money Market	77,170.24
TOTAL Cash and Bank Accounts	161,176.96
Other Assets	
Asset (*Weeds of the West* unsold inventory)	85,433.00
TOTAL Other Assets	85,433.00
Investments	
RBC Dain Rauscher Acnt 1101-5709-9275	204,148.36
TOTAL Investments	204,148.36
TOTAL ASSETS	450,758.32
LIABILITIES	0
OVERALL TOTAL	450,758.32

WSWS CASH FLOW REPORT

April 1, 2010 through March 31, 2011

INFLOWS	
Annual Meeting Income	69,981.00
Bio Control Of Invasives Book	175.56
California Weeds Books	820
Interest Inc	12,204.31
Invasive Plants Book	375
Noxious Weed Shortcourse	17,650.00
Student Travel Account	75.00
Sustaining Member Dues	13,850.00
Weeds Of The West	38,897.08
TOTAL INFLOWS	154,027.95
OUTFLOWS	
Annual Meeting Expense	35,636.53
California Weeds Books	486.73
Invasive Plants Book	270.92
Noxious Weed Short Course	4,200.00
CAST Annual Dues	1,500.00
Deposit For 2013 Meeting	1,000.00
Director Of Science Policy	8,832.00
Insurance	500
List Serve	90
Merchant Account	4,002.37
Newsletter	216.89
Service Contract	20,000.00
Stipend for RPR Editor	750
Supplies	86.05
Tax Preparation	402.89
Student Travel Account	3810
Travel To WSWS Meeting	4,869.98
Web Site Host	510
Web Site Transactions	2,394.00
TOTAL OUTFLOWS	89,558.36

WSWS 2010 FELLOW AWARDS

Dan Ball

Dr. Dan Ball is a Professor of Weed Science at Oregon State University and located at the Columbia Basin Agricultural Research Center near Pendleton, Oregon. He has been at the Center for over 20 years, with research and Extension responsibilities for weed management in dryland crops, and more recently with weed management in grass seed production in eastern Oregon and Washington. Dan has been a very active and important member of the WSWS since he was a graduate student at the University of Wyoming, where he completed his Ph.D. in 1987. He also has been an active member of the Weed Science Society of America and has served in leadership positions in the Oregon Weed Science Society.

In the WSWS, Dan has served as Research Section Chair, Education and Regulatory Section Chair, President-elect, and President. He is currently serving as immediate Past-President for the WSWS. In addition, he has served on the Resistance Management Committee, Weeds of the West Revision Committee, Student Paper Judging Committee, and Alternative Weed Control Methods Committee. In the OWSS, Dan has served as 2nd Vice President, President-elect, and President and is currently a member of the Board of Directors. As a WSSA member, Dan has served as the Graduate Student Award Subcommittee Chair.

Through his career to date, Dr. Ball has authored or co-authored over 60 refereed articles and extension bulletins, numerous abstracts and special reports pertaining to weed management issues in the Pacific Northwest. He also has made over 80 presentations as an invited speaker or contributor at the WSWS meeting and other weed science related professional meetings and has made more than 200 extension presentations.

Dan has been a mentor to many graduate students over the years and has served as major professor or as a committee member for 13 graduate students. Several of these have been in collaboration with weed scientists at other universities in addition with faculty at OSU.

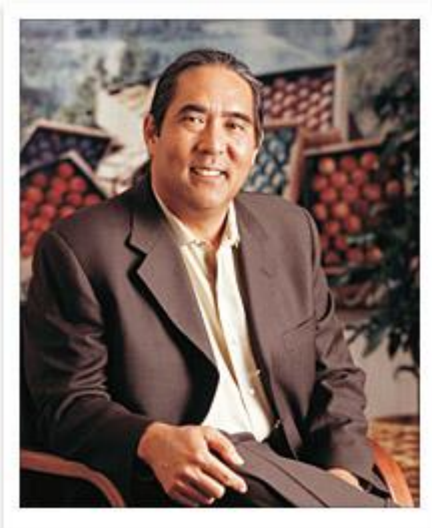
Roger Gast (no photograph available)

Roger Gast has been an active member of the Western Society of Weed Science (WSWS) for the past 15 years as well as a member of the North Central Weed Science Society, and Weed Science Society of America. Even though his job responsibilities caused him to re-locate to the Midwest, Roger has maintained an active role in the WSWS. He currently is a member of the poster committee and will serve as chair in 2013. Roger also has served as a member of the Placement and Finance committees, and chair of the Weeds of Agronomic Crops Project. For 5 years Roger coordinated the Dow AgroSciences sponsorship of the business breakfast meeting. Roger actively pursued Dow funding for this event and spent time managing it from the selection of the food to making sure that is ran smoothly during the meeting. Sponsorship of these activities is critical to the success of the annual meeting.

Roger has authored or co-authored 61 papers and posters at professional weed meetings (18 at WSWS) including international meetings. He has co-authored or coordinated book chapters such as the chapter on tree and vine weed control in “Principles of Weed Control in California” and a chapter on triazolopyrimidines in Modern Crop Protection Compounds (volume 1). He is recognized for his work with minor crop registrations and in 2008 wrote an article “Industry Views of Minor Crop Weed Control" for Weed Technology. Roger has worked closely with university and federal weed scientists over the years on numerous cooperative research projects. He is known for his professional conduct and desire to solve grower problems. Throughout his earlier work with Dow AgroSciences in California, Roger conducted numerous field research trials in the Western region leading to new herbicide registrations and use patterns important to Western specialty crop producers.

It is not always easy for members from private industry to find support within their companies to be an active member of a professional society. The WSWS is fortunate that Roger is one of those individuals.

WSWS 2011 HONORARY MEMBERSHIP AWARD – A.G. Kawamura



Former California Secretary of Agriculture A.G. Kawamura was recognized as the 2011 WSWS Honorary Member. Throughout Secretary Kawamura's service he has emphasized the need to make invasive species, including plants, insects, pathogens, invertebrates, and animals, a very high priority. He served as the State Chair for the California Invasive Species Advisory Committee.

Secretary Kawamura further demonstrated his commitment to the issue by attending the January 2010 National Invasive Species Awareness Week (NISAW) activities in Washington DC. At the meeting he gave the opening remarks in the day's program and also, in collaboration with Bob Ehart of the National Association of State Departments of Agriculture, gave a presentation on "State Invasive Species Management Efforts." His goal is to mobilize states to work together on a Biosecurity Act that provides early detection and rapid response funds to protect against invasive species that can harm agriculture and natural ecosystems.

WSWS 2011 OUTSTANDING WEED SCIENTIST, PRIVATE SECTOR – Monte Anderson

Monte is currently a Field Development representative with Bayer CropScience in Spokane, WA and has developed a reputation for excellence among his colleagues in the Pacific Northwest. Monte has focused primarily on herbicide development and weed management during his career, particularly in small grains and corn, along with contending with ACCase resistant weeds. He has conducted extensive plot work, technical writing, and sales support on a number of herbicides. In addition, Monte developed the use of fenoxaprop in grass grown for seed. Monte's research and efforts have contributed to the development of glufosinate in various markets. Monte Anderson has worked closely with various University and USDA-ARS researchers in developing numerous use patterns of Bayer, Aventis, AgrEvo, and American Hoechst herbicide products in small grains, corn, and various other crops.

Monte has been an active member of the WSWS since 1985 and has served on the board of directors as well as a member or chair of the Student Educational Enhancement, Herbicide Resistant Weeds and local arrangements committees; he chaired the Education and Regulatory Program at the 2004 meeting, and regularly presents papers or posters and serves as a judge in the student contest and at annual meetings.

One of the supporting letters stated: "I see Monte as a perfect choice for the Western Society of Weed Science Outstanding Weed Scientist Award. Monte is highly respected by all of his colleagues and peers. He has made profound and significant contributions to weed science in the western U.S., and has been a continuously productive member of the WSWS. I fully expect that his contributions and impacts to weed science will continue to expand in importance over the remainder of his career with the agrichemical industry."

WSWS 2011 OUTSTANDING WEED SCIENTIST, EARLY CAREER – Brad Hanson

Brad earned his Ph.D. in Plant Science (Weed Science/Plant Genetics) at the University of Idaho in 2004. He held a Post Doctoral Research Fellowship at Colorado State University working on the physiology of herbicide injury in imidazolinone-resistant wheat and was employed as a Research Agronomist / Weed Scientist with USDA-ARS in Parlier, CA. working on Methyl bromide alternatives in fruit and nut tree and grapevine nurseries, ornamentals, floriculture, and strawberry.. He is currently the Assistant Cooperative Extension Specialist at the University of California, Davis. He holds statewide weed management research and extension responsibilities in perennial crops and methyl bromide alternatives in nurseries, vineyards, and orchards. Dr. Hanson has obtained five grants totaling $355,022 as the Principle Investigator and an additional four grants totaling $1,378,980 as a co-investigator. He has also published 29 peer-reviewed research papers and 61 extension papers. He serves on the Board of Directors for WSWS, has been on several committees and regularly presents his work at our annual meetings in addition to being an active member in three other societies. He received strong support from his colleagues and mentors for this award. One stated: "In his short career since obtaining his PhD, Dr. Hanson has already made significant research contributions to finding technically and economically viable alternatives to methyl bromide soil fumigation, developing management strategies for herbicide-resistant weeds, and evaluating effective weed management options in tree and vine crops. His research has not only been published in peer-reviewed journals relevant to the weed science discipline, but also in numerous extension outlets directed towards his clientele and commodity groups."

