PROCEEDINGS

WESTERN SOCIETY OF WEED SCIENCE

Volume 68, 2015

ISSN: 0091-4487

OFFICERS AND EXECUTIVE COMMITTEE (2014-2015)

President	**Drew Lyons**
President-Elect	**Joe Yenish**
Immediate Past President	**Roger Gast**
Secretary	**Curtis Rainbolt**
WSSA Representative	**Pat Clay**
CAST Representative	**Phil Westra**
Member-At-Large Public Sector	**Brian Jenks**
Member-At-Large Private Sector	**Michael Hubbard**
Research Section Chair	**Ed Davis**
Research Section Chair-Elect	**Jane Mangold**
Education & Regulatory Section Chair	**Kirk Howatt**
Education & Regulatory Section Chair-Elect	**Sandra McDonald**
Constitution & Operating Procedures Representative	**Corey Ransom**

Webmaster & Web Editor	**David Krueger**
Student Liaison Chair	**Marcel Moretti**
Student Liaison Chair-Elect	**Carl Coburn**
Treasurer/Business Manager	**Phil Banks**

2015

PROCEEDINGS

OF

THE WESTERN SOCIETY OF WEED SCIENCE

VOLUME 68

PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 9-12, 2015

Hilton-Portland & Executive Tower
Portland, Oregon

PREFACE

The Proceedings contain the written abstracts of the papers and posters presented at the 2015 Western Society of Weed Science Annual Meeting plus summaries of the research discussion sections for each Project. The number located in parenthesis at 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 format editing.

This e-document is available at the WSWS website (www.wsweedscience.org) or from the WSWS Business Manager, 205 W. Boutz, Building 4, Suite 5, Las Cruces, NM 88005 (wsws@marathonag.com). Print copies may be ordered from Curran Associates (http://www.proceedings.com/agriculture-conference-proceedings.html) 866-964-0401.

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

Downy Brome Control: Soil Versus Foliar Activity of Imazapic and Tebuthiuron. Kallie C. Kessler*[1], Scott J. Nissen[2], T. Charles Hicks[2]; [1]Colorado State University, Fort Collins, CO, [2]Bayer Crop Sciences, Fort Collins, CO (006)

Imazapic and tebuthiuron control downy brome (*Bromus tectorum*) in rangeland environments through both soil and foliar activity; however, there is still debate surrounding the most efficacious application timing. Inconsistent control observed at different application timings may result from differences in bioavailability due to interception by surface litter and/or lack of timely precipitation. To quantify differences between application timings in the absence of these confounding effects, we conducted two replicated, completely randomized greenhouse dose response experiments at each application timing. Downy brome was planted into a field collected clay loam soil, followed by imazapic and tebuthiuron applications PRE or POST at eight doses between 0 and 210 g ai ha^{-1} and 0 and 1680 g ai ha^{-1}, respectively. Four weeks after treatment, aboveground biomass was collected and 50% growth reduction values (GR50) for each herbicide and timing were determined using log-logistic regression. GR50 (g ai ha^{-1} ± 95%) confidence intervals indicated no difference between application timing (imazapic; PRE 3 ± 1, POST 4 ± 2 and tebuthiuron; PRE 42 ± 8, POST 53 ± 41), but did indicate that imazapic and tebuthiuron significantly reduced downy brome biomass at 3% and 13% of the recommended field rates, respectively. These results further support the hypothesis that litter and precipitation can significantly impact field efficacy. Future research will focus on evaluating the effect of litter and precipitation on herbicide efficacy to better advise land managers on herbicide use.

Dalmatian Toadflax and Downy Brome Control on Native Colorado Rangeland. Jim Sebastian*[1], Derek J. Sebastian[2], George Beck[2], Scott J. Nissen[2]; [1]Colorado State University, Loveland, CO, [2]Colorado State University, Fort Collins, CO (007)

Dalmatian toadflax [*Linaria dalmatica* (L.) Mill., LINDA) is an invasive, perennial weed in Colorado and many other western states. Downy brome (*Bromus tectorum* L., BROTE) is an invasive winter annual weed that has invaded over 100 million acres and is a tremendous fire hazard in the western U.S. Both LINDA and BROTE are often present on similar rangeland, roadside, and disturbed sites along the Front Range of Colorado and compete with desirable native species for early spring moisture. Land managers have been faced with the problem of selectively controlling Dalmatian toadflax and other perennial invasive species with broadleaf herbicides. Subsequently downy brome invades and competes with native species recovering from Dalmatian toadflax competition. Indaziflam is a relatively new Bayer compound that is currently registered for annual weed control in turf, orchards, and noncrop. Indaziflam has excellent preemergence activity on many annual weed species. Past research conducted at CSU has demonstrated that indaziflam has excellent long term BROTE control with minimal injury to native perennial species. Imazapic is currently the standard herbicide used to control BROTE. Land managers have had mixed results controlling BROTE with imazapic in Colorado and elsewhere. Picloram and aminocylopyrachlor (MAT) provide good to excellent control of Dalmatian toadflax. The objective of this study was to determine if picloram or MAT tank mixed with indaziflam or imazapic effectively controls both Dalmatian toadflax and downy brome. This experiment was designed as a randomized complete block and treatments were replicated four times. Plot size was 10 by 30 feet. Herbicides were applied at two timings; on June 29, 2010 when LINDA was in the flower growth stage or on August 11, 2010 when LINDA displayed fall regrowth. BROTE had not emerged at either timing. All treatments were applied with a CO_2-pressurized backpack sprayer using 11002LP flat fan nozzles at 20 gal/A and 30 psi. Visual evaluations for control compared to non-treated plots were conducted in July of each year. All treatments with picloram or MAT sprayed alone controlled 87 to 100% of LINDA 1 year after treatment (YAT); however, LINDA controlled dropped to 40 to 68% by 4 YAT. Picloram or MAT tank mixed with indaziflam controlled 84 to 91% of LINDA 4 YAT. It appears that picloram or MAT controlled LINDA plants that were initially sprayed at this site. Indaziflam tank mixes increased residual control of LINDA that emerged from seed several years after treatments were sprayed. Imazapic sprayed alone or tank mixed with picloram provided good to excellent BROTE control (80 to 99%) 1 YAT; however, BROTE control dropped to 10 to 21% by 4 YAT. There was 5 to 22% BROTE control with picloram or MAT sprayed alone and 83 to 96% BROTE control 2 to 4 YAT when tank mixed with indaziflam. Control of both LINDA and BROTE dropped considerably 3 years after imazapic treatments were sprayed while there was good to excellent residual LINDA and BROTE control with indaziflam tank mixes (84 to 94% control) 4 years after treatment. Perennial native grass cover was 61 to 85% in picloram or MAT plots sprayed alone or tank mixed 2 to 4 YAT compared to 44 to 49% cover in untreated controls. This study will be repeated in 2015 in Colorado.

Comparing Indaziflam and Imazapic for Downy Brome and Feral Rye Control in Range and Pasture. Derek J. Sebastian*[1], Scott J. Nissen[1], Philip Westra[1], James R. Sebastian[1]; 1Colorado State University, Fort Collins, CO (008)

Downy brome (*Bromus tectorum* L.) and feral rye (*Secale cereale* L.) are invasive winter annual grass species that have rapidly spread throughout many regions of the US. Downy brome and feral rye infestations have resulted in decreased species diversity and productivity, increased soil erosion, and depleted soil moisture and nutrients. While glyphosate, imazapic, and rimsulfuron are commonly recommended for invasive annual grass control, these chemical control options have inconsistent performance, or have caused injury to desirable perennial species. The main objective of this research was to compare indaziflam annual grass efficacy to glyphosate, imazapic, and rimsulfuron, over three years. Four field experiments were conducted to evaluate the efficacy of indaziflam, a new pre-emergence herbicide, compared to these current herbicides being used for winter annual grass control. Indaziflam POST tank-mix treatments with glyphosate or rimsulfuron, provided better downy brome control across all three sites 2 and 3 yr after treatment (YAT), with an average of 89% downy brome control. Residual downy brome control with imazapic treatments dropped significantly 2 YAT (45-83%), and 3 YAT (10-52%). Indaziflam 8 MAT reduced feral rye dry weight biomass (93-98%), and increased perennial grass biomass eight-fold (2,292 to 2,927 kg·ha-1), compared to the untreated (311 kg·ha-1). In these studies, indaziflam provided increased residual downy brome control with a single application, compared to the currently recommended herbicides being used on rangeland. Indaziflam could enhance the competitiveness of remnant perennial plants by allowing these native plant communities to recover from winter annual grass invasions.

A Comprehensive Approach for Control of the Annual Grass Ventenata: An Analysis of Native and Invasive Populations. Fara A. Brummer*[1], Rene Sforza[2], Steve Novak[3], Massimo Cristofaro[4], Dorothy Macguire[3]; [1]North Dakota State University, Streeter, ND, [2]USDA-ARS, Montpelier, France, [3]Boise State University, Boise, ID, [4]BBCA, Sacrofano, Italy (009)

Abstract not available.

Buffelgrass Control with Imazapyr: Lessons from the Field. Travis M. Bean*[1], William B. McCloskey[2]; [1]University of California, Riverside, Riverside, CA, [2]University of Arizona, Tucson, AZ (010)

Imazapyr efficacy on buffelgrass was evaluated in the field at two sites. Treatments were applied using a calibrated CO_2 pressurized backpack sprayer. Imazapyr was applied at 0, 0.56, 1.12 and 1.68 kg ae/ha at two times of year on dormant plants (winter) or on green and actively growing plants (summer). On steep slopes at Pusch Ridge, the number of green buffelgrass tillers and estimated greenness showed that the 0.56 kg ae ha^{-1} rate killed plants treated in the winter (18 MAT) but some plants survived the summer application (24 MAT) although they had few live tillers compared to the untreated plants. At the 1.12 and 1.68 kg ae ha^{-1} imazapyr rates, all plants were killed regardless of when they were sprayed. At the Robles Junction site, buffelgrass live tiller numbers and greenness declined compared to the untreated plants but the differences were not statistically significant.

Selective Control of Buckhorn Plantain in Pasture. Ralph E. Whitesides*[1], Allan Sulser[2], Corey V. Ransom[1]; [1]Utah State University, Logan, UT, [2]Utah State University, Heber City, UT (011)

Buckhorn plantain (*Plantago lanceolata*) is a weed with increasing significance in Utah pastures and cropland. Buckhorn plantain competes for soil nutrients, water, and light and out-competes desirable plant species. Experiments were conducted during 2011 and 2012 on a 12 acre pasture in Wasatch County, Utah that was heavily infested with buckhorn plantain. Plot size for 2011 was 50’ x 425’ with three replications. Plots in 2012 were 10’ x 30’ with four replications. Each year the plot design was a randomized complete block. Density of buckhorn plantain was measured by randomly tossing a quarter square yard quadrat, ten times (2011) or three times (2012) in each plot, and completing weed density counts. Counts were repeated on 24 to 33 day intervals each year. Herbicide treatments were applied on May 4, 2011 and May 14, 2012. Treatments in 2011 were triclopyr (as Garlon 3A at 2 pt/A + NIS 0.25% v/v), chlorsulfuron (as Telar XP at 0.5 oz/A + NIS 0.25% v/v), metsulfuron (as Escort XP at 0.5 oz/A + NIS 0.25% v/v), 2,4-D amine + dicamba (as

Weedmaster at 4 pt/A), and 2,4-D amine (as Weedar 64 at 4 pt/A). Treatments in 2012 were chlorsulfuron (as Telar XP at 1.0 oz/A + 0.25% NIS v/v), metsulfuron (as Escort XP at 1.0 oz/A + NIS 0.25% v/v), 2,4-D amine (as Weedar 64 at 4 pt/A + NIS 0.25% v/v), dicamba (as Banvel at 1 qt/A + NIS 0.25% v/v), chlorsulfuron 1.0 oz/A + dicamba 8.0 oz/A + NIS 0.25% v/v, metsulfuron 1.0 oz/A + dicamba 8.0 oz/A + NIS 0.25% v/v, chlorsulfuron 1.0 oz/A + 2,4-D amine 4 pt/A + NIS 0.25% v/v, and metsulfuron 1.0 oz/A + 2,4-D amine 4 pt/A + NIS 0.25% v/v.

No significant symptoms were observed on pasture grasses in this study. Treatments with chlorsulfuron and metsulfuron caused some short-term chlorosis on grasses. Visual ratings and stand counts showed 2,4-D amine, and metsulfuron to be most effective in controlling buckhorn plantain in 2011. Control was 87 and 90% respectively 68 DAT. Metsulfuron (85%), and metsulfuron mixtures with 2,4-D (84%) or dicamba (82%) were most effective in 2012 evaluated 59 DAT. Significant reductions in weed populations were not always observed when evaluations were made 35 or 36 DAT regardless of year. Buckhorn plantain counts in treated plots 92 or 99 DAT had increased, indicating a decline in control, when compared to plant counts made 59 or 68 DAT. Further study should include herbicides from this trial and different seasonal application timings.

Control of Common Bugloss in Non-Crop Areas. Ian C. Burke*, Louise H. Lorent; Washington State University, Pullman, WA (012)

Common bugloss (*Anchusa officinalis* L.) is an invasive plant species posing a threat to pastures and other natural areas in the Pacific Northwest. Common bugloss distribution is currently limited but its invasive characteristics led several government entities to list it as a noxious weed. A perennial with a deep taproot and pubescent leaves, common bugloss can be challenging to control with herbicides. Two studies were established near Spokane Valley, WA in the summer of 2013 and the spring of 2014 to evaluate the efficacy of several herbicides on common bugloss. Treatments (rates in g ai ha^{-1}) included 2,4-D (1120), glyphosate (770), chlorsulfuron (26.3), chlorsulfuron (56) plus aminocyclopyrachlor (22.4), aminopyralid (208), aminopyralid (208) plus metsulfuron (4.2), clopyralid (240), triclopyr (2880), clopyralid (120) plus triclopyr (424) and dicamba (845). Treatments were applied post-emergence on common bugloss at the budding stage in the summer of 2013 for the first study and at the rosette stage in the spring of 2014 for the second study. Common bugloss control was evaluated 13 days after treatment (DAT), 21 DAT, 138 DAT and 383 DAT in the study established in 2013, and 16 DAT and 55 DAT for the study established in 2014. Glyphosate provided the highest level of control up until 21 DAT in 2013. In 2013, at 138 DAT, common bugloss control was >90% for 2,4-D, aminocyclopyrachlor plus chlorsulfuron, and triclopyr. Only 2,4-D controlled >90% of common bugloss at 383 DAT. In the second study, established in 2014, glyphosate provided the highest control (48%) of bugloss at 16 DAT but was the least efficacious herbicide treatment (<29% control) at 55 DAT. Chlorsulfuron, 2,4-D, and aminocyclopyrachlor plus chlorsulfuron were effective for common bugloss control, control was >95% 55 DAT. Economic considerations might favor the use of 2,4-D, above other herbicides, for long-term control of common bugloss.

Control of Western Juniper with Herbicides 18 Months After Application in Sagebrush Community. Sasha Twelker*[1], Gustavo M. Sbatella[2]; [1]Oregon Department of Agriculture, Madras, OR, [2]University of Wyoming, Powell, WY (013)

The early control of Western Juniper encroaching sagebrush communities is critical to minimizing the negative effects on the plant community. Studies were initiated in spring of 2013, near Prineville, OR to determine if herbicides can be used to effectively control Western Juniper. Individual plots consisted of ten trees with heights ranging from 0 to 7 feet. Herbicide injury was estimated based on a scale from 0 (no injury) to 99 % (dead foliage) and treatments were evaluated 3, 12 and 18 months after application (MAA). In a first study the active ingredients picloram, fluroxypyr, aminocyclopyrachlor, metsulfuron, triclopyr, imazapyr, and glyphosate were tested with a foliar application. Western juniper injury 18 MAA, with picloram alone or mixed with fluroxypyr averaged 99%, meanwhile injury with glyphosate, tanked mixed with imazapyr was 98%. Lower levels of injury were observed on trees treated with aminocyclopyrachlor combined with metsulfuron (45%) or with tryclopyr (71%). In the second study picloram, hexazinone, aminocyclopyrachlor and triclopyr were tested with spot and basal bark as applications methods. The highest foliage injury recorded 18 MAA were with picloram applied either as spot treatment (99%) or as basal bark (98%), and spot application of hexazinone (94%). Injury with aminocyclopyrachlor plus triclopyr applied as a basal bark treatment was 70%. The high levels of injury observed with many of the tested treatments 18 MAA, suggest that death of the Western juniper trees will occur as result of the herbicide activity. Nevertheless, treatments will be continued to be monitor and evaluated in order to detected new foliar growth and confirm tree death.

Enhancing the Netmap Weed Mapping and Collector App Experience with ARCGIS.COM. Larry W. Lass*, Timothy S. Prather; University of Idaho, Moscow, ID (014)

The spatial information cloud for mapping weeds is accessible with your desktop or mobile computer and android and Iphone devices. It is a collaborative, cloud-based platform that allows you to use, create, and share weed maps. The cloud has been enhanced to show sites susceptible to the major weeds found in the Inter-mountain Northwest (CO, ID, MT, NV, OR, UT, WA & WY). Data are accessible with Android and Iphone/Ipad devices using the Collector app with or without cellar phone service. ESRI Collector app is free via the App Store for your mobile device. Other devices may access data with a web browser or Arc-Info compatible product. Cloud mapping is simple to use.

You are in control of your maps on the ArcGIS.com cloud. Base maps showing weeds and site susceptibility models are easy to modify to fit your needs and saved to your private folder. Use the new map for yourself or publish your map for specific crew members to see. You may choose to allow some or all users to see and use your new map. Link map directly to your website so others can see your weed map or add new data. The cloud is flexible and ready to use. Need a FREE account? Contact Larry Lass at llass@uidaho.edu.

Mapping Invasive Plants Using a Helmet Based Video System. Corey V. Ransom*, Heather E. Olsen; Utah State University, Logan, UT (015)

Conducting invasive plant inventories is a critical component of an integrated approach to invasive plant management. Inventory data often provides the information necessary to evaluate the extent of weed invasion allowing land managers to prioritize management efforts. Invasive plant inventory data is expensive to collect. Aerial approaches to invasive plant mapping can be more efficient for highly visible species, but are limited to plants visible from the air. Recent advances in video technology allow collection of high definition video with compact, relatively inexpensive cameras. Research was conducted to compare two ground-based methods of weed mapping for infestation estimate accuracy and time required to conduct the inventories. The first inventory method involved mappers on foot inputting infestation data into a handheld GPS. The second approach utilized a person riding a mountain bike wearing two helmet mounted video cameras (GoPro Hero2, GoPro Inc.) and later using the video to generate inventory polygons on a desktop computer in the office. A GPS or smart phone was used to collect tracklog data to accompany the video footage. The helmet mounted cameras were placed facing forward and focused approximately 70 degrees apart to give wide perspective to the right and left of the rider. Five trails were mapped using both approaches in mid May 2014 while dyer's woad was in full bloom. Dyer's woad was selected as the target since its bright yellow flowers are easily distinguishable from surrounding green vegetation. The videos from both cameras were blended into a single video (Premiere CS6, Adobe) and then imported along with the corresponding tracklog into a software (VIRB Edit, Garmin Ltd.) that allows the video and the tracklog to play simultaneously. Using a second computer monitor, infestation shapes were drawn onto a GIS map (ArcPad 10, ESRI) as they were observed in the video and the location was identified on the corresponding map. The time spent mapping on the computer was recorded and was added to the time required to ride each trail section to determine total time required for mapping. Time required to stitch videos together or to sync tracklogs with the video was not included in calculations as the process could likely be automated in the future. Comparison of the two mapping methods included total time, total number of points, polygons, and lines, as well as total infested acres. Time efficiency as well as total infested acreage estimated varied widely between the two techniques. Time savings using the helmet mounted video approach ranged from 17 to 25% for a very steep trail and a small parcel to 60 to 73% for trails that were relatively flat to mostly downhill. The video mapping approach had lower estimates (70 to 83%) than the on-foot approach for 2 of the trails, but infestation estimate was almost 35% higher for another trail. Unfortunately there was no way to determine which method is more accurate since there was no actual infestation measurement for comparison. Future studies will need to include such a comparison. In some instances, both mapping methods identified small patches or single plants in the exact same location and in most cases, while infestation polygons differed in size, the location of plants and patches were similar between the methods. Many discrepancies were due to the method each mapper selected to represent any given infestation (individual patches vs. large polygons or line features). The video approach did allow fairly clear differentiation between dyer's woad and other yellow-flowered species which were in bloom. Newer video cameras offers even higher resolutions and video frame capture rates that could increase the ease of identifying specific species. Approaches to stabilize the camera during data collection are currently being investigated and have potential to improve video clarity. This research shows that helmet mounted video cameras can be used to map easily detected weed patches, with potential time savings compared to mapping on foot.

Project 2. Weeds of Horticultural Crops

Influence of Weed Species on Thrips and Iris Yellow Spot Virus in Onion. Andrew Swain*, Corey V. Ransom, Diane Alston, Claudia Nischwitz; Utah State University, Logan, UT (016)

Onion thrips (*Thrips tabaci*) and Iris Yellow Spot Virus (IYSV) form a pest-diseases complex that has in recent decades become of global concern for *Allium* producers. Numerous weed species have been documented as host plants for both onion thrips and IYSV. A study was conducted to explore the relationship between various weed species and pest incidence in onion. Onions were planted in 10 m^2 plots. Treatments were arranged in a randomized complete block design and consisted of 0.6 m borders of the following weed species surrounding each plot: common mallow, field bindweed, and prickly lettuce. Two additional treatments included borders of resident weed populations, one mowed half-way through the season. Plant samples of both onions and weeds were taken four times throughout the season. ELISA tests were used to test plant tissues for virus. Counts were used to ascertain thrips adult, larvae, and egg numbers. Thrips per gram on onions dipped mid-season but then rose at end of season. Among the single-species treatments, there were no significant differences in thrips numbers on onions. Thrips increased on onions with the resident weed mowed border compared to the unmowed border, suggesting thrips migration. The number of thrips per gram on weeds among the monoculture border treatments was highest in common mallow and bindweed and was highest at the last sampling date. Egg densities on onions declined between the first and second sample dates. Virus incidence was low but was detected in bindweed, lambsquarters, nightshade, and witchgrass.

Can the Application of Micronutrient Solutions Rescue Vegetable Crops from Glyphosate Injury? Lynn M. Sosnoskie*[1], Bradley D. Hanson[2], Bahar Yildiz Kutman[2]; [1]University of California - Davis, Davis, CA, [2]University of California Davis, Davis, CA (017)

California is an agriculturally diverse state; in 2012, more than 400 commodities were produced on 80,500 farms and ranches. The estimated value of California agriculture totaled $42.6 billion, and accounted for 11.3% of the national total in farm cash receipts. With respect to specialty crops, the state produces nearly half of all US-grown fruits, nuts, and vegetables, which contribute a total $24 billion to the California agricultural economy. The diversity of crops within the state suggests that different commodities are likely to be grown in close proximity to each other, which can result in significant economic losses in the event of a spray mis-application and off-target herbicide drift. Glyphosate, which is the predominant herbicide in perennial crops, can cause significant injury to trees, vines and annual crops and reduce yields under extreme circumstances. One current line of research in our lab is focused on the interactions between glyphosate and divalent metals; one area of interest is the potential for using foliar micronutrient fertilization to prevent or correct glyphosate drift injury.

Preliminary greenhouse projects were undertaken in 2014 to evaluate the use of commercially available foliar fertilizers (Smart Trio®, Smart Zn®, and Smart Mn®) following glyphosate applications to mitigate herbicide injury in tomato ('Halley Bos 3155') and melon ('Yosemite') transplants. Greenhouse-grown tomato (2-5 lf) and melon seedlings (2-3 lf) were treated with 0.001x, 0.01x, 0.1x solutions of glyphosate (where 1x = 1 lb ae/A) at a rate of 20 GPA using a cabinet sprayer. Foliar nutrient treatments (no nutrient treatment, Smart Trio® at 1 qt/A, Smart Trio® at 2 qt/A, Smart Trio® + Smart Zn® at 1 qt/A, and Smart Trio® + Smart Mn® at 1 qt/A) were applied at the first signs of injury on new leaf tissue (e.g. chlorosis) to simulate the observation and response a grower might make under field conditions. Plants were returned to the greenhouse and visually evaluated for 14 days after treatment (DAT) when all above-ground biomass was harvested and weighed. Untreated checks (no glyphosate and no foliar nutrients) were also included; previous studies indicated that tomato and melon growth in the greenhouse were not significantly stimulated by foliar applications Smart Trio®, Smart Zn®, and Smart Mn®, alone. All treatments were replicated five times.

Results showed that tomato and melon injury increased with increased glyphosate rate. Glyphosate at 0.001x, 0.01x, and 0.1x visually injured tomatoes and melons 0-5%, 5-15%, and 40-50%, respectively, at 7-14 DAT; symptoms included chlorosis, necrosis, leaf deformations, 'witches brooming', and shortened internodes. Despite the observed injury, glyphosate at rates of 0.001x and 0.01x often increased mean plant biomass, relative to the untreated check. Foliar micronutrients applied after simulated glyphosate drift did not provide any benefits and, in some instances, appeared to increase glyphosate injury (as determined by biomass accumulation). For example, averaged over both tomato trials, tomatoes treated with a 0.1x glyphosate solution followed by Smart Trio® at 1 qt/A, Smart Trio® at 2 qt/A, and Smart Trio® + Smart Zn® at 1 qt/A were up to 20% smaller than the plants treated with 0.1x glyphosate alone. Similarly, in the melon trial, plants treated with 0.001x or 0.01x glyphosate followed by Smart Trio® at 1 qt/A, Smart Trio® at 2 qt/A, and Smart Trio® + Smart Zn® at 1 qt/A were 15-47% smaller that plants that were treated with glyphosate only. Future greenhouse and field studies will evaluate the effect of pre- and post-glyphosate applications of elemental and commercial micronutrient fertilizer solutions on tomato and melon growth, phenology, and fruit yield.

Effects of Herbicides on Bermudagrass Growth. Cassandra Santos[1], Kai Umeda*[2]; [1]University of Arizona Cooperative Extension, Phoenix, AZ, [2]University of Arizona, Phoenix, AZ (018)

All of the sulfonylurea herbicides caused bermudagrass injury when the treatments caused a decrease for grass clipping weights for up to 2 weeks after application. Foramsulfuron at 0.026 lb a.i./A, sulfosulfuron at 0.094 lb a.i./A, and halosulfuron at 0.061 lb a.i./A showed bermudagrass recovering after the second week and grass clipping weights increased at the third and fourth weeks after application. Metsulfuron at 0.037 lb a.i./A, rimsulfuron at 0.031 lb a.i./A, both flazasulfuron treatments, and both trifloxysulfuron treatments showed a decreasing trend for grass clipping weights each week. These declining weights showed that the bermudagrass growth was still being affected even after 4 weeks. There was a rate response for trifloxysulfuron rates between 0.016 and 0.025 lb a.i./A. For 4 weeks, the average clipping weight of the higher rate of trifloxysulfuron was less than the lower rate. For the higher rate of trifloxysulfuron, the bermudagrass growth was stunted more than the lower rate. Flazasulfuron at 0.023 or 0.047 lb a.i./A did not show any significant difference for the effect on bermudagrass. Throughout the experiment, sulfosulfuron affected the bermudagrass growth the least. At 5 weeks after application, the bermudagrass treated by all the herbicides had recovered.

Mechanisms of Resistance to Glyphosate Present in Californian Junglerice Populations. Sarah Morran*[1], Marcelo L. Moretti[2], Bradley D. Hanson[2]; [1]The University of California, Davis, Davis, CA, [2]University of California Davis, Davis, CA (019)

Junglerice (*Echinochloa colona*) is a summer grass weed present in many cropping environments in California. The evolution of glyphosate resistant (GR) junglerice biotypes across the Central Valley agricultural area poses a new challenge for weed management in this region. Junglerice seed was collected from orchards and vineyards during 2010-2013 and the progeny were screened in a greenhouse dose response study. That work identified several GR populations present throughout the Central Valley. The current research aims to investigate the mechanisms of resistance in these populations. F_3 selfed single-seed lines were developed and rescreened in a controlled growth room environment. Leaf tissue was collected from the selfed seed lines for genomic DNA sequencing and the plants were sprayed with glyphosate doses ranging from 0 to 8700 g.ai.ha^{-1}. A region of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPs) gene from each line was sequenced to look for target site mutations (TSM) that may be conferring resistance to these plants. Three different single nucleotide changes at Proline 106; Pro106Leu, Pro106Thr and Pro106Ser, were identified amongst the lines. Interestingly, some lines with the same Proline106 substitution showed 2- to 3-fold differences in their LD50 values. However, when shikimic acid accumulation was measured, lines with the same Proline 106 substitution but different LD50 values accumulated shikimic acid at a similar level. This suggests that there may be more than one mechanism contributing to glyphosate resistance in some lines. The possible interaction of other resistance mechanisms contributing to the GR of these junglerice populations will be investigated in the future.