WSWS 2011 PROFESSIONAL STAFF AWARD – Robert Higgins

Robert has held the position of Research Technician at the University of Nebraska, High Plains Agricultural Laboratory, in Sidney, Nebraska since 1991. He conducts field research in weed science and, in his position, regularly interacts with local farmers, industry representatives, and university professors and graduate students. These contacts allow him to find specific weed-crop complexes for research sites when they are not available at the Ag. Lab. Robert regularly puts in the time necessary to make sure that a job is done in a timely and efficient manner. He has attended a number of WSWS meetings, and has presented five research posters. The papers he presented in 2006, 2008 and 2009 involved multi-state projects with collaborators from Wyoming, Colorado, and Kansas. According to Drew Lyon, his supervisor and nominator: "Rob's greatest contribution to Weed Science has been his impact on graduate students. Rob truly enjoys working with graduate students and he has helped many students from Nebraska and adjacent states with their research projects."

WSWS 2011 Presidential Award of Merit – Kai Umeda

Kai Umeda has gone beyond all expectations in his service to the society. For years he served as the Board representative for the Constitution and Operating Guide, which can be a very time consuming and difficult job. Just as Kai completed his responsibilities in this capacity, he was elected as President of the Society. These and all of his other duties and service to the society clearly make him an outstanding choice for the Presidential Award for WSWS.

WSWS 2011 Student Scholarship Recipients

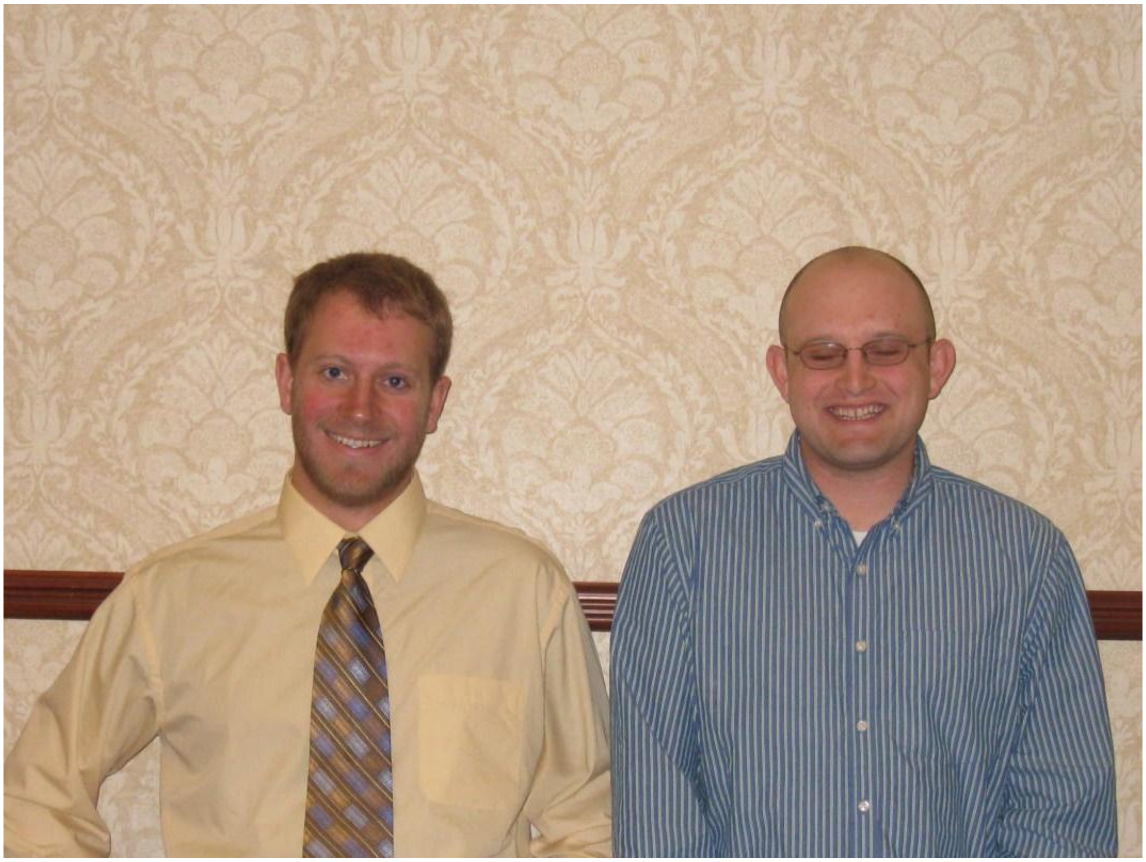
Tanya Skurski (left), Montana State University

Sandya Kesoju (middle), University of Idaho

Katie Conklin (right), North Dakota State University

WSWS 2011 Graduate Student Paper and Poster Awards

Oral Paper Contest Awards – Agronomic Crops or Basic Biology



First Place (right) – Joseph Vassios, Colorado State University

Second Place (left) – Jared Unvertzagt, University of Wyoming

Oral Paper Contest Awards – Range and Natural Areas or Horticultural Crops

First Place (middle) – Ryan Edwards, Colorado State University

Second Place (left) – Cameron Douglass, Colorado State University

Third Place (right) – Katie Conklin, North Dakota State University

Poster Presentation Awards – Agronomic Crops or Basic Biology

First Place (right) – Connor Ferguson, Oklahoma State University

Second Place (left) – Jared Unverzagt, University of Wyoming

Third Place (middle) – Bianca Martins, Oregon State University

Poster Presentation Awards – Range and Natural Areas or Horticultural Crops

First Place (middle) – Joseph Vassios, Colorado State University

Second Place (right) – Clarke Alder, Utah State University

Third Place (left) – Cassandra Setter, North Dakota State University

2011 WSWS ANNUAL MEETING NECROLOGY REPORT

Stuart W. Turner passed away on October 4, 2010 at age 89 after a 53 year career largely focused around weed science. He worked at the University of British Columbia while completing his BS in formulations of 2,4-D and performed the first commercial scale calibration, testing and aerial application of various 2,4-D formulations in May of 1943 before induction into the Canadian Army. From the D-Day landings until V-E day his unit was in almost constant combat; a tank squadron commander, his unit replaced their Shermans due to losses 3 times before it was all over....Shipped to Detroit to assist the Americans in perfecting an amphibious tank, he was among millions of service members spared by the judicious use of atomic power by President Truman. On return to civilian life, he completed a Masters degree at UBC before beginning his consulting business in 1950. During this time frame the pesticide industry was in a discovery boom, particularly for herbicides, and he was kept busy sorting out the usual teething problems of new compounds. By the mid 1950's his firm had grown to contain several other consultants, and they obtained an exclusive to act as agents for Lloyd's of London syndicates, which up until the late 1970's were the only providers of liability coverage for aerial applicators. At the peak of the firms' growth there were offices in the Southeast, Midwest, California and Washington. In 1954 he testified as an expert witness in the famous *Wenairco v. US* case, which went all the way up to the US Supreme Court, where it was upheld; as a result, BPA and other utilities were forced to mark dangerous power lines crossing rivers and ravines, which were largely invisible by air, and had claimed many crop dusters lives. An 18 month research project in Japan in the early 1950's on citrus canker allowed him to develop a treatment protocol to eliminate *xanthamonus citri* to the satisfaction of the USDA/APHIS, allowing for the Christmas time import of the delicious Unshu seedless oranges from Japan. His last major case was the largest series of pesticide claims ever recorded; the infamous DuPont Benlate claims, which eventually totaled over $1.4 Billion dollars in damage and expense world wide. He enjoyed and always attended the WSWS meetings from the late 1970's until the early 2000's. Over his 53 year career, he investigated nearly 2,500 claims, and can be fairly credited as one of the early pioneers of forensic agronomy. He was very active in the aerial application community, serving a total of 16 years on the Safety and Aerial Applications Committees of the HAI, and formed many special friends through his work. He was proudest of his offspring, daughter Anne received a PhD from Cornell in Horticulture, and has served as a consultant in almost every African nation over the past 30 years; son Stuart A. Turner followed him in the forensic and consulting business, and has been an annual attendee at WSWS since 1996. Wife of 60 years Betty remains in the family home on Bainbridge Island, WA