Assessing Weed Management Needs and Control Options in Arizona Nurseries. Worku Burayu, Kelly M. Young*; University of Arizona, Phoenix, AZ (020)

A survey was conducted in February 2014 to determine the most problematic weeds in Arizona nurseries and document current weed management practices. Based on the results of the survey, interviews and field visits, field studies were also conducted in May and June 2014 to evaluate various weed management options at two nursery production sites in Phoenix, Arizona. Survey results indicated that weed management is the biggest production challenge in Arizona nursery compared to other management issues. The most troublesome weed species in container nursery production identified by growers were *Chamaesyce prostrate* (prostrate spurge), *Cardamine hirsute (*bittercress), *Baccharis sarothroides* (desert broom), and *Taraxacum officinale* (dandelion), in that order. The management practices such as hand weeding; herbicides and mulches are the main tools growers use in the fight against weeds. Granular formulations of indaziflam at a rate of 0.0336 & 0.0448 lb. ai/A (Marengo G at a rate of 150 & 200 lb. /A); oxyfluorfen + prodiamine at 2 lb. and 0.75 lb. ai/A, respectively (Biathlon at 100 lb. /A); dimethenamid + pendimethalin at 1.125 lb. ai/A, and 1.50 lb. ai/A, respectively (FreeHand 1.75G at 150 lb. /A) were compared to a two-inch coarse wood mulch top dress and an untreated control. A randomized complete block design (RCBD) with four replications was used on each location. Data were analyzed using analysis of variance with transformed ranks and means separated using Tukey HSD, all pairs test (P = 0.05). In the field studies, the combination of dimethenamid + pendimethalin (FreeHand 1.75G) resulted in a weed free plots until eight weeks after treatment at both locations. Using two-inches thick coarse mulches had also similar control ability (>96% control) up to seven weeks after treatment. At termination of the experiment, 12 weeks after treatment, indaziflam (Marengo G) at both rates followed by combination of oxyfluorfen + prodiamine (Biathlon) resulted in 91% or better control of prostrate spurge. This was significantly different (P <0.05) from mulches and untreated control in the case of first experiment while it was not significantly different in the second experiment. Additional comprehensive study including more cost effective weed management options for the control of prostrate spurge is recommended.

Dormant Season Weed Control in Established Strawberry. Carl R. Libbey*, Timothy W. Miller; Washington State University, Mount Vernon, WA (021)

Herbicide combinations were evaluated for weed control in established strawberry near Mount Vernon, Washington in 2011 through 2014. Strawberry (cv. 'Totem') was planted in June, 2011 and 2012, and May 2013. Split blocks of these established strawberries were then treated with simazine in late fall 2011 and 2012 and the main plots were treated with sequential dormant-season herbicides applied over the winter; fall simazine was not applied in 2013. Visual crop injury and weed control were evaluated through the growing season. Mature berries were harvested 3 to 4 times and marketable berries were counted and weighed. In 2012 fomesafen + mesotrione resulted in >93% injury at the April rating. In 2013 all treatments, including the non-treated control, were showing about 11% injury at the May rating. In 2014, flumioxazin/pyroxasulfone + sulfentrazone and flumioxazin/pyroxasulfone + terbacil resulted in the highest injury at the April rating, 17 and 20% respectively. With the exception of mesotrione-treated strawberry, there was no visual foliar injury from any herbicide treatments at harvest in any year. Weed control was improved by 6% with the use of simazine prior to dormant applications in 2011 and 2012. The majority of improvement was due to enhanced common chickweed (*Stellaria media* (L.) Vill.) control in simazine-treated plots. By June 2012, only the higher rate of indaziflam (87% control), isoxaben alone and in combination with other herbicides (70-73%), and flumioxazin/pyroxasulfone with either sulfentrazone or napropamide (68-69%) were still providing weed control statistically equal to the non-treated strawberries (80%). At the June rating in 2013, only isoxaben + flumioxazin, the lower rate of terbacil, and fomesafen had less than 80% weed control. In 2014, weed control by April exceeded 85% with all treatments except fomesafen alone and saflufenacil + napropamide. By May of that year, however, there was no longer a difference in weed control among the treatments, which ranged from 78-93% control. Berry yield parameters were quite variable in 2012 and 2013. Strawberries treated with isoxaben + sulfentrazone or the lowest rate of indaziflam had higher yield than non-treated strawberries in 2012. In 2013, treatment with isoxaben alone or the lower rate of terbacil resulted in higher berry yield than the non-treated plants. Neither berry yield or fruit size differed among treatments in 2014. Fall-applied simazine applications did not significantly improve berry yield, although fruit size (g/berry) was increased compared to non-treated strawberry plants, from 13.5 to 14.8 g/berry in 2012 and 7.4 to 8.4 g/berry in 2013.

Irrigation and Residual Weed Control in Melons. Lynn M. Sosnoskie*[1], Bradley D. Hanson[2], Seth Watkins[1]; [1]University of California - Davis, Davis, CA, [2]University of California Davis, Davis, CA (022)

Successful weed management is vital for the production of quality melons. Weed control in melons is difficult due to the vining nature of the crop (which can prohibit mechanical cultivation) and the limited availability of safe and selective herbicides for the control of broadleaf species. In June 2013 and 2014, research trials were established at the University of California – Davis to evaluate the safety and efficacy of PRE herbicides in representative melon crops. Soil at the site is a fine, silty loam (Yolo series, 1.5-3% OM, pH 6.7-7.0). Cantaloupe (‘Oro Rico’ and either ‘Mercedes’ (2013) or ‘Yosemite’ (2014)) and honeydew (‘Saturno’) melons were included in the study. Melons were direct-seeded into raised beds that had been pre-irrigated prior to planting. Each individual melon plot was 30 feet in length and two rows in width. Rows were on 60 inch spacing; every other bed was planted, thus allowing for 120 inches between seed lines.

Pre-emergence herbicides were applied to the soil surface after planting but before crop emergence using a CO2-pressurized backpack sprayer calibrated to 20 GPA. Herbicide treatments included: Command (clomazone) at 0.5 pt/A, Curbit (ethalfluralin) and Strategy (clomazone + ethalfluralin) at 4 pt/A, Sandea (halosulfuron) at 1 oz/A, Dual Magnum (S-metolachlor) at 1.3 pt/A, and Zeus (sulfentrazone) at 3.2 oz/A. Herbicides were sprinkler incorporated with 0.5” irrigation water immediately following application. Each melon by herbicide treatment combination, as well as an untreated control, was replicated three times each year. Irrigation (furrow), fertilization and insect/disease management schedules followed guidelines developed by University of California Cooperative Extension.

The trials were dominated, both years, by a mixture of small seeded broadleaf species: common purslane (*Portulaca oleracea*), common lambsquarters (*Chenopodium album*), and pigweeds (a mixture of *Amaranthus blitoides* –prostrate pigweed and *A. retroflexus* – redroot pigweed. Weed cover in the 2013 trial was least in the Zeus, Dual Magnum, Strategy and Sandea treatments (1-4% weed cover), followed by Curbit (5-11% weed cover) and Command (5-18% weed cover); weed cover in the untreated check plots ranged from 50% and 80% 2-6 weeks after application (WAA). Weed control in the herbicide-treated plots at 2-6 WAA was reduced in 2014 when compared to 2013. This difference may have been due, in part, to an increase in the elapsed time between pre-plant pre-irrigation and herbicide application/activation. In 2013, PRE herbicides were applied no later than 72 hours after the field soil was pre-irrigated. In 2014, the herbicides were applied and activated up to 168 hours after the pre-plant, pre-irrigation event; by this time, many seedlings may have been at a developmental stage where they were less likely to be controlled by soil-applied products. 2015 studies will address how the (1) type, (2) amount, and (3) timing (relative to planting and herbicide activation) of pre-irrigation events affect herbicide performance in California melon production.

Results from previous trials indicated that melons can be injured by PRE applications of Dual Magnum, Sandea, and Zeus. In 2014, an additional study was undertaken to evaluate the effects of three proprietary soil adjuvants (hereafter referred to as ‘safener 1, 2 or 3’) designed to improve herbicide retention within the treatment zone, thereby minimizing the potential for crop injury. Dual Magnum (1.3 pt/A) was applied directly to the soil surface, alone, or in mixture with safeners 1, 2, or 3. Curbit at 4 pt/A (applied alone and used as a safety standard) and an untreated check were also included in the study. The trial was sprinkler irrigated, weekly, with 0.5-1” of water for up to eight weeks; overhead irrigation was utilized to facilitate movement of the herbicides into the seed line/seedling root zone and maximize crop injury. Mean melon plant biomass at eight WAA, was highest in the Curbit (585 g/plant), Dual Magnum + safener 3 (528 g/plant) and Dual Magnum + safener 1 (479 g/plant) treatments; plants receiving these treatments were larger than plants in the untreated check (379 g/plant), Dual Magnum applied alone (359 g/plant) and Dual Magnum + safener 2 (362 g/plant) treatments. Similar trends were observed with respect to the number of fruit set per plant. Based on the increase in Dual Magnum safety observed in 2014, additional studies will be conducted in 2015 to further evaluate the use of safeners with Dual Magnum, Sandea and Zeus on weed control, crop safety, and fruit yield in melon.

Establishment and Detection of the Field Bindweed Moth (Tyta luctuosa) in the Pacific Northwest. Jessica Green*, Ed Peachey, Carol Mallory-Smith, Rick A. Boydston[2]; [1]Oregon State Univeristy, Corvallis, OR, [2]USDA-ARS, Prosser, WA (023)

A field-based pheromone trapping program was implemented throughout Oregon and in Eastern Washington to assess the current range and status of the field bindweed moth, *Tyta luctuosa*. The moth has been suggested as a viable biological control agent (BCA) against field bindweed (*Convolvulus arvensis*) but not widely adopted to date. Paper wing traps, baited with a semiochemical lure, were placed at 22 locations where larvae had been released in years prior. Trapping began in late May and continued throughout September and traps were checked bi-weekly. A few additional sites were monitored as control points, where no intentional release of the BCA had been made. With the exception of a wildlife refuge, most releases were made in or near cropland. Specifically, we focused efforts on perennial crops such as small fruits, orchards, vineyards, and mint. Within the Willamette Valley, OR., adult male moths were recovered from 80% of locations where larvae had been previously released, indicating successful establishment. Seasonal activity of the bindweed moth was evident and encompassed the entire growing season of the target weed. The BCA exhibited activity patterns consistent with bivoltinism (2 generations per year), which has been reported in the insect’s native range. Trap catch data from one site were pooled across years and plotted against cumulative growing degree days. Detection of *Tyta luctuosa* in this region is one of less than five published accounts of establishment in the U.S. However, we propose that presumed failure of BCA success in other locales is more likely a reflection of less than optimal sampling measures (e.g. light traps), particularly because the bindweed moth is day-active.

Evaluating Impacts Of Herbicide Resistant GE Cropping Systems On Pollinator Habitat And Nutrition. Ramesh Sagili*, Ed Peachey, Sujaya Roa, Lisa Hooven; Oregon State University, Corvallis, OR (024)

Alfalfa is a perennial herbaceous legume and is the most important forage crop in the U.S. A number of bee-attractive weeds bloom during the production of forage alfalfa, harvested before bloom. Multiple herbicides are applied to Roundup Ready (RR) and conventional alfalfa before establishment, and glyphosate may be applied during the growing season on RR alfalfa. Repeated use of glyphosate can result in population shifts to weeds that are naturally tolerant to glyphosate, and apply selective pressure for resistant weeds. Loss of biodiversity in agricultural landscapes, including weed populations, negatively impacts the ecosystem services such as pollination that are vital for sustainable food production. In this study we are testing the hypothesis that shifts in weed populations due to glyphosate use in Roundup Ready alfalfa will alter the availability and nutritional quality of nectar and pollen resources, and reduce populations and species richness of wild and managed insect pollinators. Additionally, diminished floral resources may induce longer foraging flights, and lengthen the potential range of cross pollination between RR and non-RR alfalfa. Results from this study have the potential to enable stakeholders to manage alfalfa to maximize ecosystem services such as pollination, while minimizing ecosystem dis-services from weeds. This project also has the potential to generate significant new information that could assist regulatory agencies in making science-based decisions about the effects of introducing genetically engineered organisms in to the environment.

Project 3. Weeds of Agronomic Crops

Status of Herbicide Resistant Palmer Amaranth in Arizona - 2014. William B. McCloskey*; University of Arizona, Tucson, AZ (025)

Herbicide resistant Palmer amaranth was first discovered in Buckeye, AZ (western Maricopa Co.) in July of 2012. Greenhouse studies in 2012/2013 confirmed that this population was resistant to glyphosate and pyrithobac-sodium. Seed from several other locations in the Buckeye area were collected in 2013. In fall 2013, Palmer amaranth escapes from imazamox sprays in alfalfa fields were discovered in San Tan Valley (eastern Maricopa Co.) and seed were collected from two fields several miles apart (Gantzel and Hash Knife biotypes). Greenhouse experiments were conducted to compare suspected herbicide resistant seed with seed from a glyphosate susceptible population of Palmer amaranth collected in Sahuarita, AZ. Several seeds per pot were planted in an artificial soil mix in 10 cm pots in a greenhouse. After emergence, the plants were thinned, fertilized and irrigated as needed. Palmer amaranth plants were grown to the 4 to 6 (mostly 4) true leaf growth stage for experiments. Plants were sprayed using a CO_2 pressurized backpack sprayer equipped with a three nozzle (TeeJet XR8001VS) boom that delivered a carrier volume of 112 L/ha at 172 kPa at 4 km/h. Glyphosate, pyrithiobac-Na and imazamox formulations without added surfactant were used for the experiments. Spray solutions included a non-ionic surfactant (Activator 90) at 0.5% v/v and the glyphosate solutions also included ammonium sulfate at 1% w/w. After symptoms were expressed, shoots were harvested, oven dried at 60 C, and shoot dry weight was measured. Experiments showed that glyphosate resistant Palmer amaranth was present many miles from the field where glyphosate resistance was discovered in July 2012 in Buckeye and that the herbicide resistant Buckeye populations were also resistant to pyrithiobac-sodium and imazamox. The Gantzel and Hash Knife Palmer amaranth biotypes were more tolerant of imazamox than the susceptible Sahuarita biotype. Interestingly, the Gantzel and Hash Knife biotypes were susceptible to glyphosate. In July 2014, Palmer amaranth escapes following glyphosate applications were discovered in a Marana cotton field (Pima Co.). This field was treated with above label rates of glyphosate three times. Many plants were symptomless but others showed glyphosate symptoms. We were not able to collect seed from these plants before the grower removed them from the field. In summary, herbicide resistance genes in Palmer amaranth appear to be spreading across agricultural areas of Arizona as in other states despite Extension education efforts promoting sanitation, prevention of seed set and the use of residual herbicides.

Development of a Rapid In Vitro Dose Response Assay for Kochia. Dean Pettinga*, Philip Westra, Todd Gaines; Colorado State University, Fort Collins, CO (026)

The traditional herbicide dose response assay for *Kochia scoparia* requires greenhouse space for two to three months. This is both expensive and time-intensive. We investigated a rapid, efficient, and cost-effective herbicide dose response assay in which germinated seedlings were transplanted to ½ strength Murashige and Skoog medium dosed with dicamba concentrations ranging from 0 to 1000μM dicamba. Root growth was measured after two days. GR_{50} values for lines 7710 (dicamba susceptible) and 9425 (dicamba resistant) were identified at 0.5μM and 10.2μM, respectively. Results were compared to a traditional assay measuring change in shoot growth 2 weeks after treatment with dicamba sprayed at rates ranging from 0 to 14,000 g a.e. ha^{-1}. GR_{50} values for lines 7710 and 9425 were identified at 85 and 512 g a.e. ha^{-1}, respectively. We investigated whether GR_{50} values may be converted to a field rate (e.g., g a.i. ha^{-1}) through multiplication of a GR_{50} standard (from a greenhouse assay using a susceptible line) by the relative resistance level of a test line (compared to the same susceptible line) observed in the petri dish assay. We found that the new method reduces the time, space, and materials required for a dose response assay in comparison to a traditional biological assay conducted in the greenhouse.

Confirmation of Glyphosate-Resistant Kochia in Idaho and Oregon. Don Morishita[1], Joel Felix[2], Prashant Jha*[3], Vipan Kumar[3]; [1]University of Idaho, Kimberly, ID, [2]Oregon State University, Ontario, OR, [3]Montana State University, Huntley, MT (027)

Occurrence of herbicide-resistant kochia is an increasing concern for growers in the northwestern United States. Based on grower complaints of poor kochia control with repeated applications of glyphosate (at the recommended field-use rate) in glyphosate-resistant (GR) sugar beet in eastern

Oregon and southwestern Idaho in 2014, we collected and investigated putative GR kochia accessions from those sugar beet fields; three accessions from eastern Oregon (designated ALA, VAL, and DB) and one accession from western Idaho (designated WIL). The objective of this research was to confirm the level of resistance and investigate the molecular mechanism of resistance to glyphosate in the selected kochia accessions. On the basis of whole-plant dose-response assays, ALA, VAL and DB accessions from Oregon had I_{50} (dose needed for 50% control) R/S ratio (resistance index) of 2.1, 7.0, and 9.7, respectively, and the R/S ratio of WIL accession from Idaho was 4.7. For glyphosate resistance, 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS)* gene was analyzed for target-site mutations (PCR and sequencing) and relative increase in gene copy numbers through qPCR. No target-site mutations were detected at Pro_{106} of the *EPSPS* gene. All GR kochia accessions had ~ 3 to 8 copies of the *EPSPS* gene compared with a single *EPSPS* gene copy of a susceptible accession. This is the first confirmation of the evolution of glyphosate-resistant kochia in Idaho and Oregon. Because of lack of alternative, effective and economical herbicide options for kochia control in sugar beet, growers need to proactively manage the GR kochia seed bank with alternative effective modes of action herbicides in crops such as corn or wheat/barley grown in rotation with GR sugar beet, with the integration of tillage practices.

Variable Response of Kochia to Dicamba and Fluroxypyr in Montana. Prashant Jha*, Vipan Kumar, Shane Leland, Charlemagne Alexander Lim; Montana State University, Huntley, MT (028)

Recently, there has been an increase in grower complaints on poor kochia control with the auxinic herbicides in wheat/chemical fallow fields in Montana. We investigated three putative auxinic herbicide-resistant kochia accessions (referred as Chot-01, Chot-02, and Chot-03) collected from wheat fields in Choteau County, Montana, fall 2011. The susceptible accession (designated SUS) was collected from an organic wheat field in Montana. Inbred lines derived from field-collected accessions (after three generations of recurrent selection pressure) were used for the whole-plant dose-response experiments conducted in spring 2014. The objective of the research was to characterize the variable response of the three putative auxinic herbicide-resistant inbred lines of kochia to dicamba and fluroxypyr relative to the SUS inbred line. Dicamba dose-response study indicated that the three putative resistant accessions had R/S ratios of 1.3 to 6.2 based on visual control response (I_{50} values of 0.16 to 0.75), and R/S ratios of 1.5 to 5.9 based on shoot dry weight response (GR_{50} values of 0.18 to 0.71 kg ae ha^{-1}). Dose-response experiments with fluroxypyr determined I_{50} values of 0.04 to 0.17 kg ae ha^{-1} and GR_{50} values of 0.05 to 0.16 kg ae ha^{-1} for the three putative resistant accessions compared with the I_{50}/GR_{50} value of 0.03 for the SUS accession. The three accessions were 1.3 to 5.6 times more tolerant to fluroxypyr compared with the SUS accession. Furthermore, the selected accessions showed variable response to dicamba and fluroxypyr; Chot-01 was the most tolerant, and exhibited relatively less epinasty, stem curling/swelling, and chlorosis/necrosis compared with the Chot-02 and Chot-03 plants. Growers should diversify their weed management tools to manage further spread of auxinic or multiple herbicide-resistant kochia in the region.

Uptake, Translocation and Metabolism of Dicamba in Dicamba-Resistant Kochia from Kansas. Junjun Ou*[1], Phillip W. Stahlman[2], Mithila Jugulam[1]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Hays, KS (029)

Kochia (*Kochia scoparia*) is one of the most troublesome broadleaf weeds impacting agriculture in western regions of the United States and Canada. Dicamba-resistant in kochia is a major concern since dicamba is one of the most economical and efficient herbicide option available to control kochia, especially since the wide spread occurrence of glyphosate resistance in kochia. Kochia populations collected from Haskell County, KS were characterized and confirmed as dicamba-resistant. The objective of this study was to determine the mechanism of dicamba resistance in the Haskell County kochia population. Homogeneous lines of dicamba-resistant (R) and -susceptible (S) kochia were used in a dicamba dose-response study. Analysis of the dose-response data showed ED_{90} values of 5533 and 172 g·ae·ha^{-1}, respectively, for the R and S lines. ^{14}C dicamba uptake, translocation and metabolism experiments in temperature-, humidity- and photoperiod-controlled growth chambers were conducted using the same Haskell County R and S lines. When the R and S lines were at 6-8 cm tall, ^{14}C dicamba was applied (rate: 3.0 g·ae·L^{-1}; radioactivity: 20,000 dpm·µL^{-1}) on two fully expanded leaves of 4 to 6 plants (replicates). At 12, 24, 48, 72, 96 and 168 hours after treatment (HAT) the treated leaves (TL) were washed with 10% (v/v) ethanol solution with 0.5% (v/v) Tween-20. Subsequently, the TL, plant tissue above treated leaf (ATL) and below treated leaf (BTL) were harvested, dried and combusted to determine the amount of radioactivity. The experiments were repeated. There was no significant differences in uptake or translocation of dicamba between R and S lines after 24 HAT. Likewise, there was no difference in metabolism of dicamba between R and S lines at all the time-points tested. We conclude the mechanism of dicamba resistance in Haskell County, KS kochia population is not due to differences in uptake, translocation or metabolism of dicamba. Studies are in progress to explore other possible mechanisms involved in conferring dicamba resistance in this kochia population.

Effect of Growth Temperature on Dicamba and Glyphosate Efficacy in Kochia. Junjun Ou*, Mithila Jugulam; Kansas State University, Manhattan, KS (030)

Kochia (*Kochia scoparia*) is a major problem weed in Western United States and Canada. Dicamba and Glyphosate offer effective herbicide options to control kochia. Previous research showed the efficacy of dicamba and glyphosate varied under different environmental conditions, including plant growth temperature in several weeds. In this study, the effect of growth temperature on efficacy of dicamba and glyphosate in kochia was investigated. Dicamba- and glyphosate-susceptible kochia plants were grown in growth chambers maintained at different temperatures (day/night, °C): low (LT), 17.5/7.5; optimum (OT), 25.0/15.0; and high (HT), 32.5/22.5. When plants were at 8-10 cm tall, they were treated with 0, 1/32, 1/16, 1/8, 1/4, 1/2, 1X rates of dicamba (where X is 560 g·ae·ha^{-1}) or glyphosate (where X is 840 g·ae·ha^{-1}). Visual injury, fresh and dry biomass were recorded four weeks after treatment. Each treatment had 4-6 replications and experiments were done twice. Furthermore, dicamba and glyphosate uptake and translocation experiments were conducted using 6-8 cm tall kochia plants grown under the temperatures as mentioned above. Ten µL of dicamba (3.0 g·ae·L^{-1}) or glyphosate (4.5 g·ae·L^{-1}) containing 20,000 dpm·µL^{-1} ^{14}C radioactivity was applied on two newly matured leaves. At 24, 48 and 72 hours after treatment, the treated leaves (TL) were washed with 10% (v/v) ethanol solution with 0.5% (v/v) Tween-20. Subsequently, the TL, plant tissue above treated leaf (ATL) and below treated leaf (BTL) were harvested, dried and combusted to determine the amount of radioactivity. Results of dicamba dose-response on kochia showed ED_{50} of 49.5, 55.1, and 115.1 g·ae·ha^{-1}, at LT, OT and HT, respectively. Whereas, ED_{50} for glyphosate at LT, OT and HT were 39.3, 67.9, and 173.2 g·ae·ha^{-1}, respectively. Analysis of data of uptake and translocation studies indicate that the dicamba is more effective on kochia grown under LT or OT, possibly because of increased translocation compared to plants grown under HT. Similarly, glyphosate was also found more effective on kochia grown under LT than OT or HT. On the contrary, this increased efficacy of glyphosate under LT may be attributed to increased uptake of the herbicide rather than the translocation. In conclusion, to improve the efficacy of dicamba or glyphosate and achieve good control of kochia, these herbicides can be applied early in the season or when temperatures are cooler.

Survey of Multiple Herbicide-Resistant Kochia in Montana. Charlemagne Alexander A. Lim*, Prashant Jha, Vipan Kumar, Shane Leland; Montana State University, Huntley, MT (031)

Multiple herbicide-resistant kochia is an increasing concern for crop producers in the northern Great Plains of US, including Montana. In 2013, a random field survey was conducted across the northern region of Montana (7 Counties) to determine the distribution, frequency, and level of resistance of kochia populations to glyphosate, ALS-inhibitor herbicide, or dicamba. Seeds from fully-matured kochia plants were collected from chemical fallow-wheat fields, fence lines, field borders, and roadsides, with a total of 140 survey populations. Seeds were germinated, and seedlings were grown in germination trays filled with a commercial potting mix in a greenhouse located at the MSU Southern Agricultural Research Center near Huntley, MT. For the discriminating dose screening, 48 seedlings from each population were grown in three replicated trays (total of 144 seedlings), and treated with the field-use rate of glyphosate at 870 g ae ha^{-1}, dicamba at 280 g ae ha^{-1}, or thifensulfuron + tribenuron + metsulfuron premix at 18 g ai ha^{-1}, when kochia plants were 8- to 10-cm tall. Resistance frequency (percent survival in a population) was determined at 21 DAA. Whole-plant dose-response assays were conducted for glyphosate and ALS-inhibitor herbicide on populations with >70% survival frequency. For dicamba, populations with >20% survival frequency were used for the dose-response assay. Percent control was visually assessed at 7, 14, and 21 DAA, and shoot dry weight was determined at 21 DAA. Based on the dose-response assays, 11 populations were confirmed resistant to glyphosate. Almost 95% of the total survey populations were resistant to the ALS-inhibitor herbicide. All glyphosate-resistant populations from Hill, Toole, and Liberty Counties were highly resistant to the ALS-inhibitor herbicide. Three populations showed putative multiple resistance to glyphosate, dicamba, and ALS-inhibitor herbicide. The 11 confirmed populations exhibited low (3- to 5-fold) to high (8- to 16- fold) level of resistance to glyphosate. Majority of the confirmed populations exhibited high level (90- to 300- fold) of resistance to the ALS-inhibitor herbicide. Majority of the confirmed populations from Glacier, Toole, Hill, and Fergus Counties exhibited low level of tolerance (1.5- to 5-fold) to dicamba, except the Ch0-1 population from Chouteau County, MT, which was highly resistant (>15-fold). Kochia with low level of resistance to glyphosate was controlled by glyphosate applied at rates ≥3480 g ha^{-1}. Dicamba use rate should be at least 560 g ha^{-1} in fallow or in crop for kochia control.

Effects of Cultivar, Seed Size and Herbicide Placement on Dry Bean response to Flumioxazin. Rick A. Boydston*; USDA-ARS, Prosser, WA (032)

Dry beans (*Phaseolis vulgaris* L.) are often injured by preemergence application flumioxazin, a protoporphyrinogen oxidase inhibitor herbicide. Factors including bean market class and seed size, flumioxazin placement and application timing, soil moisture and temperature reportedly influence bean injury. Green house trials were conducted to determine the effect of seed size and flumioxazin placement depth on subsequent bean injury. The injury response of four market classes of dry beans (great northern, black, navy, and pinto) to flumioxazin applied preemergence at 54 g ha^{-1} to a silt loam soil were tested. Three cultivars differing in seed size within great northern and pinto market classes were included. Placement of flumioxazin at seed depth (4 cm) greatly increased bean injury for all market classes (66 to 83% injury) compared to applying flumioxazin to the soil surface after planting (13 to 55% injury). Within great northern market class, large-seeded cultivar 'GN10-7' and small-seeded cultivar 'GN10-9' were more susceptible to injury from both surface applied and seed depth placement of flumioxazin than 'Matterhorn' with intermediate sized seed. Within the pinto market class, larger-seeded 'Stampede' and smaller-seeded 'Medicine Hat' were more tolerant to flumioxazin than intermediate-sized pinto cultivar, 'PT11-34'. The two smallest seeded cultivars, navy bean 'Rexeter' and black bean 'Zoro' were among the most sensitive cultivars to flumioxazin applied to the soil surface. Results demonstrate that herbicide placement in relation to seeding depth plays a larger role than seed size in determining dry bean injury from flumioxazin. Seed size influence on bean sensitivity to flumioxazin was not consistent within market classes. Genetic diversity among cultivars within dry bean market classes appears to influence sensitivity to flumioxazin more than seed size.

Field Carryover of Pyroxsulam, Sulfosulfuron, and Florasulam to Lentil, Chickpea, Canola, and Barley in the Inland Pacific Northwest. Alan J. Raeder*[1], Joseph P. Yenish[2], Ian C. Burke[1]; [1]Washington State University, Pullman, WA, [2]Dow AgroSciences, Billings, MT (033)

Cases of herbicide carryover in the inland PNW are common and in the spring of 2010 and 2011, cases of pyroxsulam carryover causing injury to lentil were observed. At the time, pyroxsulam was a newly registered active ingredient, and is an ALS inhibitor and a triazolopyrimidine. The study objective was to evaluate carryover of pyroxsulam, sulfosulfuron, and florasulam to lentil, chickpea, canola, and barley. A study was established in the spring of 2011 near Oakesdale, WA (soil pH=5.8) and repeated in 2013 near Pullman, WA (soil pH=5.9). Treatments were applied in the spring to winter wheat and consisted of pyroxsulam at 18, 37, and 74 g ai ha^{-1}, florasulam at 5, 10, and 15 g ai ha^{-1} in a premix with fluroxypyr, florasulam alone at 2.5, 5, and 10 g ai ha^{-1}, or sulfosulfuron (as a positive check) at 35, 70, and 140 g ai ha^{-1}. At both locations lentil, chickpea, canola, and barley were planted into the study the following spring. No yield response was observed at either location, except when sulfosulfuron was applied at 140 g ai ha^{-1}, which injured barley. Plant injury from florasulam and pyroxsulam carryover was ≤10% and <5%, respectively, in all crops at both locations. Carryover injury to lentil of 15, 22 and 35% was observed when sulfosulfuron was applied at 35, 70, and 140 g ai ha^{-1}, respectively, and was not different than injury of 14 and 19% from pyroxsulam applied at 37 and 74 g ai ha^{-1}, respectively. Pyroxsulam carryover can injury lentil, but does not appear to injure chickpea, canola, or barley. However, it should be noted that potential carryover of pyroxsulam would increase as soil pH decreases.

Burndown of Tetraploid and Diploid Annual Ryegrass Varieties. Robert C. MacPherran*, Andrew G. Hulting, Carol A. Mallory-Smith, Daniel W. Curtis; Oregon State University, Corvallis, OR (034)

Annual ryegrass is beneficial as a cover crop in the corn-soybean cropping system of the Midwest because of its reduced seed cost and rapid establishment, and because it improves soil structure. However, the ability to terminate annual ryegrass is under question because of the perception that it may become a weed in the cropping system. An uncontrolled annual ryegrass cover crop can reduce crop yields through competition. Studies conducted at the Oregon State Hyslop Research Farm for two years investigated the efficacy of different herbicides to remove annual ryegrass as a winter cover crop. Two varieties of annual ryegrass, Bounty (diploid) and TAMTBO (tetraploid) were planted in two randomized complete block design experiments. Herbicides were applied in the spring when the first node was 2.5 cm above the soil surface. Clethodim provided the least reduction of biomass for the diploid and tetraploid varieties, 90% and 86%, respectively. Paraquat and clethodim tank mixed did not prevent regrowth, but resulted in the greatest reduction in biomass for both varieties at 96%. Glyphosate at 0.184, 0.229, and 0.367 kg/ha reduced biomass by at least 90% for both varieties. Tank mixed treatments using glyphosate with saflufenacil, rimsulfuron, or pyroxasulfone reduced biomass greater than 90% for both varieties. Annual ryegrass can be managed as a cover crop with glyphosate alone or when used in combination with other herbicides.

Italian Ryegrass Fatty Acid Biosynthesis in Response to Flufenacet and Pyroxasulfone. Suphannika Intanon[1], Andrew G. Hulting[2], Carol Mallory-Smith*[2]; [1]Postdoctoral Scholar, Corvallis, OR, [2]Oregon State University, Corvallis, OR (035)

Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) is one of the most troublesome weeds in winter wheat in the Pacific Northwest in part due to the number of resistant populations. The control of this weed species is based on the use of various herbicide modes of action including inhibitors of very long-chain fatty acid (VLCFA) biosynthesis. Flufenacet and pyroxasulfone were evaluated for their inhibitory effects on the germination and growth of Italian ryegrass and on fatty acid biosynthesis. An Italian ryegrass population with confirmed resistance to flufenacet (R) and a wild type (S) population were included in this study. In the germination study, GR50 values for the R population was 51-fold greater for flufenacet than for the S population, while GR50 values for pyroxasulfone were not different between R and S populations. In germinated seedlings after application of either flufenacet or pyroxasulfone, the growth was reduced more in roots than shoots with increase herbicide concentrations. In a study of fatty acid biosynthesis using UHPLC/MS, the profiles of R and S populations were different for flufenacet. In the R population, flufenacet likely inhibited the desaturation of C18:2. The inhibition site of pyroxasulfone was not elucidated in this study. The composition of the fatty acids present in the S population after treatment with flufenacet and pyroxasulfone was different. Therefore, it is possible that flufenacet and pyroxasulfone do not have the same site of action.

Greenhouse Studies Quantifying Crop Safety of ALS Tank Mixes on 2-Gene Clearfield Wheats. Andrew D. Leggett*, Michael Flowers, Andrew G. Hulting, Carol Mallory-Smith; Oregon State University, Corvallis, OR (036)

Abstract not available.

Pyroxsulam Resistance in Shepherd's-Purse. Rachel J. Lindell*, Louise H. Lorent, Ian C. Burke; Washington State University, Pullman, WA (037)

Shepherd's-purse (*Capsella bursa-pastoris* (L.) Medik) is an annual broadleaf weed commonly found in the Pacific Northwest. A population of shepherd's-purse near Genesee, Idaho survived a commercial application of pyroxsulam at 18.4 g ai ha^{-1} with an nonionic surfactant at 0.5% v v^{-1}. Seeds from the suspected pyroxsulam resistant shepherd's-purse population were collected from the site and screened using pyroxsulam (18.4 g ai ha^{-1}) with an nonionic surfactant (0.5 % v v^{-1}), florasulam (4.9 g ai ha^{-1}), florasulam plus MCPA (4.9 g ai ha^{-1}; 350 g ai ha^{-1}), MCPA ester (350 g ai ha^{-1}), and 2,4-D amine (530 g ai ha^{-1}) to test for resistance. Florasulam plus MCPA, MCPA ester, and 2,4-D amine controlled >80% of the resistant shepherd's-purse population. However, no control was observed with pyroxsulam and florasulam 24 DAT. A whole-plant dose response was used to quantify the LD_{50} for the resistant populations and for a known susceptible population. Pyroxsulam rates used were 0, 18.4, 36.8, 73.6, 147, 294, and 590 g ai ha^{-1} and above ground biomass was recorded 14 DAT. Results were analyzed using a four parameter log-logistic model to determine LD_{50} values. The resistant biotypes (LD_{50} 69 g ai ha^{-1}) were 2296 times more resistant to pyroxsulam than the susceptible biotypes (LD_{50} 0.03 g ai ha^{-1}). Results confirm that pyroxsulam resistant shepherd's-purse is present in the Pacific Northwest, however the commonality of the resistant biotype is unknown. Further studies could identify the distribution of resistant shepherd's-purse populations in the Pacific Northwest.

Windrow Burning Eliminates Italian Ryegrass Seed Germination. John F. Spring*, Drew J. Lyon; Washington State University, Pullman, WA (038)

Widespread resistance of Italian ryegrass (*Lolium multiflorum* L.) to ACCase- and AHAS-inhibiting herbicides poses a major management challenge in small grain production systems of the Palouse region of Washington State, particularly under conservation tillage. Harvest Weed Seed Control, where weed seed passing through combines at crop harvest is collected and destroyed, is a potential management response to herbicide resistance. The efficacy of narrow windrow burning for Harvest Weed Seed Control of Italian ryegrass was tested and compared to whole field stubble burning in field trials near Pullman, WA in 2013 and 2014. Trials were conducted in wheat stubble with no naturally occurring Italian ryegrass at harvest in a randomized complete block design with 4 replicates and plot size of 25 by 100 feet. Treatments consisted of: i. non-burned control; ii. burning of spread harvest residues and standing stubble (whole plot); and iii. burning of harvest residues concentrated into a narrow windrow, leaving remainder of plot unburned. Known quantities of Italian ryegrass seed were placed on the surface of soil-filled aluminum foil baking pans, buried to grade in plots, and covered with representative crop residue prior to burning. After burning, pans were removed to greenhouse for exhaustive germination of seeds. Temperature at the soil surface under narrow windrows exceeded 200°C (392°F) for sustained intervals of over 8 minutes during burning, while temperatures in whole plot burns exceeded 200°C for sustained intervals of only 30-40 seconds. Narrow windrow burning effectively eliminated Italian ryegrass germination (giving over 98% reduction relative to non-burned control) and likely presents a viable option for Harvest Weed Seed Control of naturally occuring Italian ryegrass populations. Whole plot burning reduced germination 27% relative to non-burned control – inadequate for use as a management tool. Burning treatments both retained roughly 60% by weight of total unburned crop residue levels in the long term no-till system (approximately 5000lb/ac and 8800lb/ac, respectively).

Wheat Response and Italian Ryegrass Control with Pyroxasulfone Plus Carfentrazone. Traci Rauch*, Joan Campbell; University of Idaho, Moscow, ID (039)

Italian ryegrass is an important grass weed in wheat cropping systems in the Pacific Northwest; and biotypes resistant to group 1 (ACCase) and group 2 (ALS) herbicides are widespread with few control options available. Pyroxasulfone is a new active ingredient that is registered in winter and spring wheat to control grass weeds. It is a group 15 herbicide that inhibits very long chain fatty acid synthesis. Studies were conducted in 2014 to evaluate winter and spring wheat tolerance and Italian ryegrass control with pyroxasulfone/carfentrazone. The experimental design in all studies was a randomized complete block with four replications. Pyroxasulfone/carfentrazone was applied alone preplant and postplant preemergence; tank mixed with sulfentrazone, pyroxsulam or pyroxsulam/ fluroxypyr/ florasulam; or with sequential application of pyroxsulam or pyroxsulam/ fluroxypyr/ florasulam and pyrasulfotole/bromoxynil plus MCPA. Pyroxasulfone/ carfentrazone treatments were compared to flucarbazone combined with pyroxsulam or pyroxsulam/ fluroxypyr/florasulam treatments as the standard. Italian ryegrass control and wheat response were evaluated visually where 0% represented no control or injury and 100% represented complete weed control or crop death. Pyroxasulfone/carfentrazone preplant and postplant preemergence treatments injured winter wheat 5 to 16%. Italian ryegrass control was 90 to 94% with all preplant and postplant preemergence treatments. Pyroxasulfone/carfentrazone preplant and pyroxasulfone/carfentrazone + pyroxsulam/ fluroxypyr/florasulam treatments injured spring wheat 5 to 12% on June 4. By July 14, only flucarbazone + pyroxsulam/fluroxypyr/florasulam caused wheat injury (14%). On June 5, pyroxasulfone/carfentrazone preplant alone or in combination controlled Italian ryegrass 84 to 94%, while pyroxasulfone/carfentrazone applied postplant preemergence or postemergence with pyroxsulam/fluroxypyr/florasulam controlled Italian ryegrass 71 to 89%. By July 14, pyroxsulam/fluroxypyr/florasulam combined with flucarbazone or pyroxasulfone/carfentrazone preplant suppressed Italian ryegrass 70 and 71%, respectively. Italian ryegrass control with all other treatments was less than 70%. Spring wheat yield for postplant preemergence pyroxasulfone/carfentrazone treatments did not differ from the untreated check but spring wheat yield was 33 to 40% greater in all pyroxasulfone/carfentrazone preplant treatments compared to the check. Wheat test weight did not differ between treatments including the untreated check.

Influence of Pyroxasulfone Rate and Application Timing on Downy Brome Control in Clearfield Winter Wheat. Charlemagne Alexander A. Lim*, Prashant Jha, Vipan Kumar, Shane Leland; Montana State University, Huntley, MT (040)

Pyroxasulfone is a relatively new herbicide for PRE residual weed control in wheat. Field experiments were conducted in 2013 and 2014 at the Southern Agricultural Research Center near Huntley, Montana, to determine the effect of pyroxasulfone rate and application timing on downy brome control in Clearfield winter wheat in comparison to standard herbicide programs. Pyroxasulfone (74 and 148 g ai ha^{-1}) was applied immediately after planting (PRE) or delayed PRE (DPRE; after 80% of the wheat seed germinated, with 0.5 inch of shoot growth) in the fall with or without a follow-up spring POST application of either imazamox (44 g ai ha^{-1}) or pyroxsulam (18.37 g ai ha^{-1}). Standard programs included DPRE propoxycarbazone-sodium (29.4 g ai ha^{-1}) only or followed by imazamox (44 g ai ha^{-1}) POST, imazamox (44 g ai ha^{-1}) POST only, and pyroxsulam (18.37 g ha^{-1}) POST only. Data on percent visual control and crop injury were recorded at 7, 21, and 56 DAA. Wheat yield was recorded at harvest. Pyroxasulfone when applied PRE at 74 or 148 g ha^{-1} rate provided >90% end-season control of downy brome compared with 32 to 69% control when applied DPRE; however, the PRE application caused 5 to 15% injury to wheat 56 DAA. There was no additional benefit of a follow-up POST application of pyroxsulam or imazamox compared with the pyroxasulfone PRE or propoxycarbazone DPRE only program for downy brome control. Nevertheless, the follow-up POST herbicide program in the spring was needed to improve downy brome control (88 to 95% at 56 DAA) with pyroxasulfone applied DPRE in the previous fall. Downy brome control with imazamox POST was superior (90%) to pyroxsulam POST (82%). Consistent with weed control, winter wheat yield with pyroxasulfone alone was higher when applied PRE in comparison to DPRE. A follow-up POST application of pyroxsulam or imazamox in the spring was needed to prevent wheat yield reductions with pyroxasulfone (at either rate) applied DPRE. In conclusion, pyroxasulfone applied PRE although caused some injury to wheat, it did not affect wheat yield, and provided excellent season-long residual control of downy brome in winter wheat.

Preemergence Weed Control Alternatives in Barley. Brian M. Jenks*; North Dakota State University, Minot, ND (041)

Some green foxtail populations across North Dakota are known to be resistant to Group 1 herbicides like fenoxaprop, clodinafop, and pinoxaden. The objective of the study was to evaluate barley tolerance to soil-applied preemergence herbicides for foxtail control. This study was conducted in 2012 and 2014. All treatments were applied preemergence (after barley was planted). In 2012, metolachlor, flucarbazone, and flumioxazin caused early moderate crop injury; however, the crop generally recovered by mid-July. Pyroxasulfone, acetochlor (microencapsulated), and pendimethalin caused minimal crop injury in 2012. In contrast, pyroxasulfone and acetochlor caused slight to moderate crop injury in 2014. Flumoxazin and pendimethalin caused only slight crop injury in 2014. Flumioxazin caused moderate crop injury both years. Metolachlor and dimethenamid caused severe injury in 2014. Despite crop injury in 2012, there was minimal effect on crop yield. In 2014, only metolachlor and dimethenamid reduced barley yield.

How Adjuvants Affect Glufosinate. Jason W. Adams*[1], Richard K. Zollinger[2]; [1]North Dakota State University, FARGO, ND, [2]NDSU, Fargo, ND (042)

Efficacy of many herbicides can be enhanced using various adjuvants. Glufosinate efficacy was evaluated at 22 fl oz A^{-1} alone and in combination with several adjuvants on flax (*Linum usitatissimum* L.), amaranth (*Amaranthus cruentus* L.), quinoa (*Chenopodium quinoa* Willd.), and tame buckwheat (*Fagopyrum esculentum* Moench). Adjuvants included diammonium sulfate (AMS), non-ionic surfactant (NIS), petroleum oil (PO or "crop oil concentrate"), methylated seed oil (MSO), and high surfactant methylated oil concentrate (HSMOC). Each adjuvant was applied with glufosinate alone and in combination with AMS. Treatments were arranged in a randomized complete block design with three replicates. Treatments were applied to plants at the 6 to 12 in stage and visible injury evaluated 14 and 28 DAT on each of the four species. Glufosinate alone averaged 49% control across all species. Efficacy was enhanced the most with the addition of AMS alone and in combination with a HSMOC, which both averaged 79% control. The addition of MSO did not increase efficacy compared to glufosinate alone. Glufosinate combined with NIS and PO had slightly higher control at 68 and 58%, respectively. The addition of AMS to other adjuvants increased efficacy, except when combined with MSO. AMS was the single largest contributor to increased efficacy. This is likely due to increased ammonia toxicity in plant cells. Surfactant load in adjuvants also trended to increase efficacy.

Exploring the Potential of Clomazone for Weed Control in Sugarbeets. Gustavo M. Sbatella*[1], Andrew R. Kniss[2], Lori Howlett[3], Robert G. Wilson[3]; [1]University of Wyoming, Powell, WY, [2]University of Wyoming, Laramie, WY, [3]University of Nebraska, Scottsbluff, NE (043)

In the summer of 2014, three field studies were conducted in Nebraska and Wyoming to evaluate the potential use of clomazone applied 7 days before planting (DBP) or at planting (AP) for weed control in sugarbeet. High levels of crop injury were recorded 30 days after planting (DAP), particularly when clomazone was applied AP. The crop recovered from the early herbicide injury and low levels of crop injury were recorded 50 DAP. Further, sugarbeet root yields were not affected by this early crop injury. Nevertheless, commercially acceptable levels of crop injury were recorded with rates of 3 to 6 oz. /A which only provided 35 to 63% weed control. The alternative of tank mixing clomazone with other active ingredients to increase weed control should be explored in the future.

Tolerance of Popcorn, Sweet Corn and Field Corn Inbreds to Preemergence and Postemergence Bicyclopyrone Containing Herbicide Applications. Peter C. Forster*[1], Thomas H. Beckett[2], Ryan D. Lins[3], Timothy L. Trower[4], Gordon Vail[5]; [1]Syngenta Crop Protection, Eaton, CO, [2]Syngenta Crop Protection, Greensboro, NC, [3]Syngenta, Byron, MN, [4]Syngenta Crop Protection, Baraboo, WI, [5]Syngenta, Greensboro, NC (044)

Acuron is a new selective herbicide under development by Syngenta with anticipated registration allowing first sales in the 2015 growing season. Acuron contains four active ingredients with three modes of action and is formulated with liquid capsule suspension (ZC) technology. Acuron will have a wide window of application including pre-plant, pre-emergence and post-emergence (up to 12" corn) and will provide broad-spectrum residual control of annual grass and broadleaf weeds in field corn, silage corn, and seed corn. It will be registered for pre-emergence use only in sweet corn and yellow popcorn.

Multiple field trials were conducted across the corn growing regions of the US to determine crop safety of field corn inbreds, sweet corn, and popcorn to pre-emergence and post-emergence applications of Acuron at 2890 and 5780 g ai/ha and compare crop tolerance to Lumax EZ at 3340 g ai/ha and 6680 g ai/ha rates. Results from these studies showed field corn inbred, sweet corn hybrid, and popcorn tolerance to Acuron were equal to or better than Lumax EZ.

Tree Nut Weed Control from Penoxsulam + Oxyfluorfen Tank Mixtures. Deborah G. Shatley*[1], Byron B. Sleugh[2], Alistair H. McKay[3], James P. Mueller[4], Richard K. Mann[5]; [1]Dow AgroSciences, Lincoln, CA, [2]Dow AgroSciences, Fresno, CA, [3]Dow AgroSciences, Clovis, CA, [4]Dow AgroSciences, Clayton, CA, [5]Dow AgroSciences, Indianapolis, IN (045)

Abstract not available.

Observations from Early Unmanned Aerial Systems (UAS) Operations in Cropland. Mike H. Ostlie*; North Dakota State University, Carrington, ND (046)

In 2014, North Dakota was chosen as a test site for the integration of unmanned aerial vehicles (UAVs) into civilian airspace. During this process, agricultural research trials were flown for data collection at the North Dakota State University – Carrington Research Extension Center. The primary goal of this research was to determine the accuracy of an aerial-mounted platform compared to more typical ground-based data collection methods. Normalized Difference Vegetation Index (NDVI) was the primary factor being evaluated from the UAV images that were collected. Trials were typically flown and ground-proofed within 24 hours. ArcGIS was used for georeferencing the maps and for identifying plots and calculating a mean NDVI value in a selected area. Nitrogen deficiency was detected with similar precision with both ground (Greenseeker sensor) and aerial platforms. The values differed between the two data collection systems, but the differences between treatments were similar. NDVI was successfully used to predict the date of soybean physiological maturity within a soybean variety trial. When measuring weed control, neither the Greenseeker sensor nor aerial image resulted in data with a strong correlation to visual weed control ratings. However, when NDVI values were limited to between the crop rows, there was a strong correlation between aerial-based NDVI and visual weed control. UAV imagery was also used to locate patches of Canada thistle in wheat stubble, where it could be georeferenced and would allow for the precise spot-treatment of herbicides. Aerial images were also used to map weed distribution in a sunflower field before harvest.

Project 4. Teaching and Technology Transfer

Posters were not submitted to this section in 2015.

Project 5. Basic Biology and Ecology

Salinity Responses of Three Invasive Lepidium Species. Triston N. Hooks*; New Mexico State University, Las Cruces, NM (047)

Weedy and invasive plants can displace native plant species, reduce biodiversity, and hinder crop yields. Edaphic factors, such as salinity, may influence the invasive potential of certain weedy plant species. We hypothesize that *Lepidium* spp. may play an important role in salinity-related vegetative community changes in semiarid landscapes. We are testing this hypothesis by evaluating the salinity responses of three invasive *Lepidium* species, *L. alyssoides*, *L. draba*, and *L. latifolium*, under a controlled greenhouse study. Our objectives are to disclose salinity tolerance and to disclose whole plant Na regulation patterns in these species. *Phaseolus vulgaris* and *Gossypium hirsutum* were grown concurrently as known crop standards. Plants were irrigated daily with three saline treatments in 1/2x Hoagland's nutrient solution: Control (no NaCl), NaCl at 23.8mM (-0.1MPa), or NaCl 47.9mM (-0.2MPa). The study was terminated after 13 weeks and the following data were collected: daily evapotranspiration (ET), growth index, leachate EC, plant fresh and dry weights, and tissue mineral concentrations. Preliminary results indicate the following for all three *Lepidium* species: Small step-wise reductions in both ET and total dried biomass across the three treatment solutions; leachate salinities ranging from 2 to 16 dS/m with minimal observed salt damage; salinity tolerance greatly exceeding that of *P. vulgaris*; and equal or greater salinity tolerance to that of *G. hirsutum*. High leaf Cl accumulation has been observed in all three *Lepidium* species with Na analysis in progress. Collectively, these characteristics may be important factors governing the invasive capabilities of these species in semiarid landscapes.

Effects of Soil pH on Establishment and Growth of Scouringrush. Blake D. Kerbs*, Andrew G. Hulting, Carol Mallory-Smith; Oregon State University, Corvallis, OR (048)

Scouringrush (*Equisetum hyemale*) is an ancient perennial plant belonging in the horsetail family (*Equisetaceae*). Historically as a weed, scouringrush has been associated with moist areas such as roadsides and ditch banks. In corn and soybean systems of the Midwestern United States, reduced tillage has created a pathway for this species to move into production fields. Similar patterns are documented in Eastern Oregon dryland winter wheat as tillage has been removed from the system. Though it appears tillage is the primary contributor for the increased in-crop scouringrush patch densities, soil pH may also play a role in the occurrence of this weed. Ideal growing conditions for the genius *Equisetum* include acid soils, but it can thrive in a remarkable range of conditions. Wheat (*Triticum aestivum*), however, does not have this ability. The minimum soil pH for a successful wheat crop is 5.4. Repeated applications of nitrogen fertilizers have reduced soil pH well below that threshold in numerous wheat systems. It is hypothesized that low soil pH has and will continue to create an additional niche for in-crop scouring rush establishment. In this preliminary study, soil collected at the Oregon State University Hyslop Field Research Lab (pH ≈ 4.6) was amended with $CaCO_3$ to create stratified pH ranges. Scouringrush rhizomes were harvested near Corvallis, Oregon, and planted into amended soils (soil target pH: 4.6, 5.1, 5.6, 6.6, and 7.6) and then grown in a greenhouse for 45 days. Measurements included above/belowground biomass and number of emerged shoots. Scouringrush biomass production increased as soil pH increased from 4.6 to 7.2, then slowed substantially at pH 7.3. The average biomass increase for scouringrush was 6.72 g at pH up to 7.2, while in soils with a pH up to 7.3 the average biomass increase was 2.46 g. Results from this preliminary study do not provide evidence that low pH soils promote scouringrush establishment. However, there was increased biomass in soil pH ranges that are unsuitable for wheat production. No correlation was found between number of emerged shoots and pH. Further research is needed to investigate the observed reduction in biomass in the high pH treatment.

Weed Seed Predation Dynamics in No-Till and Tilled Organic Wheat. Greta Gramig*[1], Patrick Carr[2]; [1]North Dakota State University, Fargo, ND, [2]North Dakota State University, Dickinson, ND (049)

Weed management is often a major challenge in organic production systems. Typically, tillage is a primary weed control tool in these systems. But, since tillage is associated with soil erosion and soil quality degradation, researchers and producers are interested in adapting no-till production systems for use in organic production systems. Knowledge about what factors influence weed population dynamics will help in designing integrated management approaches to minimize weed pressure in organic no-till systems. Survival of newly dispersed weed seed is an important life cycle phase for determining future weed population size. Granivorous animals such as mice and insects remove and destroy large quantities of dispersed weed seed. Management approaches might be timed to take advantage of natural weed population regulation via predation. But to do so requires knowledge about what factors drive these dynamics. One question is, do predator activity and seed removal follow more or less set temporal patterns, or are they influenced by different tillage systems and subsequent differences in weed community composition? To address this question, we intensively sampled weed seed rain (WSR), insect activity density, and weed seed removal from organic wheat plots under tilled and no-till management during July and August 2014. Since weed community composition in the two tillage systems differed, our question was whether these differences would shift temporal dynamics of weed seed rain, seed removal, or insect activity. This experiment was conducted at the NDSU Dickinson Research and Extension Center on certified organic plots. The experiment was arranged as a randomized complete block design with five replications. A five-crop rotation was randomized within tillage blocks (conventionally-tilled/CT or no-tilled with sheep grazing/NT). Plot size was 30 x 9 m. Measurements focused only on the spring wheat phase of the rotation. Two insect pitfall traps were installed in each plot. Traps were kept open for 48 hours per weekly sampling period, and then trapped insects were counted to determine insect activity densities for grasshoppers, carabids, and crickets. Two weed seed rain traps were installed per plot. Seed cards containing 15 seeds each of common lambsquarters, yellow foxtail, and wild buckwheat were either placed inside exclosures to limit vertebrate access or were left exposed to all seed predators. Two seed cards of each type were placed in each plot. Weed seed rain and seed removal were also sampled for 48 h time periods, concurrent with pitfall trap sampling. Resultant count data were ln(1+x) transformed and subjected to ANOVA tests to assess the effects of sampling period and tillage system on weed seed rain, vertebrate and invertebrate seed removal, and insect activity density (PROC MIXED SAS 9.3). On July 25, WSR in NT plots exceeded WSR in CT plots. This result demonstrates that the temporal availability of weed seeds varied between tillage systems. The weed species in the NT system were mostly winter annuals and early-emerging summer annuals, which matured earlier than the later summer annuals predominating in the CT system. Weed seed removal did not vary between tillage systems for either invertebrates or vertebrates, except for 8/21. One curious observation is that vertebrate seed removal appeared to be greatest when WSR was lowest. Insect activity was not affected by tillage type. However, carabid activity appeared to be correlated with weed seed rain, especially in CT. When carabid activity (lagged by one week) was regressed against WSR in CT, the relationship was 1.16x + 1.25, $R^2 = 0.9$, $P = 0.01$, demonstrating that carabid activity may be influenced by WSR, and therefore tillage system, whereas grasshopper and cricket activity appear to be unaffected. Results indicate some influence of tillage (via weed community composition) on weed seed predation.