Lynn B. Jensen, age 66 passed away Friday, January 14, 2011 in Ontario, Oregon from complications due to cancer. Lynn was born July 6, 1944 in Preston, Idaho to Elvon Monson and Jenna Vee Bright Jensen. He was raised on a family farm in Preston and graduated from high school in 1962. He served a mission in London, England for the Church of Jesus Christ of Latter-day Saints. He was an active member at the time of his death. Lynn also served in the U.S. Army. He graduated B.S. degree in Plant Science from the University of Idaho in 1972 and received his M.S. degree in Weed Science from Utah State University. He married Paulette Teuscher on January 5, 1972 in Logan, Utah. They had five children. Lynn loved his children and found great joy in being with them and his nine grandchildren. He is survived by his wife, Paulette Jensen and four children. In April 1983, Lynn came to work for Oregon State University Extension as the Malheur County Onion and Potato Specialist. He was a professor at OSU and served as staff chair of the Malheur County Extension Office for several years. During his tenure, Lynn was responsible for providing educational programs in potato and onion production and marketing in Malheur County. Prior to his position at OSU, he worked for the Farmers Home Administration in Payette, ID, AgriNorthwest in Kennewick, WA and Sun Royal Company in Royal City, WA. During his time at OSU, Lynn received multiple awards including the Oregon Potato Commission Distinguished Service Award, OSU Experienced Faculty Award, Agriculturist of the Year by the Ontario Chamber of Commerce and was a National finalist for the National Association of County Agricultural Agents Achievement Award. He loved his work and the people that he worked with in Malheur County.

WSWS ANNUAL MEETING ATTENDEES – SPOKANE 2011

RICH AFFELDT
AGENCY FARMS
932 SUNNYSIDE DR
MADRAS, OR 97741-1606
541-475-3808
richard.affeldt@gmail.com

BRUCE ALBER
WILBUR-ELLIS CO.
WILSONVILLE, OR 97070

CHRIS ALDASSY
EAST MULTNOMAH SWCD
5211 N. WILLIAMS AVE
PORTLAND, OR 97217
503-935-5372
chris@emswcd.org

CLARKE ALDER
UTAH STATE UNIVERSITY
4820 OLD MAIN HILL
LOGAN, UT 84322-4820
c.alder@aggiemail.usu.edu

CRAIG ALFORD
DUPONT CROP PROTECTION
390 UNION BLVD, SUITE 500
DENVER, CO 80228
303-716-3909
craig.alford@usa.dupont.com

KASSIM AL-KHATIB
UNIVERSITY OF CALIFORNIA – IPM
ONE ROBBINS HALL, ONE SHIELDS AVE.
DAVIS, CA 95616-8621
785-537-2963
kalkhatib@ucdavis.edu

KELLY ALLEN
ALLEN FAMILY RANCH, LLC
SPOKANE , WA

RYAN ALLEN
BAYER CROPSCIENCE
1451 ROCKY RIDGE DR. #3502
ROSEVILLE, CA 95661
530-219-1883
ryan.allen@bayer.com

MONTE ANDERSON
BAYER CROPSCIENCE
16304 SOUTH YANCEY LANE
SPANGLE, WA 99031-9563
509-443-8749
monte.anderson@bayer.com

RANDY ANDERSON
USDA-ARS
2923 MEDARY AVE
BROOKINGS, SD 57006
605-693-5239
randerson@ngirl.ars.usda.gov

JENNIFER ANDREAS
WASHINGTON STATE UNIVERSITY EXT
2606 W PIONEER
PUYALLUP, WA 98371-4900
253-445-4657
jandreas@wsu.edu

GREG ARMEL
UNIVERSITY OF TENNESSEE
2431 JOE JOHNSON DR.
252 ELLINGTON PLT. SCI BLG.
KNOXVILLE, TN 37996
865-974-8829
garmel@utk.edu

JOE ARMSTRONG
OKLAHOMA STATE UNIVERSITY
368 AG HALL
STILLWATER, OK 74078
405-744-9588
joe.armstrong@okstate.edu

RICK ARNOLD
NMSU AGRICULTURAL SCIENCE CENTER
PO BOX 1018
FARMINGTON, NM 87499
505-327-7757
riarnold@nmsu.edu

JAMSHID ASHIGH
NMSU DEPT OF EXTENSION PLANT SCIENCES
PO BOX 30003-MSC 3AE
LAS CRUCES, NM 88003
575-646-2888
jashigh@nmsu.edu

CHAD ASMUS
BASF CORPORATION
2301 BRISTOL LANE
NEWTON, KS 67114
316-251-5514
chad.asmus@basf.com

AMIR ATTARIAN
OREGON STATE UNIVERSITY
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331
541-732-7542
attariaa@onid.orst.edu

WILSON AVILA
OREGON STATE UNIVERSITY
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331
541-737-5886
wilson.avila@oregonstate.edu

JOHN LARS BAKER
FREMONT CO WEED & PEST
450 N 2ND ST ROOM 325
LANDER, WY 82520
307-332-1052
larsbaker@wyoming.com

VICTOR BAKER
UNIVERSITY OF ARIZONA
Dept. of Hydrology and Water Resources
1133 E. James E. Rogers Way
Tucson, AZ 85721
Baker@email.arizona.edu

DAN BALL
OSU COLUMBIA BASIN AG. RESEARCH CENTER
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
575-527-8853
marathonag@zianet.com

GERARDO BANUELOS
UC COOP EXTENSION -
TULARE CO.
4437 B SOUTH LASPINA ST
TULARE, CA 93274
559-684-3300
gbanuelos@ucdavis.edu

JULIET BARENTI
US FISH & WILDLIFE SERVICE
11103 EAST MONTGOMERY
DRIVE
SPOKANE VALLEY, WA 99206
509-893-8005
juliet_barenti@fws.gov

MICHAEL BARRETT
UNIVERSITY OF KENTUCKY
PLANT AND SOIL SCIENCES
LEXINGTON, KY 40546-0312
859-218-0712
mbarrett@uky.edu

SHAWNA BAUTISTA
US FOREST SERVICE
PO BOX 3623
PORTLAND, OR 97208
503-808-2697
sbautista@fs.fed.us

TRAVIS BEAN
UNIVERSITY OF ARIZONA
1955 E. 6TH ST., STE. 210
TUCSON, AZ 85719
trav.bean@gmail.com

GEORGE BECK
COLORADO STATE UNIV
116 WEED RESEARCH LAB
FT COLLINS, CO 80523
970-491-7568
George.Beck@colostate.edu

JARED BELL
WASHINGTON STATE
UNIVERSITY
PO BOX 646420
PULLMAN, WA 99164-6420
541-829-01096
bellja@wsu.edu

DAVID BELLES
SYNGENTA CROP
PROTECTION
4037 EAST KARSTEN DRIVE
CHANDLER, AZ 85249
480-214-5068
david.belles@syngenta.com

BRENT BEUTLER
UNIVERSITY OF IDAHO
554 HILLCREST AVENUE
AMERICAN FALLS, ID 83211
brent@libertyag.net

ANDRE BISCARO
UCCE
335 EAST AVE K10
LANCASTER, CA 93535
661-974-8825
asbiscaro@ucdavis.edu

LISA BLECKER
UNIV. OF NEVADA COOP EXT.
111 SHECKLER ROAD
FALLON, NV 89406
775-427-5121
bleckerl@unce.unr.edu

BILL BOEKEL
CLOVERDALE FARMS
RATHDRUM, ID

DONNA BOEKEL
CLOVERDALE FARMS
RATHDRUM, ID
donnaboekel@yahoo.com

LISA BOGGS
SW OKLAHOMA STATE
UNIVERSITY
100 CAMPUS DRIVE
WEATHERFORD, OK 73096
580-774-3090
lisa.boggs@swosu.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
919-547-2788
ryan.bond@basf.com

ANDREW BOSWELL
COLORADO STATE
UNIVERSITY
DEPT OF SOIL & CROP SCI
FT COLLINS, CO 80523
abovetheplain@yahoo.com

MONETTE BOSWELL
WHATCOM CNTY NOX WEED
CONTROL BOARD
322 N. COMMERCIAL ST.
SUITE 110
BELLINGHAM, WA 98225
360-676-6700 x50604
mboswell@co.whatcom.wa.us

RICK BOYDSTON
USDA-ARS
24106 N BUNN ROAD
PROSSER, WA 99350
509-786-9267
rick.boydston@ars.usda.gov

LOUISE BRINKWORTH
DOW AGROSCIENCES
9330 ZIONSVILLE ROAD
INDIANAPOLIS, IN 46268
317-337-3571
lbrinkworth@dow.com

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

BECKY BROWN
BC MINISTRY OF NATURAL RES OPERATIONS
808 DOUGLAS STREET
VICTORIA, BC V8W 9B4
250-356-6646
becky.n.brown@gov.bc.ca

CYNTHIA BROWN
COLORADO STATE UNIVERSITY
BIOAG SCIENCES & PEST MGMT
FT COLLINS, CO 80523-1177
970-491-1949
csbrown@lamar.colostate.edu

FARA BRUMMER
OSU EXTENSION
PO BOX 430
WARM SPRINGS, OR 97761
541-553-3238
fara.brummer@oregonstate.edu

ROY BRUNSKILL
KING COUNTY NOXIOUS WEED PROGRAM
201 SOUTH JACKSON ST, STE 600
SEATTLE, WA 98104
206-296-0442
suzanne.rowe@kingcounty.gov

KEYNA BUGNER
WA DEPT OF NATURAL RESOURCES
ELLENSBURG, WA

IAN BURKE
WASHINGTON STATE UNIVERSITY
201 JOHNSON HALL
PULLMAN, WA 99164
509-335-2858
icburke@wsu.edu

ERIN BURNS
NORTH DAKOTA STATE UNIVERSITY
1111 7TH STREET NORTH APT 1
FARGO, ND 58102
erin.burns.2@ndsu.edu

MARVIN BUTLER
OREGON STATE UNIVERSITY-COARC
850 NW DOGWOOD LANE
MADRAS, OR 97741
541-475-3808
marvin.butler@oregonstate.edu

DAN CAMPBELL
NATIONAL PARK SERVICE
600 E PARK AVENUE
PORT ANGELES, WA 98362
360-565-3076
dan_campbell@nps.gov

JOAN CAMPBELL
UNIVERSITY OF IDAHO
PSES DEPT BOX 442339
MOSCOW, ID 83844-2339
208-885-7730
jcampbel@uidaho.edu

PAUL CARTER
WSU
512 N TOUCHET RD
DAYTON, WA 99328
509-382-4741
cart@wsu.edu

LEO CHARVAT
BASF CORPORATION
6211 SADDLE CREEK TRAIL
LINCOLN, NE 68523-9227
402-421-8619
leo.charvat@basf.com

STEPHANIE CHRISTENSEN
UTAH STATE UNIVERSITY
4820 OLD MAIN HILL
LOGAN , UT 84322
435-797-2637
steph.durf@aggiemail.usu.edu

DEAN CHRISTIE
BAYER CROPSCIENCE
4402 SOUTH GLENDORA LANE
SPOKANE, WA 99223
509-443-7196
dean.christie@bayer.com

CASEY CISNEROS
LARIMER COUNTY DEPT OF NAT RES
1800 SOUTH COUNTY ROAD 31
LOVELAND , CO 80537
970-679-4571
ccisneros@larimer.org

SHANNON CLAESON
USDA FOREST SERVICE
3625 93RD AVE SW
OLYMPIA, WA 98512
360-753-7697
sclaeson@fs.fed.us

JON CLAUS
DUPONT CROP PROTECTION
PO BOX 80705
WILMINGTON, DE 19880-0705
302-999-5796
jon.s.claus@usa.dupont.com

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

DAVID CLAYPOOL
UNIVERSITY OF WYOMING
DEPT 3354 1000 E UNIVERSITY AVE
LARAMIE, WY 82071
307-766-3995
claypool@uwyo.edu

CHRIS CLEMENS
SYNGENTA CROP PROTECTION
2631 STONECREEK
RICHLAND, WA 99352
509-308-5599
christopher.clemens@syngenta.com

TAYLOR CLOSE
UNIVERSITY OF WYOMING
1864 N. 9TH ST. #4
LARAMIE, WY 82072
307-766-3103
tclose@uwyo.edu

BILL COBB
COBB CONSULTING SERVICES
815 SO KELLOGG
KENNEWICK, WA 99336-9369
509-783-3429

STEPHEN COLBERT
DUPONT CROP PROTECTION
1413 Sierra Drive
Escalon, CA 95320
559-287-3360
stephen.f.colbert@usa.dupont.com

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

CINDI CONFER
WDFW
312 MTN VALE RD
SELAH, WA 98942
509-697-4503
cindi.confer@dfw.wa.gov

KATIE CONKLIN
NORTH DAKOTA STATE
UNIVERSITY
1120 16TH ST N. APT. 14
FARGO, ND 58102
katie.conklin@ndsu.edu

GIL COOK
COOK AG SCIENCE EXPERTISE
303 S BARKER RD
SPOKANE VALLEY, WA 99016
cookge@comcast.net

SCOTT COOK
KOOTENAI VALLEY FARM &
RESEARCH
1320 N. BROOKHAVEN LN
POST FALLS, ID 83854
509-435-7559
scookh@hotmail.com

CARRIE CORDOVA
US FISH & WILDLIFE SERVICE
11103 EAST MONTGOMERY
DRIVE
SPOKANE, WA 99206
509-893-8022
carrie_j_cordova@fws.gov

LINDSAY COX
COLUMBIA COUNTY WEED
BOARD
1316 S. 5TH ST
DAYTON, WA 99328
ez_quarterhorses@msn.com

CARL CRABTREE
IDAHO COUNTY WEED
MANAGEMENT
320 WEST MAIN, ROOM 3
GRANGEVILLE, ID 83530
208-983-2667
ccrabtree@idahocounty.org

RANDY CURRIE
KSU SOUTHWEST RES & EXT
4500 E MARY STREET
GARDEN CITY, KS 67846-9132
620-276-8286
rscurrie@ksu.edu

DAN CURTIS
OREGON STATE UNIVERSITY
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331
541-737-5421
Daniel.Curtis@oregonstate.edu

GARY CUSTIS
PBI GORDON CORPORATION
1217 WEST 12TH ST
KANSAS CITY, MO 64101
816-460-6215
gcustis@pbigordon.com

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

TIM D'AMATO
LARIMER COUNTY,
COLORADO
PO BOX 1190
FT. COLLINS, CO 80522
970-498-5769
tdamato@larimer.org

JIM DANIEL
29391 WCR 8
KEENESBURG, CO 80643
303-887-2639
JimTdan@gmail.com

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

JEAN DAWSON
9103 S MOORE RD
PROSSER, WA 99350-5524
509-786-3956
jeanandconnie@gmail.com

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

ALBERT DEKLERK
DUPONT DE NEMOURS INT
STH AFRICA PTY LTD
CARINUS STR 257,
MEYERSPARK
PRETORIA, GAUTUNG, SOUTH
AFRICA 0184
+27 12 803 3524
albert.de-klerck@zaf.dupont.com

WENDY DESCAMP
WA STATE NOXIOUS WEED
BOARD
PO BOX 42560
OLYMPIA, WA 98504-2560
360-902-2082
noxiousweeds@agr.wa.gov

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

ROBERT DODD
CLOVERDALE FARMS
RATHDRUM, ID

JAMES DOLLINS
USFS PACIFIC NW RESEARCH
STATION
3625 93RD AVE SW
OLYMPIA, WA 98512
360-753-7654
jdollins@fs.fed.us

CAMERON DOUGLASS
COLORADO STATE UNIVERSTIY
1179 CAMPUS DELIVERY
FORT COLLINS, CO 80523-1179
970-491-5426
Cameron.Douglass@colostate.edu

BILL DOWDY
USFS POMEROY RANGER DIST

DON DRADER
SYNGENTA CROP PROTECTION
7080 DUNE LAKE RD SE
MOSES LAKE, WA 98837-0167
509-765-5755
donald.drader@syngenta.com

BEN DUESTERHAUS
BASF
544 BUCKAROO CT.
OAKDALE, CA 95361
916-335-3441
ben.duesterhaus@basf.com

FRANK DUGAN
USDA-ARS WRPIS
59 JOHNSON HALL, WSU
PULLMAN, WA 99164-6402
509-335-1783
fdugan@wsu.edu

CELESTINE DUNCAN
WEED MGMT SERVICES
PO BOX 1385
HELENA, MT 59624-1385
406-443-1469
weeds1@wildblue.net

BOB ECCLES
WILBUR ELLIS
PO BOX Y
FILER, ID 83328
503-881-1436
beccles@wilburellis.com

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
701-626-2087
chad.effertz@arystalifescience.com

HEATHER ELWOOD
UTAH STATE UNIVERSITY
4820 OLD MAIN HILL
LOGAN, UT 84322-4820
heather.elwood@aggiemail.usu.edu

GREG ENDRES
NORTH DAKOTA STATE UNIVERSITY
RES EXT CENTER BOX 219
CARRINGTON, ND 58421-0219
701-652-2951
gregory.endres@ndsu.edu

JANAN FARR
UNIVERSITY OF IDAHO
1693 SOUTH 2700 WEST
ABERDEEN, ID 83210
208-397-4181
janan@uidaho.edu

JOEL FELIX
OREGON STATE UNIVERSITY
595 ONION AVENUE
ONTARIO, OR 97914
541-889-2174
joel.felix@oregonstate.edu