Impact of Seed Burial Depth on Radish Seedling Emergence. Gabriel Flick*, Carol Mallory-Smith; Oregon State University, Corvallis, OR (050)

In the Willamette Valley of Oregon, post-harvest management of *Brassica* crop residues has recently come under scrutiny as a result of the increasing disease pressure from black leg caused by *Leptosphaeria maculans*. The recommendation for deep tillage to bury the infected residue also incorporates crop seed into the soil seed bank. Volunteers can serve as hosts for the disease and purity of subsequent crops can be affected if volunteers are allowed to mature. In order to identify best management practices, emergence depth was evaluated in two greenhouse experiments. Radish (*Raphanus sativus*), turnip (*Brassica rapa*), canola (*B. napus*), and forage rape (*B. napus*) seed were buried at 6 depths. Total emergence was measured, and soil examined to determine seed fate. The emergence of seeds buried at 1, 5, and 7.5 cm was not different among crops. Radish had the greatest emergence at 10 and 12.5 cm depths as expected based on seed size. No emergence was recorded at the 20 cm depth. Seed not accounted for by emergence either germinated and died or degraded within 28 days. Although these studies provide comparative results among species, field studies are needed to examine emergence under varying soil and environmental conditions.

Planting Date Effect on Winter Forage Crops for Supplemental Cornstalk Grazing. Jenna Meeks*[1], Andrew R. Kniss[2], Brian A. Mealor[2]; [1]University of Wyoming, Lingle, WY, [2]University of Wyoming, Laramie, WY (051)

Cattle in southeastern Wyoming commonly graze cornstalks during winter months. Corn residue has low forage quality compared to forage in pasture systems and quality steadily declines throughout the winter. A field study was initiated in the fall of 2013 and repeated in 2014 to determine the impact of planting date on forage crop biomass production for winter grazing. The study was conducted using a randomized complete block design with 6 planting dates per block and 4 replicates. The seed mixture included annual ryegrass, crimson clover, rapeseed, turnip, and radish aerially seeded at 13 kg/ha. Planting occurred at approximately 12 d intervals between September 2 and October 30 in 2013 and at 2 to 3 wk intervals between July 14 and October 13 in 2014. Aboveground biomass was collected from each plot, dried at 60 C for 48 hr, and weighed to estimate forage crop biomass. Digital photographs of each plot were taken of at approximately monthly intervals. SamplePoint software was used to determine percent of ground covered by the forage crops. Ground cover and biomass production collected at similar dates were highly correlated ($r=0.86$, $P<0.01$), indicating image analysis provided a non-destructive method for quantifying forage production. Biomass from the earliest planting date sampled in December averaged 81 and 87 kg/ha in 2013 and 2014, respectively. Later planting dates reduced biomass in both years.

The Environmental Impact Quotient (EIQ) Should Not Be Used to Compare Herbicides. Andrew R. Kniss*, Carl W. Coburn; University of Wyoming, Laramie, WY (052)

There is a desire by scientists and the general public to reduce the environmental impact of pesticides. Quantification of pesticide environmental impacts, however, is difficult and complex. A pesticide that is highly toxic to mammals may be relatively non-toxic to fish or birds. A pesticide that is highly persistent in soil may break down quickly in an aquatic environment. This complexity makes it difficult to declare any given pesticide as uniformly “better” or “worse” for the environment. The EIQ converts physiochemical and toxicological information on pesticide active ingredients into scores that are then combined mathematically and weighted into an index that purportedly quantifies relative risk to farm workers, consumers, and the environment. While criticized by others in the past, the EIQ continues to see regular use in the weed science literature. In particular, the EIQ is often used to compare herbicides used in genetically engineered herbicide resistant crops. A simulation and sensitivity analysis was conducted to investigate the relative sensitivity of the EIQ to changes in risk factors relevant to herbicides. Dermal and chronic toxicity have a relatively large impact on the EIQ, as expected. Two important risk factors for herbicides, leaching and surface runoff potential, have little impact on herbicide EIQ values. Most troubling, the risk factor with the greatest influence on the EIQ value is arbitrarily assigned to herbicides without any supporting quantitative data. The EIQ is a poor measure of a herbicide's environmental impact and should not be used to compare herbicides.

Green Ash and Honey Locust Response to Aminocyclopyrachlor. Curtis M. Hildebrandt*, Scott J. Nissen, Philip Westra; Colorado State University, Fort Collins, CO (053)

Aminocyclopyrachlor (AMCP) is a selective pyrimidine carboxylic acid herbicide with soil residual activity. Previous work has shown that AMCP can have off-target movement into desirable trees via root absorption, creating the need for tree safety trials. In 2012, field trials were conducted at three separate timings in April, July, and October within a site containing an established stand of 15-year-old green ash (*Fraxinus pennsylvanica*) and honey locust (*Gleditsia triacanthos*) trees. The goals of the study were to determine relative sensitivity of both species to AMCP, minimum distance for tree safety, and effect of application timing on tree response. Trials consisted of AMCP applications at 210 g ai ha^{-1} between rows of green ash and honey locust trees spaced at 1, 7 and 13 meters away from the edge of the AMCP application. Visual ratings were collected for both species two years after treatment. Injury ratings indicate that green ash trees were tolerant to the AMCP applications, showing no injury for any application, whereas honey locust trees showed severe injury to trees one meter away with moderate to severe injury on trees seven meters away for all timings. Honey locust trees growing 13 meters from the edge of AMCP applications were unaffected, suggesting a minimum safe distance from application for this species. Comparison of application timing showed October treatments were slightly less injurious, with honey locust trees one meter away from the AMCP application showing a reduction in injury rating of 8% ($p<0.05$) compared to the other timings.

Variation in Phenology of Downy Brome. Nevin Lawrence*, Ian C. Burke; Washington State University, Pullman, WA (054)

A series of field and greenhouse experiments were initiated to better understand downy brome (*Bromus tectorum* L.) phenology within the small grain production region of the Pacific Northwest (PNW). Ninety five downy brome and one ripgut brome (*Bromus diandrus* Roth.) accessions were collected in 2010 and 2011 from within small grain fields in the PNW and advanced one generation in the greenhouse by single seed decent. Accessions were transplanted as seedlings to a common garden located near Central Ferry, WA and Pullman, WA in November of 2012. The study was repeated in November 2013 near Central Ferry, WA. As soon as flowering occurred, panicles were collected from each replicate weekly. Seeds were removed from panicles and planted in a greenhouse to determine if seed was physiologically mature. Germination of downy brome seeds was regressed against cumulative growing degree days (GDD) (base 0 C) at time of collection using a two-parameter log-logistic model to estimate GDD required to produce mature seed. Phenology differed at each study location but was negatively correlated to temperature, with mature seed set occurring earlier when winter temperature was colder. Accession were clustered together into groups of similar genotypes for analysis based upon variation in single nucleotide polymorphisms. Population clusters matured, relative to each other, in the same order at each study location, suggesting a strong genetic control of phenology. As downy brome growth stage can influence the efficacy of herbicides, variation in phenology between population clusters may have management implications.

Does Biodiversity Affect Weed Seed Predation in Wyoming Dryland Farming Systems? Randa Jabbour*; University of Wyoming, Laramie, WY (055)

Development of effective, integrated approaches to managing annual weeds includes harnessing the potential for biological control by generalist seed predators in agronomic systems. However, our knowledge of how seed predators interact with one another, and the impact of such interactions on weed seed mortality, is limited. Seed-feedig animals include insects, birds, and mammals. We tested whether seed predation by invertebrates and vertebrates differed in dryland cropping systems in southeastern Wyoming. Seed predation varied according to weed species, habitat type, and functional guild. Future directions for this research area include further exploration of the interactions amongst these seed-feeding guilds in dryland cropping systems.

Population Genetics of Glyphosate-Resistant Palmer Amaranth. Anita Kuepper*[1], William McCloskey[2], Eric L. Patterson[1], Scott J. Nissen[1], Todd Gaines[1]; [1]Colorado State University, Fort Collins, CO, [2]University of Arizona, Tucson, AZ (056)

Throughout the southeastern and southwestern United States, populations of Palmer amaranth (*Amaranthus palmeri*) have been identified with evolved resistance to the herbicide glyphosate. This project aims to determine the degree of genetic relatedness among a set of glyphosate-resistant and –susceptible lines by analyzing patterns of phylogeography and diversity on an intraspecific level. Eight different lines of Palmer amaranth from different geographic regions were tested against lines from an Arizona locality for glyphosate resistance by determining their EPSPS copy number and the accumulation of shikimic acid via the shikimate assay. The susceptible lines showed an average of 40.6 mg/ml shikimic acid while the resistant lines showed an average of 0.1 mg/ml shikimic acid accumulation after exposure to a 500µm solution of glyphosate. Individuals from the Arizona glyphosate-resistant locality had increased copies of EPSPS in the range of 20 – 290-fold, the same mechanism previously identified in the Palmer amaranth lines from the southeastern U.S. DNA samples will be sent for genotyping by sequencing (GBS) to perform single nucleotide polymorphism (SNP) calling, which will be used to determine the genetic structure of the different lines. The goal is to ascertain whether resistance to glyphosate evolved independently in the Arizona locality, or whether resistance spread from outside to the location in Arizona. For example, the transportation of resistant seeds in harvesting equipment could be a source of gene flow via seed migration. This information about the evolution and migration of glyphosate resistance will be useful to design better strategies for herbicide resistance management.

Weeds as Alternate Hosts for Brassica spp. Diseases. Briana Claassen*, Carol Mallory-Smith, Cynthia Ocamb; Oregon State University, Corvallis, OR (057)

Weeds can be alternative hosts for plant pathogens and sources of inoculum. In 2014, there was an outbreak of fungal diseases in *Brassica* crops: black leg caused by *Phoma lingam*, white leaf spot caused by *Mycosphaerella capsellae*, and light leaf spot caused by *Cylindrosporium concentricum* in the Willamette Valley in Oregon. These diseases were also present on weedy *Brassica* species. Determining which *Brassica* weeds are susceptible to these fungi will help determine how important weedy hosts are to the spread of these diseases. To date, black leg has been identified on *Rorippa curvisiliqua* (Western yellowcress), *Brassica rapa L. var. rapa* (Bird's rape mustard), *Brassica nigra* (Black mustard) and *Capsellae bursa-pastoris* (shepherd's purse). White leaf spot has been found on *Cardamine oligosperma* (little bittercress) and *Capsellae bursa-pastoris* (shepherd's purse) and light leaf spot has been found on *Brassica rapa L. var. rapa* (Bird's rape mustard) and *Brassica nigra* (Black mustard). Continued surveys and pathogenicity testing are being conducted to better understand the weed host ranges of these fungi and in turn, their effect on crop disease. Management of these weed species may be critical for managing these diseases.

Description of New 2,4-D and Dicamba Acid Formulations. Jim Daniel*[1], Scott K. Parrish[2], Philip Westra[3]; [1]Agricultura Consultant, Keenesburg, CO, [2]AgraSyst Inc, Spokane, WA, [3]Colorado State University, Fort Collins, CO (058)

One of the most utilized herbicides in the world is 2,4-D. It came to market as a herbicide in 1945, and is commonly formulated in two forms, dimethyl amine salt (DMA) of 2,4-D and low volatile (LV) ester of 2,4-D. The amine salts are water soluble and are formulated in water. Low volatile esters are oils and are formulated as Emulsifiable Concentrates (EC). Dicamba was first registered in the United States in 1967. Dicamba is commonly formulated as a DMA salt or as a diglycolamine (DGA) salt. Both are water based formulations. Recently new 2,4-D and dicamba acid base formulations have been introduced. These formulations are characterized by increased herbicidal activity as compared to the amine salts and reduced volatility. AgQuam of Spokane, WA has developed new self-buffering acid formulations, AQ990 a 2,4-D formulation, AQ991 a dicamba formulation, and AQ997 a mix of the two acid actives, that are higher loaded than current commercial acid herbicide formulations. Several trials were conducted in both greenhouse and field to evaluate both volatility and efficacy as compared to the standards. In general, the AQ acid formulations were less volatile and slightly more efficacious than the standard formulations.

Effects of Hypoxia on Roughstalk Bluegrass Growth and Development. Mingyang Liu*, Andrew G. Hulting, Carol Mallory-Smith; Oregon State University, Corvallis, OR (059)

Roughstalk bluegrass (*Poa trivialis*) is a cool-season perennial grass species. The presence of roughstalk bluegrass seed in the harvested crop seed increases the cost and difficulty of seed cleaning. This weed problem has increased in the past decade, and there are few control options. In the Willamette Valley, roughstalk bluegrass is often found in tall fescue and perennial ryegrass seed crop fields with waterlogging problems. Oxygen deficiency is the major environmental stress in waterlogged soils. A comparative germination study between roughstalk bluegrass and tall fescue was conducted in a growth chamber with three oxygen conditions. Treatments included the normoxia control, hypoxia achieved by submerging the seeds into water filled petri dishes, and anoxia achieved by putting the seeds into an anaerobic box. Germination for tall fescue seeds in the normoxic control were 93, 98, and 98%, at 5, 10, and 15 days after treatment (DAT), respectively. Germination for roughstalk bluegrass seeds in the normoxic control was 71, 88, and 92%, at 5, 10, and 15 DAT, respectively. Under the hypoxia treatment, the germination for tall fescue declined more than for roughstalk bluegrass. At 5 DAT, germination for tall fescue and roughstalk bluegrass seed under hypoxia condition was 9% and 56%, respectively. At 10 DAT, the germination was 24% for tall fescue and 65% for roughstalk bluegrass. However at 15 DAT, germination was closer at 70% for tall fescue and 74% for roughstalk bluegrass. No seed of either species germinated in the anoxia treatment. At 10 d after seeds were removed from the oxygen deficiency treatments, germination in the hypoxia and anoxia treatments was 85 and 70% for tall fescue, and 80 and 62% for roughstalk bluegrass, respectively. Further studies are required to detect if the difference between the rates of germination under hypoxia may lead to greater weed density during the crop establishment stage.

GENERAL SESSION

Introduction. Joe Yenish*; Dow AgroSciences, Billings, MT (060)

Presidential Address. Drew J. Lyon*; Washington State University, Pullman, WA (061)

Welcome to the 68th meeting of the Western Society of Weed Science. My colleagues and I from the Pacific Northwest welcome you to Portland and the highly diverse and beautiful landscapes of the region. Portland is one of my favorite cities and I hope you will enjoy some of the many wonderful dining opportunities that can be found within a short walk of our hotel. I hope that some of you have taken, or will take, some extra time before or after the meeting to explore this extraordinary part of the country.

Having said that, I must also acknowledge the primary reason for meeting here in Portland is to foster and encourage education and research in weed science. We are here to share the findings of the research we have been doing this past year, discuss weed issues of mutual interest and concern, and make plans for the coming year. The annual meeting is also an opportunity for graduate students to further explore their options in weed science and to meet the people who have made a career in our field of science. There are 43 students registered for this meeting. They have submitted a total of 37 papers in the oral or poster contest. I encourage you to view their posters and attend their presentations. Consider making it a goal of yours to introduce yourself to at least five of these students before the meeting ends on Thursday. I think you will be impressed with who you meet.

It takes a lot of people donating their time, talent, and/or resources to make the annual meeting a success. I want to thank everyone who has contributed to the planning and execution of this annual meeting. From my perspective, it is just short of a miracle that everything comes together as well as it does. Of course, having Phil Banks as our business manager also helps to explain this near miracle.

I want to recognize this year's program chair, Joe Yenish, for his hard work to develop the program, including this general session. I guarantee that if you can survive my address, you will be rewarded for your perseverance by the speakers that follow me. I also want to recognize Daniel Curtis, chair of the local arrangements committee, for his work with the hotel and for his efforts to inform all of you about what the area has to offer. I would like all of us to thank the 2015 sustaining members and our breakfast and break sponsors for their financial support that helps to make these meetings a success. They are listed on the inside of the back cover of the program. I think it is also important for me to recognize and thank Pete Forster for making the arrangements for all of the sponsored activities.

We are very fortunate in the WSWS to be on a solid financial footing. This allows us to support important activities such as student travel to the annual meeting and the summer board meeting, supporting Lee Van Wychen in Washington D.C. as the Director of Science Policy, and assisting with the Herbicide Resistance Summits, all while maintaining relatively low registration and membership fees. Weeds of the West has been a major contributor to our society's income over the past two decades. As the publication ages, the income stream has declined and we will need to make up this loss of income or reduce expenditures. I have appointed two Ad Hoc committees to work with Phil Banks. One of these committees is looking for ways to increase income from the remaining inventory of Weeds of the West and the other committee is considering what might follow Weeds of the West as an income generator for the WSWS. If you have some ideas about this latter topic, please talk to Dirk Baker who is chairing that Ad Hoc committee.

I will end my comments this morning by thanking all of you for giving me the opportunity to serve as your President this past year. From my very first WSWS meeting in 1992 in Salt Lake City, I have thoroughly enjoyed my association with the WSWS. I have met many great colleagues and friends, developed many interesting projects, been given opportunities to serve and enhance my knowledge and skills, and just had a really good time. I know of no other professional society that is as welcoming and friendly as the WSWS. I encourage all of you to meet people you have not met before and to listen to one or two talks outside of your area of specialization. Be sure to get involved in at least one of the discussions sessions being held this week. They are a highlight of our annual meeting. Should you have any concerns or complaints about the annual meeting, please share those with me along with your suggestions for how to remedy the situation. Enjoy the meeting and enjoy your time with friends and colleagues.

Washington Update. Lee V. Van Wychen*; Weed Science Society of America, Alexandria, VA (062)

Director of Science Policy Report

WSWS Annual Meeting. Portland, OR. March 9, 2015

2014-15 Science Policy Committee Members

1. Lee Van Wychen	Director of Science Policy	WSSA
2. Donn Shilling	Chair	WSSA
3. Joe DiTomaso	President	WSSA
4. Dallas Peterson	President-elect	WSSA
5. Kevin Bradley	Vice President	WSSA
6. Jim Kells	Past President	WSSA
7. Michael Barrett	EPA Liaison	WSSA
8. David Shaw	E-12b Chair	WSSA
9. Jeffrey Derr	CAST rep	WSSA
10. Harold Coble	At-Large	WSSA
11. Janis McFarland	At-Large	WSSA
12. Jill Schroeder	At-Large	WSSA
13. Michael Horak	At-Large	WSSA
14. Cody Gray	President	APMS
15. Rob Richardson	President-elect	APMS
16. John Hinz	President	NCWSS
17. Mark Bernards	WSSA Rep	NCWSS
18. Greg Armel	President	NEWSS
19. Prasanta Bhowmik	WSSA Rep	NEWSS
20. Scott Senseman	President	SWSS
21. Robert Nichols	Legislative Chair	SWSS
22. Drew Lyon	President	WSWS
23. Chad Clark	Legislative Chair	WSWS

Discussion Items

1. Superweed Definition

2. National Weed Survey

3. Herbicide Resistance Summit II- steps forward

4. EPA Herbicide Stewardship Program

5. How much milkweed is out there?

-

1. Superweed Definition –How do we correct the scientific misinformation online and in dictionaries, while still capitalizing on the press coverage that has helped increase awareness of weed resistance issues? At the recent WSSA meeting in Lexington, KY, the Board of Directors unanimously approved the following definition for "superweed"

***Superweed**: Slang used to describe a weed that has evolved characteristics that make it more difficult to manage due to repeated use of the same management tactic. Over-dependence on a single tactic as opposed to using diverse approaches can lead to such adaptations.*

The most common use of the slang refers to a weed that has become resistant to one or more herbicide mechanisms of action (www.weedscience.org) due to their repeated use in the absence of more diverse control measures. Dependence on a single mechanical, biological, or cultural management tactic has led to similar adaptations (e.g. hand-weeded barnyardgrass mimicking rice morphology, dandelion seed production in a regularly mowed lawn, knapweed resiliency to gall fly biocontrol).

Two common misconceptions about a superweed are that they are the result of gene transfer from genetically altered crops and that they have superior competitive characteristics. Both of these myths have been addressed by the Weed Science Society of America (WSSA) at www.wssa.net/weed/wssa-fact-sheets.

WSSA has created a variety of free educational materials and recommendations concerning herbicide resistance and how to avoid it, available at www.wssa.net/weed/resistance.

2. National Weed Survey. We are finishing up our first national survey of the "most troublesome" and "most common" weeds. The survey link is: www.surveymonkey.com/s/2014weeds

During the 1st year we will collect baseline data for all 26 of the crop and natural area weed management categories. Depending on the survey results, we may rotate the survey to cover one weed management category every four years, i.e. 1) grass crops; 2) broadleaf crops; 3) horticultural crops, ornamentals, and turf; and 4) natural areas, range, pasture, rights-of-way, and aquatic. Initially, we were just going to identify one extension weed scientist in each state to be the lead for all categories. But that thought has evolved into online survey where any member of a National or Regional Weed Science Society can log in to enter the most common and troublesome weeds for the management systems they are familiar with. The goal is to compile the survey data each year and make it available publicly. Carroll Moseley from Syngenta, chair of the WSSA Public

Awareness Committee has provided $5,000 towards conducting and analyzing the survey results. Dr. Bob Zimdahl has expressed interest in helping lead the survey results analysis.

3. Herbicide Resistance Summit II. Sept. 10, 2014 in Washington DC. Webcasts of the entire summit are at: http://wssa.net/weed/resistance-summit-ii/ . A special open access issue of *Weed Science* in the works. Both USDA and EPA have pointed to WSSA as their go to source of science based information for herbicide resistance management. **Discussion of feasibility of Area-Wide Management (AWM) programs**. A successful example would be the TEAM Leafy Spurge AWM program in the Dakota's, Montana, and Wyoming. The Sugarbeet Growers Association is looking for assistance with a community-based pilot program for proactively managing herbicide resistance. A second pilot effort is being developed, targeting elimination of Palmer amaranth in Iowa. There have been many successful Cooperative Weed Management Areas (CWMA's) in the western U.S. for managing invasive weeds. Can this concept be successfully deployed for counties? States? Regions?

4. EPA's Herbicide Stewardship Program. EPA's registration requirements for Enlist Duo represents precedent setting requirements for a Herbicide Resistance Management Plan. In the future, the agency intends to apply this approach to weed resistance management for all existing and new herbicides used on herbicide-tolerant crops. **Are there concerns you have heard?** The pesticide Stewardship Program (SP) requirements include extensive surveying and reporting to EPA, grower education, and remediation plans. EPA asked WSSA to comment on the proposed stewardship program for Enlist Duo. Those comments are at: http://wssa.net/wp-content/uploads/WSSA-EPA-Enlist-Duo-Comments_FINAL.pdf We identified a number of significant concerns in the SP proposal for Enlist Duo and EPA addressed all of them. WSSA will continue to work with EPA and discuss its goals for a herbicide resistance management SP and how to determine its effectiveness. Other requirements on the Enlist Duo label included restrictions to avoid pesticide drift. These requirements include a 30-foot in-field "no-spray" buffer zone around the application area, no pesticide application when the wind speed is more than 15 mph and only ground applications are permitted. The Enlist Duo registration will expire in six years, allowing EPA to revisit the issue of resistance.

On Dec. 12, APHIS signed off on dicamba tolerant soybeans and cotton. EPA's proposed registration requirements for crop traits are expected to be released shortly. WSSA will likely submit comments on those registration requirements as well.

5. How Much Milkweed Is Out There?

On December 31, the Fish and Wildlife Service (FWS) said it's considering increasing protections for the monarch butterfly under the Endangered Species Act (ESA). FWS was petitioned by three environmental groups last August that claim that extensive use of glyphosate on glyphosate resistant corn and soybeans in the Midwest has devastated native populations of milkweed, the sole source of food for monarch butterfly larvae. The petitioners claim that monarch butterfly populations have decreased 90 percent over the past 20 years. FWS will be accepting comments and data submissions on the state of the monarch butterfly. You can find the petition information and submit comments at www.Regulations.gov under Docket No. FWS-R3-ES-2014-0056.

Updates

1. New Chairs for House and Senate Committees

2. FY 2015 Appropriations

3. WOTUS

4. NPDES

5. USDA-ARS NPL for Weed Science

6. WSSA-USDA NIFA Liaison

7. Noxious Weed Compliance Clause in Farm Bill

8. Foundation for Food and Agriculture

9. NISAW – Feb. 22-28, 2015

1. New Chairs for House and Senate Committees

The 114th United States Congress is now in full swing and committee leadership positions have been assigned. Due to the GOP's self-imposed rule that limits its committee chairs to three terms, nearly half of the chairs in the House had to step aside, including Ag Committee Chair Frank Lucas of Oklahoma. **Michael Conaway of Texas** takea over as new House Ag Committee chairman. He grew up in Odessa, TX and was a member of Odessa Permian High School football team that won a state championship in 1966 (which eventually led to the movie "Friday Night Lights"). He has a B.A. in accounting from Texas A & M. He worked at Price Waterhouse after serving in the army, and then was the chief financial officer for Bush Exploration. Rep. **Collin Peterson of Minnesota** will remain as the Ranking Member of the House Ag Committee.

The new chair of the House Natural Resources Committee is **Rob Bishop from Utah** who took over for the retiring Doc Hastings from Washington. Bishop grew up in Kaysville, UT, just north of Salt Lake City and has been a lifelong resident of the district that he will be representing for the 7th term in Congress. Bishop will seek to extend the expiring Payment in Lieu of Taxes (PILT) and Secure Rural Schools (SRS), two programs that provide critical funding to rural counties across the West, which includes funding for invasive weed management. Support for those programs is broad and bipartisan, but finding funding and agreeing how the money is spent will be a challenge. **Rep. Raul Grijalva (AZ)**, a strong proponent for invasive species management, is the new ranking member of the House Natural Resources Committee.

For the House Appropriations Committee, **Rep. Harold Rogers (KY)** remains the chair and **Rep. Nita Lowey (NY)** remains the ranking member of the full committee. The "cardinals" or subcommittee chairs for Agriculture and Rural Development, Energy and Water Development, and Interior and Environment also remain the same. They are **Robert Aderholt (AL), Mike Simpson (ID), and Ken Calvert (CA)**, respectively.

In the Senate, **Thad Cochran of Mississippi**, moved from the Ranking Member of the Senate Ag Committee, to one of the most powerful positions on Capitol Hill, Senate Appropriations Chairman, a position he occupied from 2005-2007. **Sen. Pat Roberts of Kansas** is the new Chair of the Senate Ag Committee. As House Ag Committee Chair in the 1990's, Roberts was a driving force behind the "freedom to farm" commodity policy in the 1996 Farm Bill. He is a fourth generation Kansan from Topeka, KS, has a journalism degree from Kansas State, and served four years in the Marine Corps. He was elected to the U.S. House of Representatives in 1980 and then to the Senate in 1996 where he has served since. Senator Roberts has been a proponent of research and technology and had led efforts in promoting food safety and biosecurity. **Sen. Deb Stabenow of Michigan** is now the Senate Ag Committee Ranking Member. Another **Kansas Senator, Jim Moran**, will chair the Senate Ag Appropriations committee with the ranking member being **Sen. Jeff Merkley from Oregon**.

Senator Lisa Murkowski of Alaska takes over as chair of the Senate Energy and Natural Resources Committee. She is a 3rd generation Alaskan and the first Alaskan-born Senator to serve the state, where she has served as Senator since 2002. It's no secret that Sen. Murkowski's top priority will be energy development. She unveiled her plan almost two years ago: Energy 2020: a Vision for America's Energy Future, which calls for opening up federal lands for energy exploration among other initiatives. However, **Sen. Maria Cantwell from Washington**, the committee's new ranking member, will run strong opposition to the chair's proposals. Murkowski's committee also has jurisdiction over most of the federal land management agencies, but don't expect much camaraderie between her and Interior Secretary Sally Jewell as they have already disagreed on a proposed road through a remote Alaskan wildlife refuge that the Senator considers a life-and-death issue for local residents. Either way, Sen. Murkowski will play a huge role in shaping Energy and Natural Resource policy in the 114th Congress because not only is she the top authorizer, but she is also the top appropriator for land management issues as chair of Senate Appropriations Subcommittee for Interior-Environment.

Finally, the Senate Environment and Public Works Committee will have a 180 degree shift in its agenda as **Sen. Jim Inhofe from Oklahoma** took over the gavel from **Barbara Boxer of California**, who slides down to the ranking member spot. However, Sen. Inhofe will only be chair for 2 years under GOP rules since he chaired the committee from 2003 – 2007. You can expect an array of oversight hearings on Obama administration environmental policies such as expanding the scope of the Clean Water Act and the science underpinning federal environmental rules. Sen's Inhofe and Boxer are about as far apart as you can get on the ideological spectrum and there will be no shortage of polarizing drama within this committee over the next two years.

2. FY 2015 USDA Appropriations. The "old" Congress passed the "Cromnibus" before leaving town for the year, which funds the federal government for FY 2015 (for most agencies). Things look pretty good for USDA budget items overall with NIFA, APHIS, NRCS, the Economic Research Service (ERS), and National Ag Statistics Service (NASS) all receiving higher budgets compared to FY 2014. Within NIFA, the Agriculture and Food Research Initiative (AFRI) grants program increased 2.8% from $316 million to $325 million. Meanwhile, FY 2015 funding for the Hatch Act ($244 million), Smith Lever 3b and 3c ($300 million), and the IR-4 program ($11.9 million) remain the same as last year. The new Farm Bill that was passed in February also revived 2 programs that would have expired. The Specialty Crop Research Initiative (SCRI) will get $80 million per year in mandatory funding. The Organic Agriculture Research and Extension Initiative (OREI) will get $20 million per year.