JOHN FENDERSON
MONSANTO COMPANY
PO BOX 47
KIOWA, KS 67070-1025
620-825-4315
john.m.fenderson@monsanto.com

CONNOR FERGUSON
OKLAHOMA STATE UNIVERSITY
368 AG HALL
STILLWATER, OK 74078
connor.ferguson@okstate.edu

MARK FERRELL
UNIVERSITY OF WYOMING
1000 UNIVERSITY BOX 3354
LARAMIE, WY 82071-3354
307-766-5381
ferrell@uwyo.edu

BOB FINLEY
FREMONT CO WEED & PEST
PO BOX 1171
DUBOIS, WY 82513
307-450-8704
rfinley@dteworld.com

CHERYL FIORE
NEW MEXICO STATE UNIVERSITY
6635 RIO DORADO
LA MESA, NM 88044
575-646-1627
cfiore@nmsu.edu

VERNON FISCHER
COLUMBIA AG RESEARCH, INC
5601 BINNS HILL DR
HOOD RIVER, OR 97031
541-387-3052
columbiaag@gmail.com

SCOTT FITTERER
BASF CORPORATION
4210 47th STREET S UNIT L
FARGO, ND 58104
701-389-0976
scott.a.fitterer@basf.com

DEBRA FITZGERALD
ISK BIOSCIENCES CORPORATION
7470 AUBURN ROAD STE A
CONCORD, OH 44077
440-357-4655
fitzgeraldd@iskbc.com

DAVID FLETCHER
ND FLETCHER PS
DAYTON, WA 99328

Albert Dinwiddy
ARP
Corvallis, OR

PETER FORSTER
SYNGENTA CROP PROTECTION
35492 WCR 43
EATON, CO 80615-9205
970-454-5478
pete.forster@syngenta.com

BILL FOUNTAIN
FOUNTAIN RANCH

JAY GEHRETT
SPRAY TECH
2338 WAINWRIGHT PLACE
WALLA WALLA, WA 99362
509-520-3546
jgehrett@charter.net

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

THOMAS GETTS
COLORADO STATE UNIVERSITY
601 MONTE VISTA AVENUE
FT COLLINS, CO 80521
970-481-9174
tomgetts@lamar.colostate.edu

DARCI GIACOMINI
COLORADO STATE UNIVERSITY
DEPT OF BIOAGRICULTURAL SCI
FT COLLINS, CO 80523
darcigiacomini@hotmail.com

BOBBY GOEMAN
LARIMER COUNTY WEED DISTRICT
PO BOX 1190
FT. COLLINS, CO 80522
970-222-5339
GoemanB@larimer.org

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

JESSICA GREEN
OREGON STATE UNIVERSITY
PO BOX 913
CORVALLIS, OR 97339
970-314-5053
greenje@hort.oregonstate.edu

PATRICIA GREEN
US FOREST SERVICE
1220 HIGHWAY 13
GRANGEVILLE, ID 83530
208-983-7009
pegreen02@fs.fed.us

BRANDON GREET
UNIVERSITY OF WYOMING
1728A HWY 434
TEN SLEEP, WY 82442
307-272-7079
bgreet@uwyo.edu

DEL GROAT
USFS POMEROY RANGER DIST

MEL GROVE
ISK BIOSCIENCES
3714 ASH GLEN DRIVE
SPRING, TX 77388
281-682-6241
grovem@iskbc.com

DIANE HAASE
USDA FOREST SERVICE
PO BOX 3623
PORTLAND, OR 97208
503-808-2349
dlhaase@fs.fed.us

JESSICA HAAVISTO
OREGON STATE UNIVERSITY
109 CROP SCIENCE BUILDING
CORVALLIS, OR 97331
541-737-5098
jessicahaavisto@live.com

JOSETTE HACKETT
HACKETT AG CONSULTING
3031 HOME ACRES ROAD
STEVENSVILLE, MT 59870
406-777-3278
josette@hackett-ag.com

LLOYD HADERLIE
AGRASERV INC
2565 FREEDOM LANE
AMERICAN FALLS, ID 83211
208-226-2602
lloyd@agraserv.com

PATRICK HAIKAL
ARYSTA LIFESCIENCE
2601 HANOVER CT.
DENVER, CO 80238
303-777-0671
patrick.haikal@arystalifescience.com

ALICIA HALL
NORTH DAKOTA STATE UNIVERSITY
NDSU DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
alicia.hall@my.ndsu.edu

MARY HALSTVEDT
DOW AGROSCIENCES
3311 HORTON SMITH LN
BILLINGS, MT 59106
406-655-9558
mbhalstvedt@dow.com

WENDY HAMILTON
NEW MEXICO STATE UNIVERSITY
PO BOX 30003 MSC 3AE
LAS CRUCES, NM 88003
575-646-5284
whamilto@nmsu.edu

BRAD HANSON
UNIVERSITY OF CALIFORNIA, DAVIS
DEPT PLANT SCIENCE MS-4; ONE SHIELDS AVE
DAVIS, CA 95616
530-752-8115
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
509-531-2003
dharper@wilburellis.com

TIMOTHY HARRINGTON
USDA FOREST SERVICE
3625 93RD AVE SW
OLYMPIA, WA 98512
360-753-7674
tharrington@fs.fed.us

TANYA HARRISON
CTUIR
PENDLETON, OR

CHARLIE HART

TEXAS A&M UNIVERSITY
1229 N. US HWY 281
STEPHENSVILLE, TX 76401
254-968-4144
cr-hart@tamu.edu

WILLIAM HATLER
TEXAS AGRILIFE EXT SERVICE
1229 N. US HWY 281
STEPHENVILLE, TX 76401
wlhatler@ag.tamu.edu

GREG HAUBRICH
WA STATE DEPT OF
AGRICULTURE
21 N FIRST AVE #103
YAKIMA, WA 98902
509-225-2604
ghaubrich@agr.wa.gov

DAVID HEIMER
WA DEPT OF FISH & WILDLIFE
4516 N 28TH
TACOMA, WA 98407
253-732-3869
david.heimer@dfw.wa.gov

ALAN HELM
COLORADO STATE UNIV EXT
SERV
315 CEDAR SUITE 100
JULESBURG, CO 80737
970-474-3479
alan.helm@colostate.edu

JILL HENSHAW
SYNGENTA CROP
PROTECTION|
1666 BARRES ST
STRASBURG, CO 80136
303-928-9735
jill.henshaw@syngenta.com

HOLDEN HERGERT
UNIVERSITY OF WYOMING
1417 E Flint St
LARAMIE, WY 82072
307-575-1052
hhergert@uwyo.edu

CHARLIE HICKS
BAYER CROPSCIENCE
3008 SHORE ROAD
FT. COLLINS, CO 80524
970-218-6301
charlie.hicks@bayer.com

EDISON HIDALGO
E.I. DUPONT DE NEMOURS &
CO
109 MICHAELS LANE
NEWARK, DE 19713
302-366-6109
hidalge@gmail.com

ROBERT HIGGINS
U OF NEB HIGH PLAINS AG
LAB
3257 RD 109
SIDNEY, NE 69162
308-254-3918
rhiggins2@unl.edu

BARBARA HINDS-COOK
OREGON STATE UNIVERSITY
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331
541-737-5172
Barbara.Hinds-
Cook@oregonstate.edu

JORDAN HOEFING
NORTH DAKOTA STATE
UNIVERSITY
5400 HWY 83 SOUTH
MINOT, ND 58701
701-857-7677
jordan.hoefing@ndsu.edu

MARK HOLLIDAY
DUPONT CROP PROTECTION
PO BOX 30, ELKTON ROAD
NEWARK, DE 19713
302-999-5398
mark.j.holliday@usa.dupont.com

HARVEY HOLT
GREEN SYSTTEMS
ANALYTICS, LLC
10203 47TH AVENUE SW, B-13
SEATTLE, WA 98146
765-427-5661
holth@purdue.edu

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

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

ED HUBER
PRIMELAND COOPERATIVES
(CHS)
PO BOX 9
ROCKFORD, WA 99030
509-981-9222
ehuber@primelandcoop.com

ANDREW HULTING
OREGON STATE UNIVERSITY
109 CROP SCIENCE BUILDING
CORVALLIS, OR 97331-3002
541-737-5098
andrew.hulting@oregonstate.edu

PAM HUTCHINSON
U OF IDAHO ABERDEEN R & E
CENTER
1693 S. 2700 W.
ABERDEEN, ID 83210
208-397-4181
phutch@uidaho.edu

SUPHANNIKA INTANON
OREGON STATE UNIVERSITY
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331
541-737-7542
suphannika.intanon@oregonstate.ed
u

VINCENT JANSEN
THE NATURE CONSERVANCY
906 S. RIVER ST
ENTERPRISE, OR 97828
541-426-3458
vjansen@tnc.org

ERIC JEMMETT
JEMMETT CONSULTING AND RESEARCH FARM
22826 GOODSON RD
PARMA, ID 83660
208-863-0269
ericjemmett@yahoo.com