3. "Administrative Rule" Clarifying Waters Of The United States (WOTUS). On April 21, the EPA and Army Corp of Engineers jointly published an "administrative rule" meant to clarify what are "Waters Of The United States" (WOTUS). The proposed rule would expand Clean Water Act (CWA) jurisdiction to almost all waters in the United States subjecting thousands of streams, ditches, and other "small" waters to federal permitting and citizen lawsuits, including those on agricultural property. The expanded jurisdiction and the imprecision of the terms used by the agencies will result in significant added legal and regulatory costs. To minimize the potential effect on agriculture, EPA issued an "interpretive rule", effective March 25, which exempted 56 NRCS conservation practices from CWA permits. However, this "interpretive rule" only added confusion to the "administrative rule" attempting to clarify what is a WOTUS. NRCS has more than a 160 approved conservation practices. Would the remaining 104 NRCS conservation practices still be considered normal farming practices? Or would they be subject to citizen lawsuits under the administration's new WOTUS rule? Thankfully Congress "ditched" EPA's interpretive rule of NRCS approved conservation practices with a rider in the "Cromnibus" that was passed on Dec. 12. However, the "administrative rule" that greatly expands EPA's authority under the CWA is still moving forward. While the Certified Crop Advisors asked WSSA to submit comments on the administrative rule that closed on Nov. 14, the Science Policy Committee decided to steer clear of the legal controversy for the time being. EPA Administrator McCarthy has said that the CWA exemptions for ag stormwater runoff and irrigation return flow will be upheld. We'll see. The bottom line is that EPA (and ACOE) are going to adopt the rule, whether we like it or not. The issue is going to be settled between the administration and the new 114th congress and that's where the National and Regional Weed Science Societies will likely expend our efforts.

4. NPDES Fix Bill There will be renewed effort to get legislation passed that would "fix" the National Pollutant Discharge Elimination System (NPDES) permit requirements that resulted from a 2009 Circuit Court ruling. There is bipartisan support in both houses of Congress that would clarify Congress's intent for the regulation of pesticides applied to or near water. The NPDES permits impose additional resource and liability burdens on small businesses, farms, municipalities, state agencies, and federal agencies. The National and Regional Weed Science Societies have supported a legislative fix for this issue since the Circuit Court ruling and will continue to support efforts to resolve this issue going forward.

5. USDA-ARS NPL for Invasive Pests of Crops. Dr. Rosalind James started at end of March in Beltsville, MD. She worked previously at the USDA-ARS Bee Biology and Systematics Lab in Logan, UT as a bee pathologist. Joe DiTomaso, Mike Barrett, Donn Shilling and I met with her to discuss the National and Regional Weed Science Society's recommendations for the NP304 Crop Protection research program. She will be attending and speaking at the WSSA annual meeting in Lexington.

6. WSSA – USDA NIFA Liaison – Dr. Donn Shilling, University of Georgia, was selected as the first ever WSSA – USDA NIFA Liaison. He is finalizing details of his liaison visits to USDA, which will begin in 2015.

7. "Noxious Weed Compliance" in Farm Bill. A reminder that farmers shall agree --- "to effectively control noxious weeds and otherwise maintain the land in accordance with sound agricultural practices, as determined by the Secretary" in order to be eligible for commodity support payments/crop insurance subsidies.

8. Foundation for Food Agricultural Research (FFAR) Authorized as part of the 2014 Farm Bill. FFAR is non-profit, nonfederal entity that will leverage public and private resources to increase the scientific and technological research, innovation, and partnerships critical to boosting America's ag economy. Congress authorized up to $200 million which must be matched by non-federal funds as the Foundation identifies and approves projects. FFAR's 15 member board was selected this summer. It will be chaired by Dan Glickman, former U.S. Secretary of Ag. Two FFAR board members we are hoping for support of weed science issues are Dr. Doug Buhler, Director of AgBioResearch and Senior Associate Dean for Research for the College of Agriculture and Natural Resources, Michigan State University and Dr. Mark E. Keenum - President, Mississippi State University. The full FFAR Board of Directors is at: http://www.ars.usda.gov/is/FFARBios2014.pdf

9. National Invasive Species Awareness Week (NISAW) – Feb. 22-28, 2015 In September, we learned that Lori Williams would be retiring as the Executive Director of the National Invasive Species Council (NISC). Chris Dionigi of NISC is serving in that role in the interim. As for NISAW, I am working with Phil Andreozzi, NISC's Assistant Director for International and Regional Affairs. We are coordinating some state focused webinars during the week as well as planning a NISAW Awards Ceremony, and an Invasive Species Kid's Day at the U.S. Botanic Garden. Please see www.nisaw.org

Working as the WSSA Liaison to EPA: Some Impressions and Experiences. Michael Barrett*; University of Kentucky, Lexington, KY (063)

The WSSA Liaison Position to the EPA Office of Pesticide Programs (EPA-OPP), also referred to as the EPA Subject Matter Expert by the WSSA, was created in 2007 modeled on the EPA-OPP liaison position established earlier by the Aquatic Plant Management Society. Steve Dewey of Utah State University served as the first WSSA liaison (2007-2008) and Jill Schroeder of New Mexico State University served as the liaison from 2009-2013. Michael Barrett became the third liaison in May 2014. There are also liaisons for the Entomological Society of America and the American Phytopathological Society. The WSSA liaison position is a three-way partnership between the home institution of the liaison (providing salary), WSSA (providing travel funds), and EPA-OPP (providing access including security clearance for the liaison). WSSA sees the liaison program as providing weed science expertise to EPA-OPP and, in addition, the agency sees the program as a way to tell its story, including how regulatory decisions are made. The liaison typically makes presentations, such as this, to professional societies to help accomplish this objective. The liaison can also help arrange for EPA-OPP staff to speak at meetings. The National Roadside Vegetation Management Association has asked the liaison to coordinate a EPA-OPP speaker for its annual conference. Both WSSA and EPA-OPP hope that their interaction through the liaison will result in trained weed scientists considering employment at the agency. Already, one WSSA member joined EPA-OPP staff since the liaison program was created. The liaison works with many parts of EPA-OPP but, to date, the interactions have been concentrated in the Biological and Economic Effects Division (BEAD) and the Registration Division (RD), especially the Herbicide Branch. The information collected by other parts of EPA-OPP funnel to the RD, or the analogous Pesticide Reevaluation Division (PRD) for herbicides and other pesticides that were previously registered. Both RD and PRD are responsible for making the final regulatory decisions. There are relatively few persons in RD and PRD responsible for making these decisions and each person has a multitude of cases to consider. In addition, the Pesticide Registration Improvement Act (PRIA) establishes time lines for registration decisions to be made. As the EPA-OPP staff working with herbicides come from a wide variety of both weed science and non-weed science backgrounds, one activity for the liaison is to provide weed science training for them. One training effort is offering "Herbicide 101" seminars on a recurring basis. Subjects already covered include an introduction to the history and development of herbicides, herbicide interactions with plants and adjuvants for herbicide use. Herbicide-soil interactions are an upcoming topic. One objective of these presentations is to relate the material to label questions that the EPA-OPP staff deals with. Another example of how the liaison can foster greater awareness of weed management issues is to help organize field tours for the EPA-OPP staff. There have been four previous tours and plans are underway to conduct a tour this summer. Recently, the EPA-OPP began putting a greater emphasis on the benefits of a pesticide registration and the liaison may have an important role is helping to assess any proposed benefits. Two areas that the liaison is normally not included in are discussions concerning development of EPA policy and meetings where confidential business information (CBI) will be presented. However, EPA-OPP recently reached out to WSSA for suggestions on how to set new policies related to preventing spread of herbicide resistance. I believe this request directly stems from previous input WSSA has provided to the agency regarding resistance. In addition, the liaison was recently included in a meeting to discuss Inzen sorghum in which CBI was presented. The company involved, DuPont, specifically gave permission for the liaison to attend the meeting. Issues on the horizon for the liaison include implementation of the new required herbicide resistance monitoring and mitigation programs for new crops incorporating herbicide tolerance traits and weed management impacts on Monarch butterfly populations. Overall, the liaison program has greatly raised the stature and visibility of weed science within, not only, EPA-OPP but also other federal agencies such as the USDA Office of Pest Management Policy and APHIS. It continues to be a very worthwhile investment for WSSA.

The Pacific Northwest Wine Industry: Less Than 30 Years From Infancy to Maturity, Growing Pains Not Withstanding. Joan R. Davenport*; Washington State University, Prosser, WA (064)

The wine industry in the Pacific Northwestern US began in 1864 in Lewiston, Idaho, and in the early 1900s had become established in central Washington and the Salem area in Oregon. However, prohibition stopped wine grape production and the industry did not begin to redevelop in the Pacific Northwest until the 1960s. Efforts in the 1960's in Oregon began privately, by David

Lett, in the Willamette Valley, and by Dr. Walter Clore at the Washington State University Research and Extension Center in Prosser, Washington. Developing quality wine grape vineyards took time in all regions in the Pacific Northwest. Despite being the first pre-prohibition location for grape production, the Idaho wine grape industry had a slow start in becoming established, largely due to cold winter temperatures leading to challenges in vineyard establishment (Table 1). Efforts in the past 30 years in Oregon and Washington have been more successful (Table 1), although for the most part, the growth in Oregon has been in the western part of the state, whereas in Washington, growth has been in the central region.

Issues have arisen, particularly in central Washington, with herbicide drift (particularly 2,4-D) from neighboring wheat production and it's adverse impact on wine grapes. Studies were conducted in the late 1990's and early 2000's to try to quantify the impact from mixed agricultural commodities. Overall, there has not been a clear conclusion that nearby farming operations are adversely impacting grape production. Wine operations continue to be successful and important contributors to the economical viability of the Pacific Northwest.

Table 1: Growth patterns, indicated by wine grape acreage and numbers of wineries, in the past 30 years in the Pacific Northwest US.

State	Year	Wine Grapes (Acres)	Wineries (#)
Idaho	2002	n/a	11
	2008	n/a	38
	2014	1600	51
Oregon	1995	7,100	92
	2005	14,100	215
	2013	24,000	604
Washington	1993	11,100	80
	2005	28,000	340
	2014	44,000	739

From Crops to Rocks: Reducing Input Costs and Improving Yields with Robotic Aircraft.
Bret Chilcott*; AgEagle, Neodesha, KS (065)

Bret Chilcott, Vice President of Business Development of AgEagle LLC of Neodesha, KS, grew up on a small farm in south central Kansas. While working for area farmers, he spent every penny he earned on model airplanes or flying lessons. After graduating from school he worked in various sales and marketing positions for companies from Snap on Tools, Cessna Aircraft and Cobalt Boats. After beginning an advanced composite manufacture, he worked with Kansas State University to develop airframes for their agricultural UAV program. After learning about this budding industry, he pivoted his composite manufacture into AgEagle which is now the largest manufacture of aerial precision robotic aircraft in the world. AgEagle manufactures complete aerial imaging for use in agriculture.

AgEagle builds robotic aircraft imaging systems and offer them for purchase to farmers, agronomists, or other precision agricultural professionals. Customers create georeferenced aerial images of fields to aid in quick accurate and complete ground truthing.

The AgEagle precision agriculture photography system is designed for agricultural professions to provide a complete aerial view of their crops to help precisely identify crop health and field conditions much faster than any other method available.

The AgEagle precision agriculture photography system is designed for agricultural professions to provide a complete Still photography includes standard full spectrum color photos (RGB) or NDVI (Normalized Difference Vegetation Index) enhanced photos that mimic infrared wavelengths. The NDVI enhanced photos are used to determine the health of plants. AgEagle currently manufactures two systems; the “CLASSIC” and the “RAPID” systems. No flying experience is required. The AgEagle flying wing will automatically launch, fly over the crop and even land by itself.

AgEagle robotic aircraft helps growers increase profits by pinpointing areas where nutrients or chemicals need to be applied versus where they don’t need to be applied thus decreasing input costs and increasing yields.

PROJECT 1: WEEDS OF RANGE AND NATURAL AREAS

The Effect of Habitat, Seedbank and Clipping on the Dominance of Medusahead. Elise S. Gornish*; University of California, Davis, Davis, CA (066)

The winter annual grass *Taeniatherum caput-medusae* (L.) Nevski, commonly known as medusahead, is one of the most dominant invasive rangeland species in the West. Medusahead research has largely focused on control methods and we know comparatively little about the environmental and demographic facts that ultimately drive medusahead spread and abundance. Understanding the demographic process and environmental conditions that influence spread and abundance is central for developing effective monitoring, prevention and control programs. We experimentally established grassland plant communities and added medusahead seed across a range of 5 densities (from 0 - 50,000 seeds) in both open grassland and oak woodland habitat. We also implemented a defoliation treatment by clipping live biomass in half the plots at the peak of the growing season. On average, oak woodlands reduced medusahead abundance by almost 500%, although the effect was greater at lower seeding rates. The negative effect of oak woodlands was almost an order of magnitude less for desired grassland species.

Our periodic matrix models demonstrated that early life stage transitions of medusahead were negatively affected by the presence of oak woodland habitat. These effects on vital rate ultimately contributed to a reduction in population growth rate of the weed, compared to populations in the open grassland habitat. This work highlights the importance of considering habitat level factors such as tree cover, and soil characteristics associated with oak woodland habitats as an effective and sustainable way to control medusahead.

Statewide Prioritization of Downy Brome Infestations in Wyoming. Brian A. Mealor, Cara E. Noseworthy*; University of Wyoming, Laramie, WY (067)

Downy brome is an invasive winter annual grass prevalent enough in the state of Wyoming to warrant concern from public and private land managers. It is one of many detrimental invasive species in the state, meaning prioritizing to ensure the most efficient use of time and resources is important. Current distribution models do not provide enough information for effective prioritization. This project has three objectives: 1) synthesize distribution data in Wyoming, (2) develop a distribution model, and (3) develop a spatially-explicit prioritization model based on invasion status, estimated recovery potential, and potential as wildlife habitat. We developed a rapid assessment protocol to classify survey points into invasion levels based on measures of downy brome, native plants and other qualitative measures (disturbance, other invasive grasses, etc.). Over 1800 sites were surveyed in the past two summers, and overall, we have compiled downy brome data for over 20,000 sites. Survey goals included balancing spatial representation of the state the first season and targeting dominant downy brome infestations the second season. Distribution prediction models, all over 80% accuracy, are complete for the state and include a presence/absence model for determining "establishment niche" and three separate abundance models for determining "impact niche." These models will be used to identify areas of high risk for downy brome impact, and in conjunction with habitat indicators, to prioritize areas for management action. The final goal is to provide a tool to land managers that will be the first step in a statewide cooperative approach to managing downy brome.

Medusahead Control Efficacy Dependant on Herbicide and Timing. Heather E. Olsen*, Corey V. Ransom, Ralph E. Whitesides; Utah State University, Logan, UT (068)

Medusahead (*Taeniatherum caput-medusae*) is an aggressive winter annual grass that is invading millions of acres in the western United States. In Utah, where it has been present since the 1970s, it is believed to be contained to three counties in the northern part of the state: Cache, Box Elder, and Morgan. In fall 2012 two sites were selected within these counties to establish trials evaluating the effect of imazapic and matrix alone and in combination with glyphosate and glyphosate alone when applied at five different timings. Treatments included: an untreated control, imazapic at 175 g ai ha^{-1}, rimsulfuron at 70 g ai ha^{-1}, glyphosate at 290 g ai ha^{-1}, imazapic + glyphosate at 175 + 290 g ai ha^{-1}, and rimsulfuron + glyphosate at 70 + 290 g ai ha^{-1}. All treatments included AMS at 10.2 g L^{-1}. Imazapic and rimsulfuron treatments also included MSO at 1% v/v. Timings included: September, October, November 2012 and April, May/June 2013. At each application date samples were collected from untreated plots to determine the number of un-germinated and germinated medusahead seeds and the number of established seedlings. Percent control evaluations were conducted in June 2013 and June 2014. In 2013, there was no significant difference in percent control among the rimsulfuron with or without glyphosate treatments at any application timing; the imazapic and imazapic + glyphosate treatments increased in effectiveness at later application timings, with the most effective control in the treatments applied in November and April at either site. The glyphosate treatments had increasing control across timings, but was never as effective alone as when used in combination with the rimsulfuron or imazapic. Because the 2013 evaluations were conducted in close proximity to the May/June application timing, the data from the last timing was not included in these comparisons. In 2014 those treatments that continued to show effective control at the Avon site included: imazapic alone or in combination with glyphosate applied at the later timings; the rimsulfuron treatments were much more variable. Rimsulfuron applied in May/June, and rimsulfuorn + glyphosate applied in September continued to show acceptable control. At the Tremonton site in 2014 treatments that continued to show effective control included: imazapic, rimsulfuron, imazapic + glyphosate, and rimsulfuron + glyphosate applied at the April and May/June timings. The number of ungerminated seeds was highest at the September timing, with a quick decline over the subsequent timings. The number of seedlings was highest at the second (Avon) or third (Tremonton) application timings. Imazapic with or without glyphosate provided the most consistent control of medusahead at both sites over the long term.

Long Term Response of Downy Brome to Multi-Year Management. Trevor M. Peterson*, Heather E. Olsen, Corey V. Ransom; Utah State University, Logan, UT (069)

Research on downy brome (*Bromus tectorum*) management was conducted at Dinosaur National Monument, located on the Colorado and Utah border. Trials were established at Josie's Ranch and Echo Park in April 2010. Trials were arranged in a split-plot design, spring whole plot treatments included: untreated, mowing, and glyphosate at 193 g ai ha^{-1}; fall subplot treatments were: untreated, imazapic at 70, 105, 140, 175, and 210 g ai ha^{-1}, sulfosulfuron at 70 g ai ha^{-1}, and rimsulfuron at 53 g ai ha^{-1}. Additional glyphosate at 193 g ai ha^{-1} was applied in spring 2013 over glyphosate whole plots along with glyphosate at 193 g ai ha^{-1} and aminopyralid at 140 g ae ha^{-1} in the fall of 2013. Glyphosate at 193 g ai ha^{-1} and imazapic at 140 g ai ha^{-1} was applied to the mowing whole plot in the fall of 2013. Plots were replicated four times. At Josie's Ranch subplot herbicide treatments effectively controlled downy brome and subsequently led to increases in desirable grass one YAT. In 2013, subplot herbicide treatments continued to reduce downy brome cover, and increase desirable grass cover at Josie's Ranch. Additional main plot treatment applied in 2013 reduced downy brome cover in 2014, and correspondingly led to increased desirable grass cover in 2014. An exception to this was found at Echo Park where imazapic likely injured desirable cool season grass. Although there was some herbicide damage to desirable grasses, competition from downy brome reduced desirable grass cover more than herbicide damage.

How Historical Information Helps Trace the Invasion of a Weed: A Case Study with Ventenata. Dorothy Macguire*[1], Steve Novak[1], Fara Brummer[2], Massimo Cristofaro[3], Rene Sforza[4]; [1]Boise State University, Boise, ID, [2]North Dakota State University, Streeter, ND, [3]BBCA, Sacrofano, Italy, [4]USDA-ARS, Montpelier, France (070)

Abstract not available.

Improving Reclamation Success Through Weed Management and Seeded Species Selection. Beth Fowers*, Brian A. Mealor; University of Wyoming, Laramie, WY (071)

As part of the energy extraction process, soils are scraped from sites to access mineral deposits or to create level surfaces for drilling or mining activities. This disturbance kills plants, and makes it necessary to reintroduce desirable species once extraction activities are completed. Reclamation after disturbance associated with energy extraction is critical for ecosystem function and is required by law. Weedy annual species often dominate reclamation sites for the short-term, competing for resources with newly-seeded desirable vegetation. Our objectives were to: 1) evaluate herbicide effects on weedy and desirable species and 2) determine the effect of treatment timing (herbicide and seeding) on reclamation success. Fifteen herbicide treatments and ten seed mixes were applied in a split-plot design to three sites in Wyoming to evaluate effectiveness of different reclamation practices. Most herbicide treatments targeted broadleaved weeds with the substitution of two treatments targeting annual grasses at one site. Desirable species were seeded at two timings (fall, spring) across herbicide treatments to investigate establishment rates of various species at different seeding times. Three years after treatment, herbicide impacts on annual forbs varied ($p<0.05$). Annual grass cover differed among seeded species ($p<0.05$), suggesting variable competition among desirable species. Establishment of seeded species differed across sites and species ($p<0.0001$). Season of treatment was important for both herbicide and seeding. Species with the greatest cover, biomass, and weed control included crested wheatgrass and Russian wildrye, followed by basin wildrye and western wheatgrass.

Two-Year Survival and Growth Responses of Planted Douglas-Fir to Logging Debris and Herbicide Combinations. Timothy B. Harrington*[1], David H. Peter[2], Robert A. Slesak[3]; [1]USDA Forest Service, Olympia, WA, [2]U.S. Forest Service, PNW Research Station, Olympia, WA, [3]University of Minnesota, Minneapolis, MN (072)

Logging debris has the potential to benefit forest regeneration by inhibiting competing vegetation and by modifying microclimate. At a recently harvested forest site near Matlock WA, two operational logging debris treatments (20 and 9 Mg ha^{-1} of debris) were replicated six times in a split-plot design with three site-preparation herbicide treatments (triclopyr ester (T), aminopyralid (A), and T+A) and a non-treated control. The debris treatments were applied in December 2011, the herbicide treatments were applied in August 2012, and Douglas-fir seedlings were planted in February 2013. Heavy debris limited grass cover, whereas triclopyr reduced cover of woody species. During the growing seasons of 2012-2014, soil water content was greater and soil temperature was lower under heavy debris than under light debris. During September and October of 2012, soil water was greater in T+A than in the non-treated control. Second-year (2014) survival of Douglas-fir was greater in heavy debris (91%) than in light debris (84%). Incidences of Douglas-fir chlorosis and top dieback were lower in heavy debris than in light debris. Second-year growth in Douglas-fir stem volume was 87-172% greater in heavy debris than in light debris for each of the herbicide treatments except T+A where the treatment difference (12% greater) was not statistically significant. In light debris, stem volume growth was up to 144% greater in herbicide-treated plots than in non-treated plots; whereas, in heavy debris, these differences (35% greater) were not significant. Because heavy debris acted like an herbicide to reduce vegetation abundance, combining heavy debris with A+T did not stimulate further increases in Douglas-fir growth. Results suggest that, on glacial outwash soils and possibly other droughty forest ecosystems in the

Pacific Northwest, a heavy debris treatment can be used to supplement or replace benefits to Douglas-fir regeneration typically derived from an effective herbicide treatment.

Efficacy of Undiluted Herbicide Injections on Tropical Woody Species in Hawaii. James Leary*[1], Jane Beachy[2], Julia Gustine[2]; [1]University of Hawaii at Manoa, Kula, HI, [2]Pacific Cooperative Studies Unit, Honolulu, HI (073)

There are hundreds of exotic, woody species naturalized in Hawaii, with many considered to be problematic, invasive weeds impacting natural areas and forested watersheds. Among conservation groups, the active ingredient triclopyr (TCP) is the most relied upon herbicide selection for woody species control, with a basal bark application of a 25% v/v oil-adjuvant blend being the most typical method. Anecdotally, the technique is mostly successful, but without calibrations to report on effective dose, supporting the observation that effective applications are mostly compensated by high doses. Starting in 2011, field efficacy trials were initiated to determine if other registered active ingredients including: aminopyralid (AMP), imazapyr (IMZ) and glyphosate (GLY), along with (unregistered) aminocyclopyrachlor (ACP); would prove to be more effective. Thus, expanding the “palette” of herbicide options. These treatments were administered via injection with metered doses of undiluted formulations. Starting in 2011, replicated efficacy trials have been administered to naturalized stands of thirty species, all from different genera. Size was a variable among experimental units with basal diameters ranging - approximately 10-30 cm (50th percentile). Dose volumes were consistent within treatment designs and ranged from 2-4 ml per target (50th percentile) across experiments. Performance was measured by recording defoliation over time. The treatments ACP, AMP and IMZ were consistently strong performers effective (>80% defoliation) on 85%, 45% and 61% of treated species, respectively, while GLY and TCP were only effective across 21% and 27% of species, respectively. Median effective doses for ACP, AMP and IMZ were 2.0, 2.3 and 2.2 mg ae cm^{-2} (acid equivalent applied to area of basal cross section), respectively, while GLY and TCP were effective at 5.7 and 5.3 mg ae cm^{-2}, respectively, with noticeable efficacy reduction at < 3 mg ae cm^{-2}. Defoliation for ACP and AMP were modestly fit to exponential decay functions (R^2 = 0.71 and 0.77, respectively) at rates of 3.6% and 3.3% canopy loss per day and >90% defoliation observed in < 100 days after treatment (DAT). The defoliation rate for IMZ was slower at 1.6% per day (R^2 = 0.53) with >90% defoliation typically observed 150-200 DAT. Effective control was determined for 73% of the species tested, with 50% of those species having a single herbicide option superior to the other herbicides and multiple options becoming less frequent among species. Furthermore, all effective options (i.e., ACP, AMP and IMZ) superseded TCP using this low-dose injection technique. The injection technique is proving to be an effective, efficient and more hygienic alternative to woody species control in Hawaii, where performance outcomes are improved with inclusion of a more diverse herbicide inventory.

Japanese Knotweed Congener Stand Reduction Following Mid-Season Herbicide Treatments - Year One. Andrew Z. Skibo*[1], Mark J. VanGessel[2], Michael Yost[3]; [1]SePRO Corporation, Fort Collins, CO, [2]University of Delaware, Georgetown, DE, [3]Environmental Planner, DNREC, Dover, DE (074)

Japanese knotweed (*Fallopia japonica* SYN *Reynoutria japonica* SYN *Polygonum cuspidatum*) and the related congers and hybrids within the genus have been documented in all but eight U.S. states and are commonly found established as dense monocultural stands along frequently disturbed waterways and waste areas. This species, *sensu lato*, is known to spread prolifically via vegetative propagation while sexual reproduction and subsequent, viable seed dispersal have been increasingly documented across the US.

Historically, this heavily rhizomatous perennial invasive has been managed most successfully via chemical intervention though these programs require repeated applications and a comprehensive restoration plan to effectively control established stands much less hope for eradication. Further, as the preferred habitat of this genera is generally riparian, herbicide selection is constrained to those registered by the USEPA for use in these ecologically sensitive areas, significantly reducing herbicide chemistry selection to the applicator.

Previous herbicide screening trials have documented the efficacy of a number of systemic herbicides such as glyphosate, imazapyr, triclopyr with varying degrees of success during season of application and during subsequent seasons. One of the chief issues with the aforementioned chemistries has been a lack of immediate destruction of treated foliar biomass and the potential for further dispersal of vegetative propagules thus further hampering site remediation efforts. In a field trial initiated mid-summer 2014, a number of systemic active ingredients (imazamox, imazapyr, triclopyr, and glyphosate) known to have excellent activity on Japanese knotweed were applied alone and in combination with Stringray™ (active ingredient: carfentrazone-ethyl) to elucidate any increases in immediate efficacy seen with these combinations during season of application. A mechanical mowing program was conducted as a positive check. Data will be collected to +1 YAT. Preliminary results of this trial will be discussed as will implications of this chemistry to the riparian manager's portfolio.

Spectrum and Efficacy of Carfentrazone-ethyl for Aquatic and Riparian Use Patterns. Andrew Z. Skibo*[1], Ben Willis[2]; [1]SePRO Corporation, Fort Collins, CO, [2]Aquatic Research Technician, Whitakers, NC (075)

Stingray™(EPA Reg. No. 279-3279), active ingredient Carfentrazone-ethyl (HRAC E; WSSA 14), a triazolinone-type protoporphyrinogen oxidase inhibitor, was first registered for use in production agriculture by FMC in 1997 with efficacy on a wide range of common broadleaf weeds in rice, sorghum, small grains and as a harvest aid for desiccation of some *Solanaceous* crops. Stingray™ was subsequently USEPA approved for use in aquatic and riparian environments circa 2004 for control of *Pistia stratiotes*, *Eichornia crassipes*, *Salvinia* spp., *Lemna* spp., *Azolla* spp., *Ipomea aquatica*, *Wolffia* spp., and for suppression of *Alternitheria philoxeroides* and *Ludwigia octovalvis*.