BRIAN JENKS
NORTH DAKOTA STATE UNIV
5400 HWY 83 SOUTH
MINOT, ND 58701
701-857-7677
brian.jenks@ndsu.edu

CORBY JENSEN
MONSANTO
8201 W MOUNTAIN ASH RD
DENTON, NE 68339
314-609-8204
corby.jensen@monsanto.com

PRASHANT JHA
MSU SOUTHERN AG RESEARCH CENTER
748 RAILROAD HIGHWAY
HUNTLEY, MT 59037
406-348-3400
jpacific10@gmail.com

KEVIN JOHNSON
DOW AGROSCIENCES
21763 161 AVE S.
BARNSVILLE, MN 56514
419-409-3002
kdjohnson@dow.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
208-226-2602
kevin@agraserv.com

SANDYA RANI KESOJU
UNIVERSITY OF IDAHO
1218 S MAIN STREET, APT # 206
MOSCOW, ID 83843
708-714-7310
keso4900@vandals.uidaho.edu

SARAH KETCHUM
WALLOWA RESOURCES
401 NE 1ST ST. SUITE A
ENTERPRISE, OR 97828
541-426-8053
sarah@wallowaresources.org

STEVEN KING
BAYER CROPSCIENCE
1321 FLORIAN AVE
HUNTLEY, MT 59037
406-696-6654
steven.king@bayer.com

ROBERT KLEIN
UNIVERSITY OF NEBRASKA
402 WEST STATE FARM ROAD
NORTH PLATTE, NE 69101-7751
308-532-3611
rklein1@unl.edu

NINA KLYPIN
NEW MEXICO STATE UNIVERSITY
EPPWS MSC 3BE
LAS CRUCES, NM 88003
575-646-1014
niklypin@nmsu.edu

ANDREW KNISS
UNIVERSITY OF WYOMING
DEPT 3354 1000 E UNIVERSITY
LARAMIE, WY 82071
307-766-3365
akniss@uwyo.edu

NATHAN KORB
THE NATURE CONSERVANCY
32 S EWING
HELENA, MT 59601
406-925-1144
nkorb@tnc.org

NICHOLAS KRICK
COLORADO STATE UNIVERSITY
2032 MANCHESTER DRIVE
FORT COLLINS, CO 80526
970-379-3206
nicholas.krick@gmail.com

BRIAN KUEHL
EST CENTRAL INC.
284 CHESTNUT DRIVE
HORACE, ND 58047
701-282-0909
bkuehl@westcentralinc.com

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

TOM LANINI
UNIVERSITY OF CALIFORNIA
278 ROBBINS HALL
DAVIS, CA 95616
530-752-4476
wtlanini@ucdavis.edu

LARRY LASS
UNIVERSITY OF IDAHO
PSES BOX 442339
MOSCOW, ID 83844
208-885-7802
llass@uidaho.edu

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

JAMES LEARY
UNIV. HAWAII AT MANOA
PO BOX 269
KULA, HI 96790
808-956-9268
leary@hawaii.edu

GLENN LETENDRE
SYNGENTA CROP PROTECTION
11852 W ONEIDA DR
BOISE, ID 83709-3882
208-241-5813
glenn.letendre@syngenta.com

CARL LIBBEY
WSU - MOUNT VERNON
NWREC
16650 SR 536
MT VERNON, WA 98273-4768
360-848-6139
libbey@wsu.edu

BRIAN LIND
ARCH CHEMICALS
2018 AVE. O
SCOTTSBLUFF, NE 69361
308-631-5579
blind@archchemicals.com

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

ROB LINDSAY
THE NATURE CONSERVANCY
632 MILL ROAD, PO BOX 205
PAISLEY, OR 97636
rlindsay@tnc.org

MINGYANG LIU
OREGON STATE UNIVERSITY
109 CROP SCIENCE BUILDING
CORVALLIS, OR 97331-3002
541-737-5886
liumi@onid.orst.edu

MARK LONAM
PRIMELAND COOPERATIVES
(CHS)
PO BOX 9
ROCKFORD, WA 99030
509-990-4063
mlonam@primelandcoop.com

FRANCES LUCERO
KING COUNTY NOXIOUS
WEED PROGRAM
201 SOUTH JACKSON ST, STE
600
SEATTLE, WA 98104
206-296-0442
suzanne.rowe@kingcounty.gov

KELLY LUFF
BAYER CROPSCIENCE
3554 EAST 4000 NORTH
KIMBERLY, ID 83341
208-423-6371
kelly.luff@bayer.com

ROD LYM
NORTH DAKOTA STATE UNIV
NDSU DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
701-231-8996
rod.lym@ndsu.edu

DREW LYON
UNIVERSITY OF NEBRASKA
PHREC 4502 AVENUE I
SCOTTSBLUFF, NE 69361
308-632-1266
dlyon1@unl.edu

JUSTIN MACK
BASF CORPORATION
1630 DAKOTA DR. #106
FARGO, ND 58102
701-249-2531
justin.mack@ndsu.edu

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

MAYANK MALIK
MONSANTO
7321 PIONEERS BLVD #330
LINCOLN, NE 68506
402-486-1054
mayank.s.malik@monsanto.com

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

RICHARD MANN
DOW AGROSCIENCES
9330 ZIONSVILLE RD, BLDG
308/1F
INDIANAPOLIS, IN 46268
317-337-4180
rkmann@dow.com

MISHA MANUCHEHRI
WASHINGTON STATE
UNIVERSITY
300 NE MAPLE ST #5
PULLMAN, WA 99163
425-246-7853
misharose@wsu.edu

STEVE MARLL
TIMOTHY HAY
203 PATIT ROAD
DAYTON, WA 99328
509-382-4063
steve@marll.com

KENT MARTIN
KANSAS STATE UNIVERSITY
4500 E. MARY ST.
GARDEN CITY, KS 67846
620-275-9164
kentlm@ksu.edu

BIANCA MARTINS
OREGON STATE UNIVERSITY
109 CROP SCIENCE BUILDING
CORVALLIS, OR 97331
541-737-7542
bianca.martins@oregonstate.edu

DEAN MARUSKA
BAYER CROPSCIENCE
408 E. JOHNSON AVE
WARREN, MN 56762
218-745-7568
dean.maruska@bayer.com

PAUL McCATHERN
CHS INC.
PO BOX 9
ROCKFORD, WA 99030
509-283-2322
paul.mccathern@chsinc.com

BILL McCLOSKEY
UNIVERSITY OF ARIZONA
PLANT SCIENCE FORBES 303
TUCSON, AZ 85721-0036
520-621-7613
wmcclosk@ag.arizona.edu

SANDRA McDONALD
2960 SOUTHMOOR DRIVE
FT COLLINS, CO 80525
970-491-6027
sandrakmcdonald@gmail.com

L. DEAN McFETRIDGE
METHOW VALLEY RANGER DISTRICT
24 WEST CHEWUCH RD
WINTHROP, WA 98862
509-996-4030
lmcfetridge@fs.fed.us

BRIAN MEALOR
UNIVERSITY OF WYOMING
DEPT OF PLANT SCIENCES,
BOX 3354, 1000 E. UNIV. AVE.
LARAMIE, WY 82071
307-766-3113
bamealor@uwyo.edu

GARY MELCHIOR
GOWAN COMPANY
625 ABBOTT RD
WALLA WALLA, WA 99362
509-520-4779
gmelchior@gowanco.com

FABIAN MENALLED
MONTANA STATE UNIVERSITY
719 LEON JOHNSON HALL
BOZEMAN, MT 59717-3120
406-994-4783
menalled@montana.edu

KURT MERG
WDFW
ST. JOHN, WA

ABDEL MESBAH
UNIVERSITY OF WYOMING
747 ROAD 9
POWELL, WY 82435
307-754-2223
sabah@uwyo.edu

TINA MIERA
UNIVERSITY OF IDAHO
1693 S. 2700 W.
ABERDEN, ID 83210
208-397-4181
tinaservin@yahoo.com

TIM MILLER
WASHINGTON STATE UNIV
16650 STATE ROUTE 536
MT VERNON, WA 98273-9761
360-848-6138
twmiller@wsu.edu

DON MORISHITA
UNIVERSITY OF IDAHO
PO BOX 1827
TWIN FALLS, ID 83303-1827
208-736-3616
don@uidaho.edu

EDWARD MORRIS
MARATHON AG CONSULTING
205 W. BOUTZ, BLDG. 4, STE 5
LAS CRUCES, NM 88005
575-527-8853
edward.morris@marathonag.com

DOUG MUNIER
UC COOPERATIVE EXT
PO BOX 697
ORLAND, CA 95963
530-865-1153
djmunier@ucdavis.edu