Greenhouse mesocosm trials on Variable-leaf Watermilfoil (*Myriophyllum heterophyllum*) and Giant Salvinia (*Salvinia molesta*), which indicated that treatments of Carfentrazone (.002 and .004 Kg ai/Ha, respectively) plus glyphosate (0.75, 1.52 and 4.54 Kg ai/Ha, respectively) was statistically equivalent to applications of flumioxazin plus glyphosate and provided control similar to operational applications of diquat plus glyphosate commonly used by the Lousiana Department of Wildlife and Fisheries (LDWF). Creeping water primrose (*Ludwigia peploides*) was controlled with combinations of Stingray (0.006 Kg ai/Ha) plus Renovate 3 (ai: triclopyr, 1.68 Kg ae ai/Ha) and combinations of Stingray (0.006Kg/Ha) plus Clearcast (ai: imazamox, 0.28Kg ai/Ha). Field demonstrations in the 2014 showed a high degree of efficacy on *Butomus umbellatus* at rates far below maximum labelled rate (0.225 Kg/Ha) and on Water hyacinth (*Eichornia crassipes*) when applied in combination with Clearcast (0.03 + 1.52 Kg ai/Ha) while exhibiting excellent safety on Nuphar spp. and Southern cutgrass (*Leersia hexandra*).

The developing aquatic efficacies of Stingray™, when combined with known species spectrum from terrestrial use patterns, increases apparent activity on submersed aquatic vegetation (SAV) when combined with systemic active ingredients such as imazamox and triclopyr, adds rapidity of burn-down to riparian weed control programs utilizing systemic herbicides commonly used in the aquatic and riparian niche market, such as imazapyr, imazamox, fluridone, glyphosate, penoxsulam, triclopyr etc.; the implications of which will be discussed as will preliminary results of several field programs conducted in 2014.

Penoxsulam + Oxyfluorfen for Site Preparation and Conifer Release Applications in Forestry. Vanelle F. Peterson*[1], Ed Fredrickson[2], Richard K. Mann[3]; [1]Dow AgroSciences, Fort Collins, CO, [2]Thunder Road Resources, Redding, CA, [3]Dow AgroSciences, Indianapolis, IN (076)

Foresters use mechanical, cultural, chemical, and other tools to prepare sites for planting seedling conifers and to help provide the new seedlings the resources (light, water, and nutrients) necessary for growth. Herbicides are used in forest management in order to prepare sites for planting ("site preparation") by reducing vegetation on the site and later in the life of a plantation to release conifers ("conifer release") from undesired plant competition.

Site Preparation and early conifer release treatments may be applied in 1 or 2 fall or spring applications to prepare the site and to keep grasses and herbaceous vegetation from out-competing the conifers once they are planted. Some common weeds targeted for site preparation and early plantation release applications are: annual grasses such as downy brome (*Bromus tectorum),* wild oats (*Avena fatua),* marestail (*Conyza canadensis),* bull thistle (*Cirsium vulgare),* and prickly lettuce (*Lactuca serriola).* Woody brush species can be problematic early in the life of a plantation if the seedlings begin to germinate soon after planting. Target brush species include: manzanita species [greenleaf (*Arctostaphylos patula*, whiteleaf, *A. viscida* and hairy, *A. columbiana*)], deerbrush (*Ceanothus integerrimus*), snowbrush (*C. velutinus*), squawcarpet (*C. prostratus),* chinquapin (*Chrysolepis chrysophylla),* and whitethorn (*Acacia constricta*). Common herbicide active ingredients used for woody brush control include: triclopyr, imazapyr, hexazinone, glyphosate, fluroxypyr, and 2,4-D.

Pindar® GT herbicide is a pre-emergence and early post-emergence herbicide currently registered for use in tree nuts and noncropland. It contains penoxsulam at 0.083 lb/gallon plus oxyfluorfen at 3.96 lb/gallon in a soluble concentrate formulation. Over 20 small plot research trials have been established in northern California to study conifer tolerance and efficacy on key weeds. Pindar GT exhibited excellent conifer tolerance when applied for site preparation prior to planting and as a broadcast application over the top of seedling conifers such as Douglas-fir (*Pseudotsuga* *menziesiii*) and Ponderosa pine (*Pinus ponderosa*). Conifer tolerance was also excellent when applied prior to planting or over the top of conifers such as sugar pine (*Pinus lambertiana*) or white fir (*Abies concolor*) that are intolerant to hexazinone. Pindar GT provides foresters another tool in their herbicide tool box and controls weeds that impede conifer growth. Surprisingly, Pindar® GT controlled seedlings of 2 woody brush species: squaw carpet and deerbrush. When applied in the early spring prior to seedling emergence, 3 pints/A of Pindar GT reduced cover of squaw carpet from 60% cover to 10 - 20% cover, facilitating the survival and growth of conifer seedlings. This reduction in squaw carpet cover doubled the conifer volume growth in treated plots over the conifer volume growth in the non-treated plots. When applied in the fall, 4.5 pints/A of Pindar GT controlled 85% of deerbrush seedlings the following spring.

Herbaceous and woody plant weed control provided by Pindar GT at 3 to 4.5 pints/A during preparation or conifer release improved conifers stands. A Special Local Need (SLN) for Pindar GT registration for use in California forestry was submitted to California Department of Pesticide Registration in September 2014.

®™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow.

Penoxsulam + Oxyfluorfen Use in Western Non-Crop Vegetation Management. Byron B. Sleugh*[1], Vanelle F. Peterson[2], Scott Flynn[3], Richard K. Mann[4]; [1]Dow AgroSciences, Fresno, CA, [2]Dow AgroSciences, Fort Collins, CO, [3]Dow AgroSciences, Lee's Summit, MO, [4]Dow AgroSciences, Indianapolis, IN (077)

Pindar® GT Herbicide (penoxsulam + oxyfluorfen, 0.083 lb + 3.93 lb a.i./gallon) combines two herbicide modes of action into one product. Oxyfluorfen is a PPO (protoporphyrinogen oxidase) inhibitor in HRAC mode of action group E. For many years, it has been the standard for residual weed control in a variety of crops and is also used for weed control in some non-crop areas. Penoxsulam is an ALS (acetolactate synthase) inhibitor in HRAC group B. It provides post-emergence and extended residual weed control at 0.016 to 0.032 lb a.i./acre. Penoxsulam is currently registered as Grasp® SC Herbicide /Granite® SC Herbicide in rice, as Galleon® for aquatic weed control, and as Sapphire® Herbicide and LockUp® Herbicide for control of weeds in turf. Oxyfluorfen is currently registered as Goal® Herbicide/Goaltender® Herbicide. The combination of penoxsulam with oxyfluorfen provides broad spectrum and long lasting pre-emergence and post-emergence control of many difficult to control broadleaf weeds and some major grass species including horseweed (*Conyza canadensis*), hairy fleabane (*Conyza bonariensis*), cheeseweed (*Malva*spp), redstem filaree (*Erodium cicutarium*), shepherd's purse (*Capsella bursa-pastoris*), coast fiddleneck (*Amsinckia intermedia*), common chickweed (*Stellaria media*), London rocket (*Sisymbrium irio*), sowthistle (*Sonchus* spp), white clover (*Trifolium repens*), barnyardgrass (*Echinochloa crus-galli*), annual bluegrass (*Poa annua*), and other weeds. Pindar GT controls susceptible weeds that are resistant to other herbicide classes, and when applied during the winter dormant season in California, Pindar GT can provide up to six months residual control of key weeds. Pindar GT is currently registered for use in tree nut orchards and noncrop areas. Three trials were established between 2012 and 2014 to determine the efficacy of Pindar GT applied alone or in combination with other herbicides for long term vegetation control compared to current standards. Treatments included Pindar GT applied alone and in combination with Milestone® Herbicide (aminopyralid) and Dimension® Herbicide (dithiopyr) compared to Esplanade® (indaziflam). Pindar GT and Pindar GT combinations provided excellent control of Russian thistle (*Salsola iberica*), London rocket (*Sisymbrium irio*), wall barley (*Hordium murinum*), coast fiddleneck (*Amsinckia intermedia*), redstem filaree (*Erodium cicutarium*), and fivehook basia (*Bassia hyssopifolia*) and maintained excellent bareground weed control for up to 96 weeks in some instances. These results indicate that Pindar GT can be an excellent tool in non-crop vegetation management programs that control a broad range of weed species under the wide variety of environmental conditions common in the western US.

®™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

® Esplanade is a registered trademark of Bayer Crop Sciences

® Galleon is a registered trademark of SePRO Corporation

A Novel Method for Removing Downy Brome Contaminants from Reclamation Seed. William C. Rose*, Brian A. Mealor, Andrew R. Kniss; University of Wyoming, Laramie, WY (101)

Seed used in reclamation projects is often contaminated by weed seeds such as downy brome. Because downy brome germinates more rapidly and at colder temperatures than many native grasses, it may be possible to remove downy brome by exploiting germination differences. We initiated a sequence of experiments subjecting native grass and downy brome seeds to a wet germination treatment and a drying period. We used three downy brome populations and six native grass species in four replicates of fifty seeds each. During the first experiment, we evaluated three different germination temperatures for 20-days. We maintained temperature at 6°C in the second experiment and compared four treatment lengths. To evaluate treatment effects on germinabilty, we reinserted all seeds into growth chambers set at optimal temperatures for germination after a 14-day drying period. We observed species by temperature (first experiment) and species by duration of treatment (second experiment) interactions ($p < 0.0001$). Downy brome germinated earlier and more rapidly than native species at all three temperatures, and no downy brome survived the 6°C and 12°C treatments. Germination treatments reduced survival of all species except blue grama when compared to non-treated seeds. The 3°C treatment did not affect germinability of blue grama seeds. Blue grama germinability was unaffected by treatment duration in the second experiment, and thickspike wheatgrass was only affected by the 14-day treatment. Downy brome removal was limited in the second experiment. Our results indicate germination differences may be exploited to reduce downy brome contaminants in some native grass species.

Effect of Russian Olive Seed Burial Depth on Seedling Emergence and Seed Viability. Roger Hybner*; USDA-NRCS, Bridger, MT (102)

Russian olive *Elaeagnus angustifolia*, is a non-native tree widely used for windbreaks, but has spread across the landscape and infested many eastern Montana and Wyoming riparian areas. With a combination of shade tolerance, high seed viability, reliable fruit production after 10 years of age, and transport of the seeds by numerous vectors, Russian olive can infest a riparian area quickly. Tree removal, however, creates openings for the regeneration of Russian olive from migrant seed, and most importantly, seedling emergence from the existing seed bank in the soil. To investigate factors influencing the successful reestablishment of Russian olive, a greenhouse study at the USDA Bridger Plant Materials Center began on June 7, 2013, to determine: 1) if seed burial depth influenced the emergence of Russian olive seedlings, 2) if non-emerged seed remained viable at the end of the study, and 3) if emergence from depth varied between planted and invasive populations. Russian olive seeds were collected from trees in the fall of 2012 from four planted upland sites and four invaded riverine sites along the Yellowstone River, between Miles City and Sidney, Montana. Sample lots of 200 seeds per site were submitted for tetrazolium viability testing. The propagation medium used was Yellowstone River bank sandy loam, collected near Miles City where Russian olive had been removed. After 188 days from planting, all containers were emptied and each non-emerged seed was inspected for viability through ocular observation and testing for firmness by squeezing the seed between two fingers. Emergence data collected from the 1-inch burial treatment were analyzed using Bartlett's test of Equal Variances. Differences in the distribution of live-emerged seeds, live non-emerged seeds, and dead non-emerged seeds from the 1-inch depth among the two populations were tested using nominal logistic regression. The first seedling emerged from the 1-inch depth 8 days after seeding. By the end of the study, a total of 533 seeds emerged: all but one from the 1-inch depth (66.5%). No seedlings emerged from the 5-inch depth. The lone emergence at the 3-inch depth may have been the result of improper planting depth. There were no statistical differences between the individual riverine and upland populations. Compared to all the seed sources, Elk Island and Love Street were significantly different from the other collection populations for the distribution of live non-emerged, live emerged, and dead non-emerged seed buried 1-inch deep. Of the 267 non-emerged seeds from the 1-inch burial depth, 62 (23.2%) were viable, but had not germinated. There were no viable, non-emerged seeds from either the 3- or 5-inch burial depths. Our results suggest if Russian olive seeds are buried to a 3-inch or greater depth by a flood event, the seed may germinate, but will not emerge. Therefore, Russian olive seeds buried beyond a 3-inch depth may not be viable if uncovered by a future flood event. In another study on the Marias River in Montana and other studies in the western United States, Russian olive was not observed on sandbars, but did occur on low- and high-terrace plots. This, in combination with the results of our study, suggests sediment deposition may limit Russian olive seed viability within stream channels.

Targeted Grazing and Herbicide for Dalmatian Toadflax and Geyer Larkspur Management.
Julia M. Workman*, Brian A. Mealor; University of Wyoming, Laramie, WY (103)

Rangeland weeds are said to have greater economic impact on livestock producers than any other pests, by reducing forage, adversely affecting livestock, or increasing management costs. Some weeds like Dalmatian toadflax (*Linaria dalmatica* [L.] Mill.) are invasive and considered noxious in much of the West. In contrast, the native Geyer larkspur (*Delphinium geyeri* Greene) is limited in distribution but associated with high spring cattle mortality. Targeted grazing may be used to reduce weed impacts, but research to evaluate grazing for managing these two species is limited and sometimes conflicting. Our objectives were to determine effects of sheep grazing on Dalmatian toadflax, Geyer larkspur, and the desirable plant community, and to compare grazing against herbicide treatments. Ewes grazed in cells containing both target weed species, in four treatments of varying density and timing with constant annual stocking rate. We also evaluated two spring herbicide treatments. We measured cover, biomass, and weed density two months after the first treatment and analyzed data with a one-factor ANOVA. All grazing treatments initially reduced larkspur density and limited regrowth, with larkspur density in herbicide treatments intermediate between grazing treatments and the non-treated check two months after defoliation ($p<0.0015$). Grazing most greatly reduced perennial grass biomass ($p=0.0009$). More than 80% of Dalmatian toadflax stems were impacted in all grazing treatments ($p<0.0001$), but we detected no treatment effects on any toadflax variables two months after defoliation ($p>0.58$). These are preliminary results from the first year in a two-year study.

Direct and Indirect Impacts of Invasive Plants to Wildlife. Shawna L. Bautista*; US Forest Service, Portland, OR (104)

Research investigating the ecological effects of invasive plant infestations often focuses on effects to plant communities or soil properties. However, there is a growing body of evidence that invasive plant infestations have serious, and sometimes deadly, impacts to wildlife species as well. General habitat loss, or loss of forage are some of the most commonly cited effects to wildlife, but recent research and anecdotal evidence have indicated more complex interactions. Some invasive plants may be acting as population sinks by impacting breeding even though native wildlife will use the non-native plants. For example, use by native birds of invasive buckthorn for nesting results in significantly higher predation rates of the buckthorn nests (Chew 1981, Schmidt and Whelan 1999). Similarly, native hummingbirds nesting in gorse in coastal Oregon may be subject to competitive interactions and direct predation by wrentits because the hummingbirds nest lower to the ground in gorse than they do in native vegetation (Saylor, pers. obs., video). While Oregon spotted frogs, a proposed threatened species, may use areas invaded by reed canarygrass during parts of the year, they strongly avoid it during the breeding season because it does not provide the needed structure for egg laying (Cushman and Pearl 2007, White 2002, Watson et al. 2003). The result may be complete loss of breeding habitat for the frogs. A less-known effect of invasive plant infestations is direct mortality to wildlife. Young moose in Achorage, AK have been killed by consuming introduced European bird cherry (*Prunus padas*) due to the cyanide concentrated in the trees shoots during winter (Grove 2011). Death of the moose occurred in as little as 20 minutes. Direct mortality to wildlife has also been reported for burdock (bats, hummingbirds; Raloff 1998), hydrilla (bald eagles, waterfowl; Wilde et al 2005), ripgut brome (*Bromus diandrus*) and foxtail barley (*Hordeum jubatum*)(red-shouldered hawks; McCrary and Bloom 1984), and on important seabird islands in South Korea from Japanese chaff flower (*Achyranthes japonica*)(Swinhoe's storm-petrels; Pearson 2010). The direct and indirect effects of invasive plants on wildlife, particularly the potential for direct mortality, are not well-known and should be further investigated and publicized. In addition, it is important to understand that use of invasive plants by native wildlife does not necessarily confer a benefit to the wildlife, and may actually pose a serious threat to individuals or populations.

Evaluating Multi-Species Targeted Grazing for Downy Brome Control. Brian A. Mealor, Cara E. Noseworthy*; University of Wyoming, Laramie, WY (105)

Downy brome is an invasive plant negatively affecting rangelands across western North America. Few studies have directly compared herbicides and targeted grazing for downy brome control. This study's objectives are to: determine the effectiveness of targeted grazing for downy brome control, determine the effects of livestock species and timing on downy brome populations, and compare the results to those of commonly used herbicide treatments. Plots are located in Lingle, Wyoming and arranged in a randomized complete block design. Grazing treatments included two factors: species (cattle, sheep, or both) and timing (spring, fall, or both spring and fall). Stocking density was constant across all treatments at approximately 247 au ha^{-1} with a goal of 90% utilization. Treatments were applied in spring and fall of 2013 and spring of 2014. Herbicide treatments included imazapic at 123 g ai ha^{-1} and rimsulfuron at 52.5 g ai ha^{-1} applied early post-emergent in fall 2013. Canopy cover, biomass, and downy brome seed production data were collected and analyzed using a two-way ANOVA. Most treatments reduced summer 2014 downy brome cover ($p < 0.0001$). Spring and dual-season grazing and rimsulfuron treatments decreased downy brome biomass irrespective of livestock species ($p < 0.0001$). Cheatgrass seed production was lower in spring and dual-season grazing and rimsulfuron treatments compared to fall grazing and imazapic treatments ($p = 0.0074$). Based on cheatgrass, perennial grass, and kochia responses, we conclude that springtime targeted grazing has potential as a control method for downy brome, especially in severely-degraded sites.

Impact of Spotted Knapweed on Pollination Services to and Reproduction of a Co-Flowering Native Plant. Christina Herron-Sweet, Jane Mangold*, Erik Lehnhoff, Laura Burkle, Jeff Littlefield; Montana State University, Bozeman, MT (106)

The integration of invasive plants into pre-existing mutualistic networks can directly influence the organisms with which they interact as well as indirectly influence native plants that share mutualistic partners. There is concern that this phenomenon may negatively impact native plant-pollinator mutualisms. Spotted knapweed (*Centaurea stoebe)* is one of the most widespread invasive plants in the western United States and Canada. We conducted a study in Montana to investigate how the presence and density of spotted knapweed affected pollination services to the co-flowering native plant hairy goldenaster (*Heterotheca villosa)*. Although we found little evidence of competition between spotted knapweed and hairy goldenaster for pollinators at low relative densities of spotted knapweed, we observed a non-significant trend of decreasing visits per flower to hairy goldenaster with increasing density of spotted knapweed. There was no change in reproductive output of hairy goldenaster with increasing density of spotted knapweed. The impact of an invasive plant on pollinators and plant-pollinator interactions likely depends on the relative density of the invasive plant and the timing of its bloom. Based on our results, keeping spotted knapweed at low density may be sufficient to prevent negative repercussions to native plant reproduction and may even be beneficial to some pollinators.

Evaluating Direct Herbicide Impacts on Desirable Species Used in Reclamation. Beth Fowers*, Brian A. Mealor; University of Wyoming, Laramie, WY (107)

Sites disturbed by energy extraction require reclamation to be returned to a desirable state. Managers must address a variety of issues including weed management and desirable species establishment. Herbicides are commonly used to control weeds that would compete with seeded species if left uncontrolled. Because common weed species on reclamation sites are often broadleaf annuals, herbicides are typically broadleaf specific. Reclamation seed mixes are often composed of grass, forb and shrub species. Unintended impacts of herbicides on desirable species may inhibit the progress of reclamation. Our objective was to evaluate direct impacts of herbicides on 11 desirable species and two weed species commonly used in reclamation. In a greenhouse experiment we applied 10 herbicide treatments at three timings (pre-emergence and two post-emergence timings) in a factorial arrangement set in a randomized complete block design. Species included 10 desirable grasses, one desirable forb, and two broadleaf weeds. We harvested aboveground biomass from all plants 30 days after the final herbicide application. Application timing affected herbicide impacts ($p<0.0001$), and those impacts varied according to plant species ($p<0.0001$) Preemergence applications were the most damaging across species ($p<0.0001$). Herbicides causing the least damage included aminocychlopyrachlor+chlorsulfuron at a low rate, saflufenacil, and chlorsulfuron. Species least affected by herbicides included streambank wheatgrass, blue grama, bluebunch wheatgrass, and crested wheatgrass. Species most sensitive to our herbicide treatments were blue flax, alkali sacaton, kochia, and common lambsquarters. Understanding potential herbicide impacts on seeded species may illuminate some challenges facing reclamation projects.

PROJECT 2: WEEDS OF HORTICULTURAL CROPS

Topramezone Weed Control Efficacy and Safety in Warm- and Cool-Season Turfgrasses. Kai Umeda*; University of Arizona, Phoenix, AZ (078)

Small plot experiments were conducted in the low desert near Phoenix, AZ on a golf course in a rough area infested with goosegrass (*Eleusine indica*) adjacent to a fairway with Tifway 419 bermudagrass during the summers in 2013 and 2014. The goosegrass was mature and seedheads were prevalent at the initiation of the field trial on 13 August 2013. Sequential applications of topramezone at 0.0055, 0.011, and 0.016 lb a.i./A were made on 03 September. A single application of topramezone at 0.022 lb a.i./A gave 95% goosegrass control but bermudagrass injury was severe for over 2 weeks. Two applications of topramezone at lower rates controlled goosegrass but injury following the second application was especially severe on bermudagrass. Topramezone at 0.0055 lb a.i./A gave marginally acceptable goosegrass control with bermudagrass recovering to an acceptable level. Another experiment was initiated on 11 July 2014 when the oldest goosegrass was in the boot stage and first seedheads were appearing and sequential applications were made on 07 August. All topramezone treatments gave near complete control of goosegrass. Bermudagrass injury was approaching acceptable for only the 0.0055 lb a.i./A rate of application of topramezone. Topramezone at 0.022 lb a.i./A combined with metribuzin or triclopyr applied once was extremely injurious to the bermudagrass while giving acceptable goosegrass control.

A series of small plot experiments were conducted at various elevations (2,100 to 4,500 ft) around Arizona where Tifway 419 bermudagrass is a weed that encroaches upon creeping bentgrass golf greens and into perennial ryegrass and Kentucky bluegrass mix collars around greens. Fall or spring applications of topramezone at 0.022 lb a.i./A, three applications, and 0.033 lb a.i./A, 2 applications, demonstrated severe phytotoxicity on bermudagrass following each application. Creeping bentgrass, perennial ryegrass, and Kentucky bluegrass were tolerant and exhibited minimal injury.

Utilizing Linuron Tank Mixtures in Russet Burbank Potato Production. Andy Robinson*; North Dakota State University / University of Minnesota, Fargo, ND (079)

Timing of herbicide application can be the difference in having a one-pass weed control system or needing multiple herbicide applications. One of the biggest challenges with postponing herbicide application is crop safety. The objectives of this study were to quantify the effects of linuron + metribuzin treatments applied at preemergence, 50% emergence, and postemergence on weed control, crop injury, and yield. At 14 and 28 days after treatment crop injury was not observed from the preemergence and 50% emergence treatments, but injury ranged from 19-65% in the postemergence treatment. Control of wild-proso millet (*Panicum miliaceum*) was less (53 to 63%) from the preemergence treatment of 420 g ai/ha linuron + 563 g ai/ha metribuzin than the other treatments applied. Marketable yield was highest when 840 g/ha linuron + 563 g/ha metribuzin were applied at 50% emergence when compared to all other treatments, except when 420 g/ha linuron + 563 g/ha metribuzin were applied at 50% emergence. Application of linuron + metribuzin at 50% emergence provided good weed control (> 97%), no crop injury, and the highest marketable yields indicating this would be an effective treatment in potato production systems.

New and Not-So-New Linuron Tank Mixtures for Weed Control in Potatoes. Pamela Hutchinson*, Brent R. Beutler, Celestina Miera; University of Idaho, Aberdeen, ID (080)

Linuron for use in potatoes west of the Rockies had not been labeled for some time until Section 24(c) labels were issued for ID and WA beginning 2012. Dimethenamid-p, flumioxazin, and rimsulfuron - herbicides used to target nightshade sp. weeds, do not always provide satisfactory control of common lambsquarters control. Other than metribuzin or pendimethalin, there have been no tank-mix partners to help with this weed. Moreover, metribuzin cannot be used on sensitive potato varieties without risk of injury. Dimethenamid-p, flumioxazin, EPTC, rimsulfuron, or metribuzin were applied at typical use rates preemergence alone or in tank mixtures with linuron at 0.84 or 1.4 kg per ha in Idaho in 2013 and 2014. Season-long common lambsquarters control by metribuzin alone was 95 to 100%. Otherwise, control by the other herbicides without linuron was less than 90%. When tank mixed with linuron at either rate, however, control was improved to greater than 95%. With the exception of metribuzin alone, season-long hairy nightshade control was 90% or greater. Regardless of treatment, early season injury to Russet Burbank with linuron alone or tank-mixed was usually less than 5% and tuber yield and quality resulting from any of these treatments was not different. Postemergence treatments of rimsulfuron or metribuzin tank mixed with linuron resulted in 20 to 60% injury, consisting of chlorosis, necrosis, and stunting. Yields were less with the tank mixtures than with either herbicide applied alone postemergence.

New Preemergence Herbicide Tankmixes that Include Pyroxasulfone and Fomesafen for Weed Control in Pacific Northwest Potatoes. Joel Felix*[1], Rick A. Boydston[2], Pamela Hutchinson[3]; [1]Oregon State University, Ontario, OR, [2]USDA-ARS, Prosser, WA, [3]University of Idaho, Aberdeen, ID (081)

Weed control is a necessary operation in potato production. Weeds are a major concern for potato growers because they often reduce yield, impede harvest, and could possibly serve as alternative hosts for other crop pests. Herbicide tank mixtures comprised of two- or three-way products are often needed in order to expand the weed spectrum and provide season-long weed control. Studies were conducted in 2014 in Oregon, Washington, and Idaho to evaluate weed control with pyroxasulfone plus carfentrazone alone and in tankmixes with metribuzin. Potato varieties were Umatilla, Ranger Russet, and Russet Burbank at WA, OR, and ID, respectively. Herbicide treatments were applied after hilling, prior to potato and weed emergence, and sprinkler incorporated within 6 hours of application. Potato injury was transient and ranged from 0 to 3% across herbicide treatments. Early season control for common lambsquarters ranged from 84 to 100% across sites and herbicide treatments compared to 41 to 100% during mid-season. Late season control for common lambsquarters was ≥ 21% across herbicide treatments and sites. Early season hairy nightshade control was ≥ 93% across herbicide treatments and sites and ≥ 80% for late season evaluation. Control for pigweed species was ≥ 90% for the early season evaluation, compared to ≥ 78% during late season. Season long annual grass weed control ranged from 94 to 100% across herbicide treatments and sites. The U.S. No.1 potato yield at OR ranged from 30 to 55 Mg ha^{-1} across herbicide treatments, compared to 47 to 63 Mg ha^{-1} at WA. The U.S. No. 1 potato yield at ID ranged from 31 to 54 Mg ha^{-1}. The results suggested that herbicide combinations that included pyroxasulfone and carfentrazone and metribuzin could provide broad spectrum, season long weed control in potato in the Pacific Northwest region without injury to potato.

Efficacy of Long-Term, Preemergence Herbicide Treatments in Arizona Nut Crops. William B. McCloskey*; University of Arizona, Tucson, AZ (082)

Arizona pecan and pistachio producers manage orchard floor weeds to reduce water consumption and minimize interference with the trees. Although orchard floor management typically involves tillage during winter months following pruning operations, Arizona nut growers have relied predominantly on postemergence glyphosate applications for weed management for almost two decades. Many producers maintain a bare ground strip along the tree row and mow resident vegetation between the bare strips/tree rows or maintain a completely bare ground orchard floor. With the development of herbicide resistant weed populations in Arizona, growers need to diversify the herbicide mechanisms of action they use to help mitigate the development of herbicide resistant weed populations. Preemergence herbicides can be used to diversify weed management programs by including additional mechanisms of action. Studies were initiated at four orchards in Arizona (Red Rock, Green Valley and Kansas Settlement [2 sites]) in 2013 to study the long term effects on weed populations of annual preemergence herbicide applications. In addition to periodic visual estimation of weed control and identification of the weeds present, percent weed ground cover was measured by taking nadir photographs in subplots. Percent groundcover was determined by pixel analysis using Access 2.0 software (American Phytopathological Society). Spring herbicide treatments included pendimethalin (Prowl H_2O @ 4 qt./A), pendimethalin plus flumixoazin (Chateau @ 6 oz/A) and Pindar GT @ 3 pt./A (oxyfluorfen and penoxsulam). Three additional treatments also included summer sequential treatments of pendimethalin (following either Prowl H_2O or Pindar GT) or rimsulfuron (Matrix) following pendimethalin. All treatments received maintenance applications of glyphosate (usually at 1.13 lb. a.e./A) as needed and were compared to a commercial standard treatment of repeated glyphosate applications (i.e., no preemergence herbicide). Plots were large, 12 to 20 trees per plot, and were between 0.25 to 0.42 acres depending on tree spacing. Herbicides were applied using a tractor mounted sprayer. Results of the first two years of a four year study indicate that treatments that included preemergence herbicides resulted lower density weed populations measured as percent groundcover compared to the postemergence herbicide only treatments. There were small differences between preemergence herbicide treatments except that the sequential preemergence herbicide treatments within a year resulted in significantly lower winter weed populations during harvest preparations. Trends indicate that preemergence herbicide treatments can reduce the number of postemergence herbicide applications needed per year to maintain acceptable weed control.