MARQUES MUNIS
COLORADO STATE UNIVERSITY
408 N LOOMIS AVE
FORT COLLINS, CO 80521
marques.munis@gmail.com

TODD NEEL
NATIONAL PARK SERVICE
7280 RANGER STATION RD
MARBLEMOUNT, WA 98267
Todd_Neel@nps.gov

RYAN NELSON
UTAH STATE UNIVERSITY
695 NORTH 1100 EAST
LOGAN, UT 84322
rlnelson1@gmail.com

DEBORAH NEMENS
DNR
1111 WASHINGTON ST. SE
OLYMPIA, WA 98504
360-902-1634
deborah.nemens@dnr.wa.gov

GEORGE NEWBERRY
GOWAN COMPANY
1411 SOUTH ARCADIA STREET
BOISE, ID 83705
208-884-5540
gnewberry@gowanco.com

JEF NICHOLS
GOWAN COMPANY
897 SELAH NACHOS ROAD
YAKIMA, WA 98908
509-969-1780
jnichols@elltel.net

LUCAS NIPP
EAST MULTNOMAH SWCD
5211 N WILLIAMS AVE
PORTLAND, OR 97217
503-935-5363
lucas@emswcd.org

SCOTT NISSEN
COLORADO STATE UNIVERSITY
115 WEED RESEARCH LAB
FT COLLINS, CO 80523-1177
970-491-3489
snissen@colostate.edu

JAMES OLIVAREZ
3691 BRANDON WAY
MISSOULA, MT 59803
406-329-3621
jolivarez@msn.com

BRIAN OLSON
KANSAS STATE UNIVERSITY
PO BOX 786
COLBY, KS 67701
785-443-1264
bolson@oznet.ksu.edu

NOELLE ORLOFF
MONTANA STATE UNIVERSITY
3910 TOOLE ST.
BOZEMAN, MT 59718
406-529-7814
noelleorloff@gmail.com

STEVE ORLOFF
UNIV OF CALIF COOP EXT
1655 S MAIN ST
YREKA, CA 96097
530-842-2711
sborloff@ucdavis.edu

JOHN ORR
AMVAC
PO BOX 369
STAR, ID 83669
208-286-9300
johno@amvac.net

YVETTE ORTEGA
USDA FOREST SERVICE

KEVIN OSBORNE
OREGON STATE UNIVERSITY
876 COLUMBIA AVE
NYSSA, OR 97913
541-889-2174
kvosborne1@gmail.com

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

JIM PAROCHETTI
NIFA USDA
14th AND INDEPENDENCE
AVE., SW
WASHINGTON, DC 20250
202-401-4354
jparochetti@nifa.usda.gov

SCOTT PARRISH
AGRASYST
16412 NORTH NAPA
SPOKANE , WA 99206
509-467-2167
scott.parrish@agrasyst.com

BOB PARSONS
PARK COUNTY WEED & PEST
PO BOX 626
POWELL, WY 82435-0626
307-754-4521
pcwp@wir.net

KIM PATTEN
WASHINGTON STATE
UNIVERSITY
2907 PIONEER ROAD
LONG BEACH, WA 98631
360-642-2031
pattenk@wsu.edu

MARY PAULSGROVE
BAYER CROPSCIENCE
2 TW ALEXANDER DR - PO
BOX 12014
RTP, NC 27709
919-549-2177
Mary.Paulsgrove@bayer.com

PAMELA PAVEK
USDA-NRCS
HULBERT 211H WASHINGTON
STATE UNIV.
PULLMAN, WA 99164
509-335-6894
pamela.pavek@wa.usda.gov

ED PEACHEY
OREGON STATE UNIVERSITY
HORT DEPT ALS4017
CORVALLIS, OR 97331
541-737-3152
peacheye@hort.oregonstate.edu

DEAN PEARSON
USDA FOREST SERVICE

DAVID PETER
USFS PACIFIC NW RESEARCH
STATION
3625 93RD AVE SW
OLYMPIA, WA 98512
360-753-7654
dpeter@fs.fed.us

BEN PETERSON
KING COUNTY NOXIOUS
WEED BOARD

SEATTLE, WA

VANELLE PETERSON
DOW AGROSCIENCES
28884 S MARSHALL ROAD
MULINO, OR 97042-8709
503-829-4933
vfpeterson@dow.com

TIMOTHY PRATHER
UNIVERSITY OF IDAHO
1387 WALENTA
MOSCOW, ID 83843
208-885-9246
tprather@uidaho.edu

STEVE PYLE
SYNGENTA CROP
PROTECTION
410 SWING ROAD
GREENSBORO, NC 27455
336-632-2236
steve.pyle@syngenta.com

MICK QUALLS
QUALLS AG LABS
3759 DODSON RD
EPHRATA, WA 98823
509-787-4210 X16
mqualls@qa-lab.com

HAROLD QUICKE
BASF
1140 SHORELINE DR.
WINDSOR, CO 80550
334-703-7795
harold.quicke@basf.com

ALAN RAEDER
WASHINGTON STATE
UNIVERSITY
212104 E. 355 PR-SE
KENNEWICK, WA 99337
509-628-6244
greenkawa96@gmail.com

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
435-797-2242
corey.ransom@usu.edu

TRACI RAUCH
UNIVERSITY OF IDAHO
PO BOX 442339
MOSCOW, ID 83844-2339
208-885-9709
trauch@uidaho.edu

SARAH REICHARD
UNIVERSITY OF WASHINGTON

BILL REYNOLDS
CONFEDERATE TRIBES OF
WARM SPRINGS
PO BOX C
WARM SPRINGS, OR 97761
541-553-2010
bill.reynolds@wstribes.org

CHUCK RICE
BASF CORPORATION
725 N CENTER PKWY APT. R302
KENNEWICK, WA 99336
206-714-0712
chuck.rice@basf.com

PETER RICE
UNIV OF MT BIO SCIENCES
32 CAMPUS DR #4184
MISSOULA, MT 59812-4184
406-243-2671
peter.rice@umontana.edu

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
760-949-2565
jmrichardson@dow.com

JOHN RONCORONI
UCCE NAPA COUNTY
1710 SOSCAL AVE SUITE 4
NAPA, CA 94559-1315
707-253-4221
jaroncoroni@ucdavis.edu

MARNIE ROUT
UNIVERSITY OF MONTANA

ROBERT RUPP
DUPONT CROP PROTECTION
5813 SANDSAGE DR.
EDMOND, OK 73034
405-820-2423
robert.n.rupp@usa.dupont.com

STEVE RYDER
COLORADO DEPT OF AGRICULTURE
700 KIPLING ST. STE 4000
LAKEWOOD, CO 80215
303-239-4173
cedarmesa@gmail.com

LUKE SAMUEL
MONSANTO
506 W 40TH ST.
HAYS , KS 67601
785-656-3393
luke.samuel@monsanto.com

ELENA SANCHEZ
OREGON STATE UNIVERSITY
107 CROP SCIENCE BLDG
CORVALLIS, OR 97331
541-250-9683
elena.sanchez@oregonstate.edu

CURTIS SANDBERG
FMC CORPORATION
7508 SONG SPARROW WAY
ELK GROVE, CA 95758
916-691-2119
curtis.sandberg@fmc.com

KEN SAPSFORD
UNIVERSITY OF SASKATCHEWAN
51 CAMPUS DRIVE
SASKATOON SK, CANADA S7N 5A8
306-966-4999
k.sapsford@usask.ca

STEVE SAUER
BOULDER COUNTY PARKS & OPEN SPACE
5201 ST. VRAIN RD.
LONGMONT, CO 80503
303-678-6110
ssauer@bouldercounty.org

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

ROLAND SCHIRMAN
120 WEINHARD RD
DAYTON, WA 99328-9677
509-382-2778
schirman@innw.net

MARTY SCHRAER
SYNGENTA CROP PROT
152 E CASSIDY DRIVE
MERIDIAN, ID 83646
208-250-0937
marty.schraer@syngenta.com

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

JAMES SEBASTIAN
COLORADO STATE UNIV
258 TIABI DRIVE
LOVELAND, CO 80537
james.sebastian@colostate.edu

CASSIE SETTER
NORTH DAKOTA STATE UNIV
DEPT 7670 PO BOX 6050
FARGO, ND 58108-6050
701-388-3680
cassandra.setter@ndsu.edu

DALE SHANER
USDA-ARS
2150 CENTRE AVE BLDG D
FT COLLINS, CO 80526
970-492-7414
dale.shaner@ars.usda.gov

DEB SHATLEY
DOW AGROSCIENCES
PO BOX 519
LINCOLN, CA 95648
916-434-2266
dgshatley@dow.com

DONALD SHOUSE
UNIV OF IDAHO
P.O. BOX 1827
TWIN FALLS, ID 83303
208-736-3617
dshouse@uidaho.edu

ROBIN SIMPSON
CLARK COUNTY WEED MGMT
11104 NE 149 ST, C-200
BRUSH PRAIRIE, WA 98606
360-397-6140
robin.simpson@clark.wa.gov

LARRY SKILLESTAD
USDA APHIS PPQ
222 N HAVANA STREET ROOM 109
SPOKANE , WA 99202
509-353-2950
larry.d.skillestad@usda.gov

TANYA SKURSKI
MONTANA STATE UNIVERSITY
1205 S. GRAND AVE.
BOZEMAN, MT 59715
tskurski@gmail.com

BRENDA SMITH
USDA-ARS
67826 HWY 205
BURNS, OR 97720
541-573-4084
brenda.smith@ars.usda.gov

KEVIN SMITH
ALK – ABELLO
POST, ID

MONICA SORRIBAS
DOW AGROSCIENCES
949 JUNCTION PL
INDIANAPOLIS, IN 46220
559-494-3322
msorribas@dow.com

PHIL STAHLMAN
KANSAS STATE UNIVERSITY
1232 240TH AVENUE
HAYS, KS 67601-9228
785-625-3425
stahlman@ksu.edu

VALDASUE STEELE
UNIVERSITY OF IDAHO

KATIE STOKER
UTAH STATE UNIVERSITY
205 W 100 N
LOGAN, UT 84321
435-770-1761
katie.archer@aggiemail.udu.edu

BOB STOUGAARD
MSU NW AG CENTER
4570 MONTANA 35
KALISPELL, MT 59901
406-755-4303
rns@montana.edu

KYRRE STROH
UNIVERSITY OF WYOMING
205 S 30TH ST APT E14
LARAMIE, WY 82070
307-766-3103
kstroh1@uwyo.edu

LINDA SWARTZ
US FOREST SERVICE
PO BOX 670
RANDLE, WA 98377
360-497-1164
lswartz@fs.fed.us

SIYUAN TAN
BASF CORPORATION
1200 WHEELWRIGHT PL 207
CARY, NC 27519
919-465-1096
siyuan.tan@basf.com

DONN THILL
UNIV OF IDAHO PSES DEPT
PO BOX 442339
MOSCOW, ID 83844-2339
208-885-6214
dthill@uidaho.edu

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

JEFF TICHOTA
MONSANTO
3018 E NICHOLS CIRCLE
CENTENNIAL, CO 80122
303-324-4941
jeffrey.m.tichota@monsanto.com

MARIE TURNER
COLORADO STATE UNIVERSITY
DEPT SOIL & CROP SCIENCES
FT COLLINS, CO 80523
mariefsturner@gmail.com

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

SAM TURNER
WASHINGTON STATE UNIVERSITY
635 NW CHARLOTTE ST
PULLMAN, WA 99163
360-393-1662
sfturner@wsu.edu

STUART A TURNER
TURNER & CO
5903 KILAWEA DRIVE
WEST RICHLAND, WA 99353
509-967-0460
agforensic@aol.com

KAI UMEDA
UNIVERSITY OF ARIZONA
4341 EAST BROADWAY
PHOENIX, AZ 85040
602-827-8200x314
kumeda@cals.arizona.edu

RACHEL UNGER
WASHINGTON STATE UNIVERSITY
JOHNSON HALL
PULLMAN, WA 99164
rachel.unger@wsu.edu

DARREN UNLAND
BAYER CROPSCIENCE
2 TW ALEXANDER DR
RTP, NC 27709
919-549-2294
darren.unland@bayer.com

JARED UNVERZAGT
UNIVERSITY OF WYOMING
1359 N 17TH ST
LARAMIE, WY 82072
307-575-2330
jzagt@uwyo.edu

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

STEVE VANVLEET
WSU EXTENSION
702 N. Park St.
COLFAX, WA 99111
509-397-6290
svanvleet@wsu.edu

LEE VANWYCHEN
WSSA-DSP
900 2ND ST NE STE 205
WASHINGTON, DC 20002
202-408-5388
Lee.VanWychen@wssa.net

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

Al Vinwiddie
ARP
Corvallis, OR

JENNIFER VOGEL
CENTRAL KOOTENAY INVAS PLANT COMMITTEE
BOX 896
ROSSLAND, BC V0G 1Y0
250-362-5624
assistant@kootenayweeds.com

BRYAN VOGT
NORTH FORK JOHN DAY WATERSHED COUNCIL
PO BOX 444
LONG CREEK, OR 97856
541-421-3018
bryan@nfjdwc.org

KURT VOLKER
TKI NOVASOURCE
7610 SCENIC DRIVE
YAKIMA, WA 98908
509-952-9878
kvolker@tkinet.com

GREG WAHL
BECKER UNDERWOOD
3329 MCCOWAN WAY
CARMICHAEL, CA 95608
925-519-2193
greg.wahl@beckerunderwood.com

DARRIN WALENTA
OSU EXTENSION
10507 NORTH MCALISTER ROAD
LAGRANDE, OR 97850
541-963-1010
darrin.walenta@oregonstate.edu

JOHN WALLACE
UNIVERSITY OF IDAHO - PSES DEPT
875 PERIMETER DR, RM 2339
MOSCOW, ID 83844-2339
jwallace@uidaho.edu

CRAIG WALTERS
PACER CORPORATION
PO BOX 145
COLTON, WA 99113
509-330-1172
cwalters@pullman.com

SARAH WARD
COLORADO STATE UNIV
DEPT SOIL & CROP SCIENCES
FT COLLINS, CO 80523-1170
970-491-2102
sarah.ward@colostate.edu

TIFFANY WAX
WASHINGTON STATE UNIVERSITY
2606 WEST PIONEER
PUYALLUP, WA 98371
509-834-0530
twax@wsu.edu

LEN WELCH
VALENT USA
PO BOX 300
HOOD RIVER, OR 97031
541-490-2101
len.welch@valent.com

ERIC WESTRA
CSU
401 N. SHERWOOD ST.
FORT COLLINS, CO 80521
970-412-7029
epwestra@rams.colostate.edu

PHIL WESTRA
COLORADO STATE UNIVERSITY
112 WEED LAB
FT COLLINS, CO 80523
970-218-2344
cows19@comcast.net

CHRIS WHARAM
BASF
1091 DEER TRAIL LANE NE
THOMPSON, ND 58278
218-791-1714
chris.wharam@basf.com

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

RALPH WHITESIDES
UTAH STATE UNIVERSITY
4820 OLD MAIN HILL
LOGAN, UT 84322-4820
435-797-8252
ralph.whitesides@usu.edu

DAVID WILDERMAN
DNR
1111 WASHINGTON ST. SE
OLYMPIA, WA 98504
360-902-1556
david.wilderman@dnr.wa.gov

SAM WILLINGHAM
BASF CORPORATION
6626 CHAPEL HILL BLVD #A304
PASCO, WA 99301
509-306-1335
samuel.willingham@basf.com

GARY WILLOUGHBY
NORTH CENTRAL RESEARCH EXT CENTER
5400 HWY 83 SOUTH
MINOT, ND 58701
701-857-7677
gary.willoughby@ndsu.edu

ROBERT WILSON
UNIVERSITY OF NEBRASKA
4502 AVENUE I
SCOTTSBLUFF, NE 69361
308-631-1230
rwilson1@unl.edu

STEVE WRIGHT
UC COOP EXTENSION - TULARE CO.
4437 B SOUTH LASPINA ST
TULARE, CA 93274-9597
559-684-3300
sdwright@ucdavis.edu

JOE YENISH
DOW AGROSCIENCES
1001 CALENDULA CIRCLE
BILLINGS, MT 59105
509-332-8215
jpyenish@dow.com

HARVEY YOSHIDA
DOW AGROSCIENCES
432 AIMEE DRIVE
RICHLAND, WA 99352
509-628-1368
hyoshida@dow.com

FRANK YOUNG
WSU-USDA-ARS
161 JOHNSON HALL
PULLMAN, WA 99164-6420
509-335-4196
youngfl@wsu.edu

KELLY YOUNG
UNIVERSITY OF ARIZONA
4341 E BROADWAY RD
PHOENIX, AZ 85041
kyoung@arizona.edu

STEVE YOUNG
UNIV OF NEB WEST CENTRAL R&E CNTR
402 WEST STATE FARM ROAD
NORTH PLATTE, NE 69101
308-696-6712
syoung4@unl.edu

JIALIN YU
UNIVERSITY OF IDAHO
235 LAUDER AVENUE
MOSCOW, ID 83843
208-421-1245
yu3577@vandals.uidaho.edu

BEN ZAMORA
WSU – NRS
PULLMAN, WA

JOE ZAWIERUCHA
BASF CORPORATION
26 DAVIS DRIVE
RTP, NC 27519
919-547-2095
joseph.zawierucha@basf.com

TRAVIS ZIEHL
TETON COUNTY WEED & PEST DISTRICT
PO BOX 1852
JACKSON, WY 83001
307-413-4261
tziehl@tcweed.org

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

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