Penoxsulam + Oxyfluorfen for Weed Management in Western Pecans. Jesse M. Richardson*[1], William B. McCloskey[2], Jamshid Ashigh[3], Richard K. Mann[4]; [1]Dow AgroSciences, Hesperia, CA, [2]University of Arizona, Tucson, AZ, [3]Dow AgroSciences, London, ON, [4]Dow AgroSciences, Indianapolis, IN (083)

Paper withdrawn

Testing Several New Herbicides for Weed Control in Beet Seed Production. Timothy W. Miller*, Carl R. Libbey; Washington State University, Mount Vernon, WA (084)

Red and yellow garden beets are biennial crops grown for seed in northwestern Washington. Overwintered roots (stecklings) or vernalized seedlings are transplanted into production fields in April or May with seed harvested in August or September. Given their size at transplanting, beet stecklings and seedlings tolerate rates of certain herbicides that might injure beets grown from seed. Recent manufacturer cancellations of desmedipham and pyrazon registrations in garden and sugar beet has heightened interest in testing new herbicides for this crop. Nonregistered products tested that displayed selectivity in beet stecklings and/or seedlings include asulam, diuron, EPTC, flumioxazin, linuron, oxyfluorfen, and sulfentrazone. Weed control from these products used alone or in sequence with clopyralid, cycloate, ethofumesate, s-metolachlor, phenmedipham, or triflusulfuron ranged from fair to excellent up to 8 weeks after treatment (WAT). Metribuzin at 0.58 kg/ha reduced red beet seedling survival at 4 WAT, although weed control was excellent through 8 WAT. There was no difference in steckling emergence due to metribuzin, and biomass of beets treated with any herbicide did not differ from that of nontreated beets by 8 WAT. In a separate trial, apparent red beet seedling survival was reduced by flumioxazin at 71.4 g/ha at 2 WAT while survival with 35.7 g/ha was not significantly different than from nontreated beet seedlings. By 3 WAT, however, some of the seedlings had recovered and started to produce leaves. At that time, seedling survival was no longer different between treatments when compared to nontreated beet seedlings. There was no difference in red beet steckling emergence at 2 or 3 WAT, although there was a trend toward slower emergence for beets treated with flumioxazin, sulfentrazone, or EPTC at 2 WAT. Beet seedling or steckling biomass did not differ among treatments at 7 WAT. Early season weed control with flumioxazin was uniformly excellent, while control with sulfentrazone was good and with EPTC was fair. Continued testing of combination and/or sequential treatments with these herbicides is warranted based on these data.

Mechanism of Glyphosate and Paraquat Resistance in Conyza Species. Marcelo L. Moretti*, Bradley D. Hanson; University of California Davis, Davis, CA (085)

Populations of *Conyza bonariensis* and *C. Canadensis* were confirmed to be resistant to glyphosate and paraquat in the Central Valley of California, but the mechanism(s) of resistance in these populations is unknown. Resistance to glyphosate or paraquat in other *Conyza* spp populations has been attributed to reduced translocations of herbicide. The objectives of this study were to evaluate absorption and translocation of glyphosate and paraquat in the multiple-resistant California biotypes of *C. bonariensis* and *C. canadensis*. Glyphosate-paraquat-resistant (GPR), glyphosate-resistant (GR), and glyphosate-paraquat-susceptible (GPS) of both *Conyza* spp were treated with 1 uL droplet of solution containing 1.1 kBq of radioactive ^{14}C-glyphosate or ^{14}C-paraquat. Plants were harvested at intervals to 72 hours after treatment (HAT) for glyphosate, and 24 HAT for paraquat. No difference in glyphosate absorption was observed among biotypes within a species, but *C. bonariensis* absorbed more glyphosate (52 to 58%) than *C. Canadensis* (28 to 37%). In *C. bonariensis,* less glyphosate translocation was observed in the GPR and GR biotypes with 21% compared to 29% in the GPS biotype. A similar trend was observed in *C. Canadensis* (GPR-7%, GR-10%, and GPS-14%). For paraquat, absorption was similar for both species and all biotypes and reached a maximum of 71% within 4 HAT. Translocation of 5% or less of paraquat was observed in the GPR biotypes of both species, whereas the GR and GPS biotypes translocated up to 36% of applied paraquat. These results indicate that reduced translocation is a mechanism involved in glyphosate and paraquat resistance in these biotypes.

Advances in Weed Management in Edamame. Martin M. Williams II*; USDA-ARS, Urbana, IL (086)

Weed interference is a major impediment to domestic commercial production of edamame, a vegetable-type soybean with growing demand in the U.S. yet largely imported from Asia. My lab began working on improving weed management in edamame in 2010, when only a single herbicide had a federal label for use on edamame. Excellent crop tolerance was confirmed for five additional herbicides. As of February 2015, six active ingredients, each with a unique herbicide mode of action, are labeled for use on edamame. Field experiments compared weed management systems comprised of these and other herbicides that may be available for use in the near future. Based on 3-year results from Urbana, a system that included metolachlor preemergence followed by imazamox postemergence plus interrow cultivation resulted in among the lowest weed density, lowest weed biomass, and greatest yield of marketable edamame pods. Furthermore, experiments revealed cultivars differ in their weed suppressive ability and certain cover crops improve crop emergence - findings that could be exploited in the development of multi-tactic weed management systems. Although the vegetable industry is beginning to have nascent weed management options in edamame, the level of additional research and development applied towards commercial production may be a driving factor of the extent to which edamame is ultimately grown in the U.S.

Using Cover Crops for Weed Management in Tulip Production. Yushan Duan*[1], Carl R. Libbey[2], Timothy W. Miller[2]; [1]Grad Student, Pullman, WA, [2]Washington State University, Mount Vernon, WA (087)

Tulip is grown on over 400 acres in western Washington, representing 76% of U.S. tulip bulb production. Tulip is a poor weed competitor and subject to soilborne diseases due to wet conditions during its growing season. These pests are primarily controlled using herbicides and fungicides. However, pesticide applications are sometimes limited by proximity to sensitive areas and products are sometimes inadequate. To better understand the effectiveness of cover cropping for pest management in tulip, four trials were conducted in western Washington. The first was conducted in a commercial tulip field where mustard or cereal rye plus pea were sown in midsummer, killed with tillage alone or with glyphosate plus tillage, then transplanted to tulip. During the two and half years of this trial, no significant impacts of cover crop on weed or tulip foliar biomass, flower quality, or bulb yield have been observed. A second field trial is being conducted at WSU NWREC in which the same cover crops were seeded in early July or early August, treated with glyphosate, and either incorporated or left on soil surface before bulb transplanting. Weed biomass was suppressed at least 69% and 98% in 2013 and 2014, respectively, before cover crop termination. Reduced tulip foliar biomass and bulb yield loss caused by *Botrytis tulipae* were significantly reduced by the late-seeded cereal rye plus pea mixture according to the first year data. In an outdoor pot trial, the same cover crops and seeding timings as in the research field trial were applied to four tulip cultivars. Weed biomass was suppressed at least 85% and 38% in 2013 and 2014 before cover crop termination. Tulip bulb yield did not differ by cover crop treatment or tulip variety, due to highly variable first-year data. In a second greenhouse trial, forced tulip bulbs of four cultivars were treated with three rates of dry cover crop materials either incorporated or left on the soil surface. Flower quality did not differ among the treatments. Taken together, these data indicate that cover cropping does not negatively affect tulip production, may decrease weed growth prior to tulip transplanting, and aid in the suppression of certain soilborne tulip diseases.

Field Bindweed Control in Small Fruits with Quinclorac. Ed Peachey*[1], Jessica Green[2]; [1]Oregon State University, 97331, OR, [2]Oregon State Univeristy, Corvallis, OR (088)

Field and hedge bindweed interfere with small fruit production by reducing yields and interfering with cultural practices and harvest equipment. Quinclorac herbicide controls bindweed very well but crop safety has not been demonstrated for small fruit crops such as blackberries, raspberries and blueberries. Experiments were conducted at 12 sites from 2008 through 2014 throughout western Oregon to demonstrate crop safety to quinclorac and develop effective use patterns. Quinclorac was directed next to the crop row at 0.375 or 0.75 lb ai/A 30 d before harvest, after harvest, or in the fall before the first frost. Quinclorac broadcast over-the-top of micro-propagated blackberries and rooted raspberry cuttings had no impact on plant height or primocane growth. At one site, quinclorac applied to AY (alternate year harvest) Marionberries at 0.75 lb ai/A may have reduced yield by five percent. In a plot of EY (every year harvest) Marionberries, quinclorac applied consecutively in the fall and spring may have reduced yield slightly at 0.75 lb ai/A. In raspberries, quinclorac may have reduced yield when applied at 0.75 lb ai/A in the spring when applied in consecutive years. Blueberry growth and yield was unaffected by quinclorac. Bindweed control improved if quinclorac was applied to bindweed that was just emerging in the spring rather than 30 days before first harvest. Overall, small fruit tolerance to quinclorac was adequate at the typical use rate of 0.375 lb ai/A.

Absorption and Translocation of Glyphosate in Gala Apple on M9 Rootstock. Alan J. Raeder*, Ian C. Burke; Washington State University, Pullman, WA (089)

Observations of glyphosate injury to apple trees have increased as high-density apple orchards have become more common, and growers are now concerned that applications of glyphosate could be leading to an accumulation of glyphosate in the trees. The study objective was to quantify absorption and translocation of glyphosate in apple trees based on application site. Dormant 'Gala' trees (caliper size < 1.25cm) grafted on an M.9 rootstock were potted in a greenhouse. The trees were allowed to break dormancy, set leaves, and flower before treatment application. Treatments included a below graft basal (BGB), above graft basal (AGB), and foliar application of ^{14}C-glyphosate. Trees were harvested 1, 7, 14, and 28 days after treatment (DAT). At each harvest interval, the treated leaf or bark section was harvested and the tree was partitioned into 30 cm sections. In each section, leaves and stems were separated before plant parts were dried, weighed, subsampled, and oxidized. Average recovery of ^{14}C-glyphosate was 92%. Basal applications resulted in increased absorption of glyphosate compared to foliar application. Average absorption of glyphosate 28 DAT was 87 and 93% for BGB and AGB applications, respectively, but only 45% in the foliar application. Translocation 28 DAT was <3% of the absorbed herbicide for BGB, AGB, and foliar applications. While translocation of glyphosate from the treated sections is low, the absorption observed by basal applications compared to foliar application is troubling and at variance with previously reported behavior of glyphosate. Additional evaluation of absorption of glyphosate through bark, in both lab and field conditions, is necessary to confirm the result.

PROJECT 3: WEEDS OF AGRONOMIC CROPS

Expanding Distribution of Glyphosate-Resistant Palmer Amaranth in Kansas. Phillip W. Stahlman*[1], Jennifer Jester[1], Amar S. Godar[2], Mithila Jugulam[2], Dallas E. Peterson[2], Curtis R. Thompson[2], Randall S. Currie[3]; [1]Kansas State University, Hays, KS, [2]Kansas State University, Manhattan, KS, [3]Kansas State University, Garden City, KS (090)

Palmer amaranth has increased in abundance and distribution throughout much of Kansas during the past two decades. The first case of confirmed glyphosate resistance in Palmer amaranth in the state was in 2011. Other Palmer amaranth populations exhibiting lack of control from glyphosate treatment in 2012 were tested but none had sufficiently altered levels of EPSPS enzyme to declare them resistant to glyphosate. However, early in the 2014 summer crop growing season there were numerous reports of glyphosate ineffectiveness in controlling Palmer amaranth throughout several counties in south-central and southwestern Kansas. Inspection of many fields revealed plant response symptomology consistent with glyphosate resistance evolution in kochia, such as variable Palmer amaranth response to glyphosate including arrested growth and side-by-side dead and live plants; response consistent with a segregating population. Seed was collected from more than 150 populations covering 26 counties for greenhouse trials that are testing for resistance to multiple herbicides.

Molecular Basis of Glyphosate Resistance and the Rapid Necrosis Response in Giant Ragweed. Christopher R. Van Horn*[1], Philip Westra[2]; [1]Colorado State University, Fort Collins, CO, [2]Colorado State University, Ft. Collins, CO (091)

The introduction of glyphosate resistant crops along with widespread multiple in-season applications of glyphosate as part of weed management strategies that fail to address long-term weed control have provided the perfect scenario to foster the recent boom in glyphosate resistant weeds. In order to implement best strategies to manage glyphosate resistant weeds, it is important to understand the mechanism of resistance. Glyphosate targets and inhibits the enzyme 5-enolpyruvalshikimate-3-phosphate synthase (EPSPS), which prevents the synthesis of essential aromatic amino acids. The unique aspect of resistance in giant ragweed is the rapid necrosis response. Never before has glyphosate been shown to induce a hypersensitive-like response in plants. H_2O_2 accumulation has been observed as early as 30 minutes after glyphosate application. The resistant biotype (RN) is approximately 6-fold more resistant than the susceptible (S) biotype at the glyphosate labeled rate. Shikimate data suggests resistance is not due to a less sensitive form of the target enzyme. Sequence analysis showed no nucleotide mutation at the Proline-106 target site region across all populations sequenced. A transcriptomics analysis will be used to observe gene expression and identify candidate genes that may play a role in resistance. These initial results provide a much needed framework for the future of giant ragweed glyphosate resistance research, which becomes increasingly important as the use of glyphosate-resistant crops develops world-wide.

Glufosinate Efficacy with Tank-Mix Partners and Droplet Size. Kirk A. Howatt*, Richard K. Zollinger; NDSU, Fargo, ND (092)

The threat and reality of glyphosate-resistant weed biotypes is promoting interest in glufosinate-resistant crops. This especially is true for weed control in soybean because control of several broadleaf weeds can be difficult with existing chemistries. Evaluating weed control for glufosiante-based programs where large spray droplet size is desired to mitigate particle drift is important because large droplets may not provide as much coverage of leaf area compared to previous research protocol. Three trials have demonstrated control with glufosinate in coarse or very coarse droplet size generally to be equal to or better than control when applied in fine and medium droplets. Two of these studies with prescribed spray volume differences showed greater control with more water volume from 5 to 20 gpa, with 10 and 15 gpa providing generally similar control. In the third study, glufosinate provided exceptional and similar weed control across most species present regardless of tank-mix partner or droplet size. However, yellow foxtail control at the margin of the spray pattern was as much as 10 percentage points greater with medium to coarse droplets than with very to extremely coarse droplets. Addition of clethodim did not improve yellow foxtail control, but 2,4-D or dicamba did not antagonize glufosinate efficacy either. Also in this study, 2,4-D or dicamba provided residual activity against broadleaf weeds that resulted in 65 to 99% control at mid-August evaluation in plots without crop canopy. Greater residual benefit was observed with tips that produced smaller droplet size.

Glyphosate-Resistant Kochia Management in Canola. Eric P. Westra*[1], Scott J. Nissen[1], Andrew R. Kniss[2], Todd A. Gaines[1]; [1]Colorado State University, Fort Collins, CO, [2]University of Wyoming, Laramie, WY (093)

Glyphosate-resistant kochia (*Kochia scoparia*) has become a serious problem for canola producers in Canada. A field study was initiated to evaluate the impact of several herbicide management strategies on the further evolution of glyphosate-resistant kochia in canola production. RoundUp Ready (DKL 30-42), and Liberty Link (InVigor L130) canola varieties were planted in a split plot design. Kochia (10% glyphosate-resistant: 90% glyphosate-susceptible) was seeded into each plot to achieve a density of 270 plants m^{-2}. Treatments were post only (glyphosate or glufosinate), pre (pendimethalin) + post, hand weeded check, and a weedy check. Canola and kochia densities were measured after emergence and after post-emergent herbicide applications. Canola yield and kochia biomass were determined and a subsample of kochia seed from each plot was screened for changes in the frequency of glyphosate-resistant. Pendimethalin significantly reduced the number of kochia plants subsequently exposed to post emergent herbicides, but did result in canola injury that reduced yield. Glyphosate only treatments slightly stunted glyphosate-resistant kochia, and the combination with canola competition significantly reduced kochia densities. There was a similar reduction with glufosinate treatments. Phenotypic differences in canola varieties resulted in more kochia surviving in weedy Liberty Link plots compared to RoundUp Ready, resulting in greater yield penalties. By screening kochia in the greenhouse, we will determine changes in the frequency of glyphosate-resistant. Originally, we hypothesized that glyphosate-resistance evolution would be highest in glyphosate only treatments, and reduced in treatments that included glufosinate and pendimethalin; however, we may be underestimating crop competition as an important component in resistance management.

Kochia Control Strategies. Phillip W. Stahlman*, Jennifer Jester, David A. Brachtenbach; Kansas State University, Hays, KS (094)

Kochia has been a major weed in cropland for decades but in recent years it has become especially troublesome throughout semi-arid regions of the North American Great Plains as a result of evolved resistance to glyphosate. When moisture is adequate most kochia seed produced the previous year emerges within about a two-week period in early spring, as early as mid- to late-February in Oklahoma and southwest Kansas and progressively later in more northern latitudes. Emergences slows after the initial flush but continues with some plants emerging as late as July. The control implications of this emergence pattern are that the first flush of kochia needs to be controlled early in the growing season and later emerging plants will require an extended period of residual control. Based on research findings, many Kansas growers have adopted the practice of applying soil-active herbicides, such as various mixtures of atrazine, dicamba, isoxaflutole or metribuzin, in early spring prior to kochia emergence. However, wet soils can interfere with early spring herbicide application, especially in more northern parts of the Great Plains. Multiple field trials were conducted in western Kansas to assess whether applying the herbicides in late November or early December, when wet soils typically are less of an issue than in early spring, might be an effective alternative application strategy. Results were mixed in 2014 with some herbicide treatments applied the previous fall performing as well or nearly as well compared to when the same herbicides were applied in early spring, whereas other fall-applied treatments were not as effective as when applied in early spring. Additional research is needed to fully assess the practicality and effectiveness of late-fall herbicide application for control of kochia the following spring.

Correlation of EPSPS Gene Amplification with Resistance Level and Fitness of Glyphosate-Resistant Kochia. Vipan Kumar*[1], Prashant Jha[1], Shane Leland[1], Charlemagne Alexander A. Lim[2], Swayamdipta Misra[3]; [1]Montana State University, Huntley, MT, [2]Monatana State University, Huntley, MT, [3]University of Georgia, Athens, GA (095)

Evolution and rapid spread of glyphosate-resistant (GR) kochia is an increasing threat to no-till wheat-fallow and GR cropping systems in the US Great Plains. We confirmed 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS*) gene amplification as a mechanism of glyphosate resistance in GR kochia accessions collected from wheat-fallow fields in Montana. Gene amplification may impact the growth and fitness of GR kochia due to (1) metabolic cost incurred on additional EPSPS enzyme synthesis, and (2) functional disruption of other genes by amplified copies of the *EPSPS* in GR kochia genome. Greenhouse experiments were conducted in 2013 and 2014 to investigate the effect of the *EPSPS* gene amplification on (1) fitness traits and (2) glyphosate resistance level in GR kochia. Inbred lines (developed after three generations of recurrent selection with glyphosate and two generations of selfing under pollen isolation conditions) of glyphosate-susceptible (SUS) and GR kochia (CHES01 and JOP01 accessions) were grown under intraspecific competition at 1, 85, and 170 plants m^{-2}. Results indicated no differences in growth and fitness of GR vs. SUS kochia on the basis of plant height, width, branches, leaf area, shoot biomass, seed production, progeny 1000-seed weight, seed viability, seed germination, and radicle length. Survival of GR kochia with glyphosate at 870 (field-use rate) and 4350 g ae ha^{-1} (five times the field use-rate) was assessed. GR plants with ~ 2 to 4 *EPSPS* gene copies survived the field-use rate, but failed to survive the 4350 g ha^{-1} rate of glyphosate. In contrast, GR plants with ~ 5 to 14 *EPSPS* gene copies survived 4350 g ha^{-1} of glyphosate. No fitness cost conferred by *EPSPS* gene amplification and the additive effect of the gene amplification on glyphosate-resistance level suggest that GR kochia with high *EPSPS* gene copies will most likely persist in field populations, irrespective of glyphosate selection pressure.

Impacts of Environmental and Biological Stressors on the Demography of Multiple Herbicide Resistant Wild Oat in Montana. Erin Burns*, Barb K. Keith, Erik Lehnhoff, William E. Dyer, Fabian D. Menalled; Montana State University, Bozeman, MT (096)

Abstract not available.

Sustaining Herbicide Efficacy: Preventing the Distribution of Multiple Resistant Italian Ryegrass Seed During Winter Wheat Harvest by Removal/Destruction of Chaff. Kyle C. Roerig*, Andrew G. Hulting, Daniel W. Curtis, Carol Mallory-Smith; Oregon State University, Corvallis, OR (097)

Italian ryegrass resistant to multiple herbicide sites of action continues to limit winter wheat production in western Oregon. Italian ryegrass populations are currently documented to be resistant to a number of herbicides representing four different herbicide groups. An Italian ryegrass plant does not have the means to distribute its seed more than a few meters, however, harvest equipment does. Some progress has been made in controlling weeds seeds in the chaff using collection carts, narrow windrow burning, seed destruction or placing the chaff on top of the straw for baling. A trial was initiated to test the feasibility and efficacy of weed seed management at harvest. This trial focused on the reduction of the population. Treatments included an untreated check (no herbicide, standard harvest practices), propoxycarbazone, propoxycarbazone plus harvest using a chaff collection system and chaff collection alone. Propoxycarbazone was chosen as the herbicide treatment because it was expected to provide marginal control of Italian ryegrass. Thus Italian ryegrass with no herbicide resistance could be planted and we could achieve approximately 50-70% control thereby simulating the level of control which might occur in a wheat field with resistant Italian ryegrass using the most effective herbicides. Two years of harvest with the chaff collector and application of propoxycarbazone reduced populations 40%, to an average of 441 plants per m^2compared to the check which had an average of 732. Populations with the chaff collection alone or propoxycarbazone treatments were not different from the check at p-value 0.05. These results indicate that preventing Italian ryegrass seed dispersal at harvest can reduce population densities; however, it remains to be seen whether this reduction can substantially increase yield of winter wheat.

The Potential for Harvest Weed Seed Control on the Canadian Prairies. Breanne Tidemann*[1], K. Neil Harker[2], Linda Hall[1]; [1]University of Alberta, Edmonton, AB, [2]Agriculture and Agri-Food Canada, Lacombe, AB (098)

As the incidence of herbicide resistance increases, and with no new herbicide modes of action released in over 20 years, new weed management methods are required. Harvest Weed Seed Control (HWSC) has been widely adopted in Australia and has proven effective at controlling problematic weeds. For HWSC to be effective, weed seeds must be produced at a collectible height, and must be retained on the plant at crop maturity. Cleavers (*Galium spurium* L.), canola (*Brassica napus* L.), and wild oat (*Avena fatua* L.) were cross-seeded with 1x and 2x seeding rates of wheat and fababean to determine seed retention and height of seed production at 3 locations in Western Canada. Seed loss was quantified using shatter trays collected twice a week, and number of seeds retained determined at wheat swath timing, wheat direct harvest timing and fababean direct harvest timing. During plant harvests, weeds were sectioned into four heights (0-15cm, 15-30cm, 30-45cm, and 45+cm) to determine the height of seed production. Results after one year of the trial indicate variability in seed retention between sites, likely due to environment and weed competition differences. Volunteer canola retained the highest amounts of seed with over 90% retention at all sites. Cleavers seed were well retained until swathing (>80%) after which losses at some sites were rapid with final retention varying between 10-80%. Wild oat had the lowest retention values with between 10-40% retention. Wild oat (>96%) and canola (>98%) produce the majority of their seed in the highest fraction of 45+cm when averaged across treatments. Cleavers retains a minimum of 85% of its seed in the collectible height fraction (>15cm) when averaged across treatments. Based on a single year (2014), these results indicate that canola is likely compatible with HWSC although cleavers may require swathing to be collected. High wild oat seed loss indicates far less potential for control with HWSC methods. Variability in retention between sites indicates seed retention may vary by location and potentially year, making it more difficult to determine target weeds.

Winter wheat and Italian Ryegrass Response to Fall and Spring Applications of Pyroxasulfone. Ian C. Burke*, Louise H. Lorent; Washington State University, Pullman, WA (099)

Pyroxasulfone is a recently developed herbicide in the isoxazoline family with a low water solubility and low sorption coefficient, and has the potential to be readily available for seedling absorption without leaching past the seed zone. Three studies were conducted near Pullman, WA in 2013-2014 to evaluate the safety of pyroxasulfone on winter wheat and the efficacy of pyroxasulfone on Italian ryegrass [*Lolium perenne* L. ssp. *Multiflorum* (Lam.) Husnot]. Two studies were based on small plots using a randomized complete block design with four replications. Treatments consisted in preemergence (PRE) applications of pyroxasulfone at a rate of 30 or 36 g ai ha^{-1}; delayed preemergence (delayed PRE) applications of pyroxasulfone applied at 30 or 36 g ai ha^{-1} applied alone or mixed with metribuzin at 31 g ai ha^{-1}; postemergence (POST) application of pyroxasulfone a 48 g ai ha^{-1}, pinoxaden at 24 g ai ha^{-1} or pyroxasulfone at 48 g ai ha^{-1} plus pinoxaden at 24 g ai ha^{-1}. To compare pyroxasulfone to an herbicide with the same mode of action (inhibition of very long chain fatty acid synthesis), flufenacet at 154 g ai ha^{-1} plus metribuzin at 36 g ai ha^{-1} was applied as a delayed PRE. PRE and delayed PRE applications were followed by 0.6 cm of supplemental water applied through a plot-sized PVC-pipe sprinkler system. Plots were harvested using a 1.5 m header combine. One of the small-plot studies was kept weed-free to investigate winter wheat response. No injury was observed on winter wheat during the growing season. Treatment did not significantly affect wheat test weight or yield. The other small-plot study was kept free of broadleaf weeds to investigate winter wheat and Italian ryegrass response. Italian ryegrass control was significantly lower when pyroxasulfone was applied POST rather than PRE or delayed PRE. Differences in weed control did not translate into wheat yield or test weight differences. Pyroxasulfone plus metribuzin treatments were as safe and as efficacious as flufenacet plus metribuzin. A third study was set up as a large scale trial to simulate herbicide utilization by growers. Treatments consisted of PRE applications of pyroxasulfone at 30 or 36 g ai ha^{-1}; delayed PRE applications of pyroxasulfone applied at 30 or at 36 g ai ha^{-1} applied alone, and pyroxasulfone applied at 36 g ai ha^{-1} mixed with metribuzin at 31 g ai ha^{-1}; and a POST application of pyroxasulfone at 48 g ai ha^{-1} plus pinoxaden at 24 g ai ha^{-1}. Each treatment was applied to a one strip approximately 30 m wide by 660 m long. Strips were adjacent to each other and varied in topography. Nontreated control consisted of randomly assigned GPS locations within each strip, and were covered by a 1.8 m by 2.4 m plastic tarp during herbicide application. Tarps were removed shortly after application. All treatments significantly reduced Italian ryegrass populations compared to a non-treated check. Pyroxasulfone plus metribuzin applied as a delayed PRE reduced the Italian ryegrass population by more than 90% of the nontreated control levels. Pyroxasulfone applied as an early PRE at 30 g ai ha^{-1} reduced wheat biomass by 7% compared to the nontreated control, but the biomass reduction did translate to grain yield reduction. Pyroxasulfone plus pinoxaden applied as a POST resulted in a biomass reduction of 15% and a grain yield of 16% compared to the non-treated check. All three studies corroborated the safety of pyroxasulfone applied PRE or delayed PRE on winter wheat, and the efficacy of the herbicide on Italian ryegrass when applied PRE or delayed PRE at 36 g ai ha^{-1}, preferably mixed with metribuzin.

Weed Control and Crop Injury Studies with Saflufenacil in California Alfalfa. Steve B. Orloff*[1], Mick Canevari[2]; [1]University of California, Yreka, CA, [2]University of California, Stockton, CA (100)

No new herbicide registrations have occurred for California alfalfa in over a decade. A new postemergence herbicide would be desirable to control weeds that escape many current weed management programs and to include as part of an integrated weed control system to avoid the evolution of herbicide resistant weeds in alfalfa production systems. The herbicide saflufenacil is used in other cropping systems and has potential for use in alfalfa for broadleaf weed control. A total of eight trials have been conducted since 2010 in San Joaquin County (Central Valley of California) and over the past 2 years in Siskiyou County (Intermountain Region) to evaluate the spectrum of weeds controlled with saflufenacil in alfalfa and to ascertain the safety of saflufenacil when applied in late winter and after the first harvest in spring. Saflufenacil was evaluated at both locations at 50 and 100 g/ha with methylated seed oil (MSO) at 1% v/v. It was compared with paraquat at 560 g/ha with NIS at 0.25% v/v to measure crop tolerance. In addition to these core treatments, standard herbicides used in alfalfa including hexazinone, metribuzin, flumioxazin, pendimethalin, sethoxydim and imazamox were used in combination with saflufenacil for in efficacy trails. Crop injury was by visually estimated by comparing the degree of leaf burn and stunting to an untreated check. Saflufenacil caused a more complete burndown of alfalfa foliage than did paraquat. Initial alfalfa burndown ratings, approximately 1 week after application, exceeded 60 percent and 80 percent for the 50 and 100 g/ha rates, respectively. In contrast, the rating for paraquat, across multiple trials, was approximately 40 percent. A growth reduction from the saflufenacil applications was still evident 60 days after application but was not significant at first harvest and did not result in a yield reduction. Although not significant, there was a consistent trend for slightly reduced yield in the saflufenacil-treated plots (<0.45 Mg ha^{-1} reduction) in the Intermountain Region. An in-season application of saflufenacil between alfalfa harvests resulted in yield decrease when the interval between application and harvest was too short (23 days or less). In most trials, saflufenacil provided better than 90 percent control of common annual broadleaf weeds including shepherd's purse (*Capsella bursa-pastoris*), chickweed (*Stellaria media*) and the troublesome toxic weed common groundsel (*Senecio vulgaris*), which oftentimes escapes adequate control with standard winter dormant applications of hexazinone or paraquat. Control of these weeds, and especially annual grasses, was improved by combining saflufenacil with hexazinone, pendimethalin, and flumioxazin, but alfalfa injury increased with flumioxazin combinations. Saflufenacil shows promise for use in California alfalfa but additional research is needed, and is currently underway, to further define the alfalfa growth stage at which saflufenacil can be safely applied and the appropriate interval between application and first harvest to avoid excessive crop injury.

Tillage, Irrigation, and Nitrogen Effects on Weeds in Sugar Beets. Kelli M. Belmont*, Don Morishita, Kyle G. Frandsen; University of Idaho, Kimberly, ID (108)

The amount of tillage, irrigation, and nitrogen fertilizer applied in a cropping system has been shown to influence weed populations and diversity. Strip tillage and direct seeding became economically viable after glyphosate-resistant technology was introduced in sugar beet. A field study was conducted in 2013 and 2014 to determine the effect of irrigation amount, nitrogen fertilizer rate, and level of tillage on weeds in sugar beet. Three crop residue levels were established using conventional tillage (CT), strip tillage (ST), and direct seed (DS). Irrigation treatments were based on sugar beet evapotranspiration (ET) and were 50, 100, and 150% of ET. Four nitrogen (N) fertility rates were applied: 60, 80, 100, and 120% of recommended rates for CT sugar beets. Weed seedling emergence counts were made within a 0.125 m^2 area both in- and between-rows of every plot four times. Glyphosate was applied at the 2-leaf crop stage at 0.84 kg ha^{-1} and two more times at 15 day intervals in combination with dimethenamid-P at 0.95 kg ha^{-1} at the second application. Weed populations, such as CHEAL ($p=0.0077$) and SETVI ($p < 0.0001$), were significantly affected by a tillage and irrigation interaction early in the spray season. By mid spray season, there was a significant tillage by irrigation by N fertilizer rate with CT having a greater weed abundance in CHEAL (p=0.0427) and SETVI (p=0.049). However, by the end of the spray season, weed populations were primarily affected by the main effects, such as tillage, only.

Grass Weed Control with Rimsulfuron in Cool Season Grasses Grown for Seed. Daniel W. Curtis*, Kyle C. Roerig, Andrew G. Hulting, Carol Mallory-Smith; Oregon State University, Corvallis, OR (109)

Oregon's seed industry is built on the ability to produce pure seed. For decades, utilization of a narrow band of activated carbon over newly seeded rows has minimized crop injury of a preemergence diuron application while controlling weeds between the rows. However, diuron resistant *Poa annua* is now found in many grass seed fields in the Willamette Valley. Recently, *P. trivialis* has emerged as another weed contaminate in seed. Oregon State University studies with rimsulfuron since 2011 have shown a high degree of tolerance in carbon seeded perennial ryegrass to preemergent applications of rimsulfuron. This research has included *P. annua* and *P. trivialis* seed obtained from samples provided by area growers. These *P. annua* and *P. trivialis* populations have variable susceptibility to rimsulfuron as well as to diuron and pronamide which are registered for use with carbon seeding in grasses grown for seed. In a 2012-2013 carbon seeding study, preemergence applications of rimsulfuron controlled 30% of *P. annua* and 32% of *P. trivialis* seedlings. Diuron followed by (fb) ethofumesate controlled 30% of *P. annua* and 40% of *P. trivialis* seedlings. Diuron + pronamide fb ethofumesate controlled both species 96% or greater. In a 2013-2014 study, rimsulfuron controlled greater than 90% of both species and diuron + pronamide controlled 75% of the *P. annua*. Pronamide alone controlled 65% of *P. annua* and 78% of *P. trivialis*. Combinations of rimsulfuron with increasing rates of pronamide resulted in greater than 97% control. Yields were not reduced by any of the treatments. Dry conditions slowed growth of *P. annua* and *P. trivialis* in this study and then the planting was subjected to a period of very low temperatures (3 F) when the *Poa* species were at the early tillering stage. In 2014, rimsulfuron was evaluated for fall carbon seeding of tall fescue which must be planted earlier than perennial ryegrass to enable adequate vernalization to occur. Irrigation was used to activate the herbicides and germinate the seed. In this study, early evaluations show control of 75% of *P. annua* and 90% of *P. trivialis* with rimsulfuron and 70% control of *P. annua* and 87% of *P. trivialis* with diuron + ethofumesate. Rimsulfuron + pronamide provided 94% or greater control of both species, while the diuron + pronamide treatment provided 100% control. In a second study with carbon seeded perennial ryegrass planted three weeks later, rimsulfuron control is 90% of *P. annua*, an increase of 15% compared to the tall fescue study, and 97% of *P. trivialis*. Diuron followed by ethofumesate controlled both species greater than 95%, again a substantial increase in control of *P. annua*. Rimsulfuron + pronamide and diuron + pronamide controlled 100% of the two species. Fall temperatures were mild until a week of low temperatures occurred when *Poa* species were in the 1 to 2 leaf stage in the perennial ryegrass planting and had several tillers in the tall fescue planting. These two current studies show the variable control that can occur with diuron, pronamide and rimsulfuron. The addition of a low rate of pronamide to the rimsulfuron treatment provided the level of *P. annua* and *P. trivialis* control the industry needs. An IR-4 project for rimsulfuron use in grasses grown for seed IR-4 project is nearing completion.

The Effects of Simulated Weed Canopies on Sugarbeet Growth. Thomas J. Schambow*, Andrew R. Kniss; University of Wyoming, Laramie, WY (110)

Light reflected from weed canopies may cause a shade avoidance response in many plant species. Shade avoidance responses can influence plant growth, potentially increasing internode length, changing leaf angle and reducing yields. Experiments were conducted on three subspecies of *Beta vulgaris* (sugarbeet, Swiss chard and table beet) to determine if light reflected by nearby weeds or colored plastic mulch would alter growth. Plants were grown individually in five gallon pales surrounded by the light treatment. Each plant was grown so that no direct competition for other resources occurred, increasing the likelihood that light quality was solely responsible for any observed differences in *Beta vulgaris* growth. Non-destructive measurements during the growing season included weekly petiole and leaf lengths, leaf angles and growth stages. At harvest, petiole and leaf length, leaf number and leaf area, leaf biomass, root diameter, root length, and root weight were measured. Growth differences were observed between light treatments within 60 days after planting in all three subspecies. Sugarbeet grown in a weed-free environment reached the 10 true-leaf stage 39 days after planting (DAP), whereas plants grown in a weedy environment required 58 DAP to reach the same growth stage. At harvest, sugarbeet grown in the weed-free treatment had an average root weight of 287 g, compared to 85 g in the weedy treatment. This data suggests shade avoidance responses may be responsible for significant reduction in *Beta vulgaris* growth. This has direct implications for early-season weed control.

Utilizing Winter Rye for Weed Suppression in Soybeans. Mike H. Ostlie*, Steve Zwinger; North Dakota State University, Carrington, ND (111)

Soybeans are a staple of production agriculture across much of the United States. Traditionally, soybeans have suffered from few pest and management issues compared to other commodity crops. More recent problems, such as herbicide resistant weeds, soil erosion, and increasing soil salinity, have made soybean production in certain areas more difficult. Cover crop utilization is one way that these issues can be mitigated. However, in northern climates the growing season is too short to effectively utilize many cover crops before or after soybean production. There is a growing resurgence in the interest in winter rye as a cover and cash crop in the northern Great Plains. Winter rye has a number of unique characteristics that synergize with soybeans, including allelopathy, salt tolerance, and fall residue for winter soil cover. In the fall of 2013 winter rye was planted. The following spring, soybeans were direct seeded into the rye. The goal of the study was to evaluate different methods and timing of rye removal. Soybeans were planted at rye jointing. Rye removal methods included tillage (soybean pre-plant only), spraying (soybean pre-plant and at rye anthesis) and mowing (rye anthesis only). Winter rye provided 30-70% suppression of kochia prior to soybean planting, varying with rye stand. At the end of the season, the best weed management practice was to allow rye to reach anthesis and apply glyphosate. This provided a temporary canopy until the soybeans grew through the rye. Soybean yields were impacted by the removal strategy. The highest soybean yield was achieved with applying glyphosate to the rye prior to soybean planting. Other rye removal strategies were similar to each other in soybean yield, including the no-rye check. In areas with soil erosion, salinity, or weed management problems, winter rye could be an alternative biological solution for soybeans.

Residual Corn Herbicide Effects on Fall Cover Crop Establishment. Jenna Meeks*[1], Andrew R. Kniss[2]; [1]University of Wyoming, Lingle, WY, [2]University of Wyoming, Laramie, WY (112)

Due to a short growing season, cover crops in southeast Wyoming may need to be planted in mid- to late-summer to reach optimal growth potential. Cover crops seeded into corn may be susceptible to residual herbicides used in corn. A field study was conducted in the fall of 2014 to determine biomass reduction of annual ryegrass, crimson clover, rapeseed, turnip, and radish due to residual effects of 8 herbicides. Corn herbicides were applied at 6 rates using a half-step logarithmic sprayer. Atrazine, dicamba, dimethenamid-P, glyphosate, pyroxasulfone, S-metolachlor, saflufenacil, and 2,4-D were applied at 1x, 0.5x, 0.25x, 0.13x, 0.06x and 0.03x rates on August 21, 2014 and plots were seeded on August 29. Aboveground biomass was collected from 0.46m^2 quadrats in each plot on October 29. A significant rate response on total cover crop biomass was observed for atrazine and pyroxasulfone ($P<0.01$). Atrazine rates greater than 0.07 and 0.43 kg ai/ha reduced biomass ≥10% for annual ryegrass and turnip, respectively. Pyroxasulfone caused ≥10% biomass reduction of annual ryegrass, rapeseed, and turnip at rates greater than 0.01, 0.04, and 0.02 kg ai/ha, respectively. S-metolachlor decreased biomass of annual ryegrass ≥10% at rates greater than 0.24 kg ai/ha. Results suggest rotation intervals could be shortened for herbicides which did not cause a significant decrease in biomass production of these cover crops.

Postemergence Herbicide Control of Canada Thistle in Corn. Gregory J. Endres*; NDSU, Carrington, ND (113)

A field study was conducted in 2013 at the North Dakota State University Carrington Research Extension Center to examine control of Canada thistle (*Cirsium arvense*) in corn with selected POST herbicides. Experimental design was a randomized complete block with four replicates. Roundup Ready corn was planted into untilled wheat stubble on May 14. SureStart (acetochlor & clopyralid & flumetsulam & diclormid) at 38 fl oz/A + Roundup PowerMax (glyphosate) at 32 fl oz/A + Class Act NG at 32 fl oz/A was PRE applied to all plots on May 23 to emerging to 3-inch tall Canada thistle. Eight POST herbicide treatments were applied June 17 to 2 to 15-inch tall Canada thistle and V3- to V4-stage corn: Roundup PowerMax (glyphosate) at 22 fl oz/A + Class Act NG (surfactant & AMS) at 2.5% v/v; Widematch (clopyralid & fluroxypyr) at 21.3 fl oz/A; Capreno (tembotrione & thiencarbazone & isoxadifen) at 3 fl oz/A + Aatrex 4L (atrazine) at 16 fl oz/A + Destiny HC (high surfactant methylated seed oil) at 1% v/v + UAN at 48 fl oz/A; Halex GT (mesotrione & glyphosate-K & S-metolachlor) at 64 fl oz/A + Aatrex 4L at 16 fl oz/A + Class Act NG at 2.5% v/v; Laudis (tembotrione & isoxadifen) at 3 fl oz/A + Aatrex 4L at 16 fl oz/A + Destiny HC at 1% v/v + UAN at 48 fl oz/A; Status (dicamba & diflufenzopyr) at 5 and 10 oz wt/A + Class Act NG at 2.5% v/v + Superb HC (high surfactant petroleum oil concentrate) at 0.5% v/v; and Armezon (topramezone) at 1 oz wt/A + Aatrex 4L at 16 fl oz/A + Destiny HC at 1% v/v + UAN at 48 fl oz/A. Status at 5 and 10 fl oz/A provided 82 to 83% control 1 mo after treatment

(MAT). Canada thistle was suppressed (64 to 76% control) 2 MAT with Roundup PowerMax, WideMatch, Halex GT plus Aatrex 4L and Status. At 3 MAT, Status at 10 fl oz/A provided suppression (71%), while control with other herbicides ranged from 23 to 61%. Full-season control of Canada thistle in corn was not satisfactory with the PRE followed by selected POST herbicides.

Dry Bean Growth and Development in Reduced Tillage Systems. Clint W. Beiermann*, Andrew R. Kniss, David A. Claypool; University of Wyoming, Laramie, WY (114)

Conventional harvest methods for dry bean production are time and energy intensive and leave fields with little residue cover at the end of the growing season. Direct harvest methods increase time and energy efficiency but can result in greater harvest loss. The perceived increase in harvest loss has limited adoption of direct harvest by many producers in Wyoming. Cultural practices that influence dry bean to grow taller or produce pods higher above the soil surface could reduce harvest loss when direct harvesting. A large-scale field study was conducted in 2014 to determine whether planting dry bean into standing wheat stubble could alter dry bean growth and reduce losses when direct harvesting. Wheat stubble was cut at 19, 25, and 36 cm heights the year prior to the study and no tillage was done before dry bean was planted. Dry bean was drilled into 25 cm rows on May 22, 2014. There was a significant effect of stubble height on dry bean plant height recorded on July 16th. Dry bean planted into 36 cm high wheat stubble had an average total plant height of 39 cm compared to 36 cm for dry beans planted into 19 cm wheat stubble. Dry bean yield was reduced as wheat stubble height increased. Dry bean yield was 15% greater when planted into 19 cm wheat stubble compared to dry bean planted into 36 cm wheat stubble. There was no significant difference in harvest loss among the stubble height treatments.

Crop Safety and Efficacy of Thiencarbazone-methyl plus Broadleaf Herbicides in Wheat. Dean W. Maruska*[1], Steven R. King[2], Kevin B. Thorsness[3], Michael C. Smith[4], Charlie P. Hicks[5], George S. Simkins[6], Mark A. Wrucke[7]; [1]Bayer CropScience, Warren, MN, [2]Bayer CropScience, Research Triangle Park, NC, [3]Bayer CropScience, Fargo, ND, [4]Bayer CropScience, Sabin, MN, [5]Bayer CropScience, Fort Collins, CO, [6]Bayer CropScience, St. Paul, MN, [7]Bayer CropScience, Farmington, MN (131)

Varro® is a new postemergence grass herbicide that has been developed by Bayer CropScience for use in spring wheat, durum wheat, and winter wheat. Varro is a pre-formulated mixture containing thiencarbazone-methyl and the highly effective herbicide safener, mefenpyr-diethyl. Varro provides consistent control of the most common annual grass species of the northern plains with excellent crop tolerance. Rapid microbial degradation is the primary degradation pathway for thiencarbazone-methyl and mefenpyr-diethyl has no soil activity. Therefore, Varro has an excellent crop rotation profile, allowing re-cropping to the major crops grown in the northern cereal production area including peas and lentils. Varro was successfully launched in the northern plains cereal production area in 2014.

Varro is specially formulated as a liquid for easy handling and optimized for grass weed control. Varro at 6.85 fl oz/A can be applied to wheat from emergence up to 60 days prior to harvest. Grass weeds should be treated with Varro between the 1-leaf and 2-tiller stage of growth depending on the species. Varro also readily mixes with many broadleaf herbicides for cross-spectrum grass and broadleaf weed control.

Varro provides control of ACC-ase resistant and susceptible wild oat and green foxtail, yellow foxtail, and barnyardgrass and partial control of Persian darnel and Japanese brome. Varro also provides control or partial control of 12 broadleaf weed species that are common in the northern cereal production area of the United States. Varro in combination with broadleaf tankmix partners resulted in excellent broadleaf weed control, and in several cases, has been shown to increase the control of broadleaf weeds compared to the control provided by the broadleaf herbicides applied alone. Varro has been tested on spring wheat, durum wheat, and winter wheat varieties and crop tolerance was excellent. Broad spectrum grass control, excellent crop safety, many recropping options, and the freedom to tankmix with several different broadleaf herbicides make Varro a valuable and easy to use tool for northern plains cereal grain producers.

A New Pyroxsulam + Fluroxypyr + Clopyralid Premix Formulation for Broad Spectrum Weed Control in Wheat. Joseph P. Yenish*[1], Patricia Prasifka[2], Michael Moechnig[3], Roger E. Gast[4]; [1]Dow AgroSciences, Billings, MT, [2]Dow AgroSciences, West Fargo, ND, [3]Dow AgroSciences, Toronto, SD, [4]Dow AgroSciences, Indianapolis, IN (132)

Dow AgroSciences is introducing PerfectMatch™ herbicide, a new premix herbicide formulation for spring and winter wheat which combines the grass activity of PowerFlex™ herbicide with the broadleaf activity of WideMatch™ herbicide. Moreover, the new formulation will provide the same degree of crop safety to both spring and winter wheat (including durum) as GoldSky™ herbicide. PerfectMatch will be labeled at a single application rate of 1.17 liters/ha (1 pint/A) which delivers 15 g ai pyroxsulam, 105 g ae clopyralid, and 105 g ae fluroxypyr/ha. In field trials conducted in 2013 and 2014 across Idaho, Montana, North Dakota, South Dakota, and Washington, PerfectMatch provided control of wild oats, Persian darnel, yellow foxtail, and green foxtail that was equal to that observed with GoldSky.

PerfectMatch provided slightly greater control of wild buckwheat (POLCO), dogfennel (ANTCO), common lambsquarters (CHEAL), and prickly lettuce (LACSE) compared to GoldSky, along with much greater control of Canada thistle (CIRAR). Crop injury with PerfectMatch was essentially equal to GoldSky with less than 10% injury observed 1 week after treatment and less than 5% observed 2 weeks after treatment. PerfectMatch will provide growers another alternative for controlling annual grasses and tough to control broadleaves in wheat.

™Trademark of The Dow Chemical Company ("DOW") or an affiliated company of Dow.

Halauxifen methyl + Florasulam: a New Multi-Mode of Action Herbicide for Broadleaf Weed Control in Cereal Crops. Daniel Chad Cummings*[1], Roger E. Gast[2], Robert A. Haygood[3], Larry C. Walton[4]; [1]Dow AgroSciences LLC, Perry, OK, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences LLC, Collierville, TN, [4]Dow AgroSciences LLC, Tupelo, MS (133)

Arylex™ Active (Halauxifen methyl) a new active ingredient from Dow AgroSciences, is a novel synthetic auxin (WSSA group 4) herbicide from the new “arylpicolinate” chemical class being developed for the U.S. and all major cereal markets around the globe. The first U.S. product, Quelex™ herbicide is a premix with florasulam, with a use rate of 0.75 oz pr/acre [Arylex (halauxifen methyl 5.25 g ae/ha) + florasulam (5.25 g ai/ha)] and will be registered in wheat (including durum), barley and triticale. It offers unique broadleaf weed control spectrum and favorable crop rotation flexibility for cereals producers. Field research was conducted during 2013 and 2014 at 18 locations across the U.S. to determine the efficacy of Quelex applied in the spring to typical broadleaf weeds in winter wheat. Quelex was compared to competitive standards when applied alone in water and differing levels of UAN fertilizer, as well as in tank mixes with phenoxy (2,4-D LVE or MCPA LVE) herbicides. Quelex demonstrated similar to or better control of multiple broadleaf species, including henbit, flixweed, marestail, and mustards compared to Finesse (chlorsulfuron + metsulfuron methyl) + MCPA low volatile ester at standard rates. Henbit control was rapid with Quelex, especially when mixed with phenoxy herbicides or 50% UAN fertilizer tank mixes versus the standard treatments. By 6 to 10 weeks after treatment, Quelex treatments controlled 7 of 12 weed species; while Quelex + a phenoxy herbicide or UAN and Finesse + MCPA ester controlled all 12 weed species. Crop rotation trials confirmed that double crop cotton, soybean and sunflowers can be planted 3 months after application of Quelex. Quelex herbicide with Arylex active will provide cereal growers with an alternative mode of action for many difficult to control broadleaf weeds traditionally targeted by sulfonylurea herbicides. It will also allow for superior rotational crop flexibility compared to chlorsulfuron and metsulfuron herbicides.

Evaluation of Saflufenacil for Use in Dormant Season Alfalfa. Kyle E. Keller*[1], Mark Oostlander[1], Sanjeev Bangarwa[2], Dawn Brunmeier[3]; [1]BASF, Research Triangle Park, NC, [2]BASF, Fresno, CA, [3]BASF, Stockton, CA (134)

Saflufenacil, a protoporphyrinogen-oxidase (PPO) inhibitor, provides both burndown and rate-dependent residual broadleaf weed control in a wide range of crops. Potential use in dormant alfalfa for winter weed control was evaluated in western US field trials in 2013 and 2014. Saflufenacil was applied to dormant alfalfa to monitor crop response and yield. Saflufenacil, at 50 to 100 g ai/ha with methylated seed oil (MSO) and ammonium sulfate (AMS), was included in multiple, non-sequential dormant applications. Paraquat with crop oil concentrate was included as a comparison treatment in the studies. Regardless of the date of application during the dormant stage, more leaf necrosis occurred from saflufenacil than paraquat. Necrosis from all treatments declined over time. Some initial stunting was visible from the saflufenacil treatment but rapidly dissipated and was not evident at the first cutting. There was no crop stunting or necrosis in subsequent cuttings nor was there a reduction in yield from any application of saflufenacil. Based on the results of these field trials, once registered, saflufenacil may be an effective alternative for use in dormant alfalfa for broadleaf weed control.

New and Improved Three Pound Clethodim Formulation Performance. Rodney V. Tocco Jr.*[1], Greg K. Dahl[2], Laura J. Hennemann[2], Joe V. Gednalske[2], Eric P. Spandl[1], Lillian C. Magidow[2], Jo A. Gillilan[3], Andrea C. Clark[2]; [1]Winfield Solutions LLC, Shoreview, MN, [2]Winfield Solutions LLC, River Falls, WI, [3]Winfield Solutions LLC, Nashville, TN (135)

WinField has launched a new 3 lb/gal formulation of clethodim under the name Section® Three. The product offers users convenience with a higher concentration, and is labeled for same crop and tank mix compatibilities as Section®. Target weeds include volunteer corn and sorghum, and annual and perennial grasses. Use rates are 2.67-10.67 fl oz/A, 66% the rate of Section. Section Three requires a COC or HSOC adjuvant such as Superb HC or Destiny HC. The product was tested in 2013 and 2014 at many locations across the US, on volunteer corn, volunteer sorghum, shattercane, crabgrass and foxtail (POST). Data were subjected to repeated measures ANOVA ($P = 0.05$) and means were separated according to Fisher's Protected LSD ($P < 0.1$). Performance was at least equal to Section applied at the same ai/A rate. The use of COC adjuvants with the clethodim products generally improved weed control. Testing of tank-mix combinations with other commonly used herbicides, fungicides, insecticides and micronutrients indicated that there was no antagonistic effect on weed control.

Acuron Herbicide: Preemergence Weed Control and Corn Safety. Stephen M. Schraer*[1], Scott E. Cully[2], Ryan D. Lins[3], Monika Saini[4], Gordon Vail[4]; [1]Syngenta, Meridian, ID, [2]Syngenta, Marion, IL, [3]Syngenta, Byron, MN, [4]Syngenta, Greensboro, NC (136)

Acuron™ is a multiple mode-of-action herbicide premix that provides preemergence and postemergence grass and broadleaf weed control in field corn (as well as seed corn, sweet corn and yellow popcorn). In addition to mesotrione, s-metolachlor, and atrazine, Acuron™ also contains bicyclopyrone, a new HPPD (4-hydroxyphenyl-pyruvate dioxygenase) inhibitor. Acuron™ applied preemergence is effective on difficult-to-control weeds, including common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemisiifolia*), giant foxtail (*Setaria faberi*), giant ragweed (*Ambrosia trifida*), Palmer amaranth (*Amaranthus palmeri*) and waterhemp (*Amaranthus rudis*) with improved residual control and consistency compared to commercial standards. Additionally, preemergence applications of Acuron™ are safe to corn. Pending regulatory approvals, first commercial applications are anticipated in the 2015 growing season.

PROJECT 4: TEACHING AND TECHNOLOGY TRANSFER

Weeds: Up Close and Personal. Robert F. Norris*; University of California, Davis, CA (117)

A macro photography revolution has occurred in the last five years. Very high resolution sensors in cameras now provide extremely detailed images of plants, and permit extensive cropping with little loss of details. More significantly, development of hardware and software to facilitate focus stacking (bracketing) has removed the limitation of narrow depth of field in macro photography.

Development of high power LED lights provides much improved lighting for close-up plant photography. The utility of these changes to plant photography are illustrated using weed examples. Problems associated with object movement, and focus 'blooming', during focus stacking will be demonstrated.

Spray Particle Sizes for Increased Pesticide Efficacy and Spray Drift Management. Robert N. Klein*; University of Nebraska, North Platte, NE (118)

Many pesticide labels now list recommended or required spray droplet size (or sizes) for application. Following the label guides can increase pesticide efficacy and help manage spray drift. The droplet size classes are based on BCPC specifications and in accordance with ASABE standard S572.1. The approximate DvO.5 (VMD) in microns is taken from TeeJet Technologies Catalog 51.

Category	**Symbol**	**Color Code**	**Approximate DvO.5 (VMD) (microns)**
Extremely Fine	XF	Purple	~50
Very Fine	VF	Red	<136
Fine	F	Orange	136-177
Medium	M	Yellow	177-218
Coarse	C	Blue	218-349
Very Coarse	VC	Green	349-428
Extremely Coarse	XC	White	428-622
Ultra Coarse	UC	Black	>622

The 2015 Nebraska Weed Management Guide EC130 tables list the recommended sprayer nozzle tips, nozzle spacing, pressures and speeds to achieve various droplet size with water. Tables include 10 and 20 GPA for medium, coarse and very coarse spray quality sizes. Also included are tables for glyphosate at 10 GPA and fungicide and insecticide at 15 and 20 GPA. Following is a table for coarse spray quality at 20 GPA.

For Coarse Spray Quality at 20 GPA

		Nozzle Spacing		**Nozzle Spacing**
Speed mph	Rate gpm	20 inch	Rate gpm	15 inch

6	0.404	AIXR11003 @ 72 psi or TT11004 @ 41 psi	0.303	AIXR110025 @ 59 psi
7	0.471	TT11004 @ 55 psi	0.354	AIXR11003 X 56 psi* or TT11004 @ 31 psi*
8	0.538	TT11005 @ 46 psi*	0.404	TT11004 @ 41 psi
10	0.674	TT11006 @ 50 psi* or XRC11008VK @ 28 psi	0.505	TT11005 @ 41 psi*
12	0.808	XRC11008VK @ 41 psi* or TT11006 @ 72 psi	0.606	XRC11008VK @ 23 psi or TT11005 @ 59 psi
14	0.942	XRC11010VK @ 35 psi	0.707	XRC11008VK @ 31 psi or TT11006 @ 55 psi

*Just into coarse droplet size

Multi-Species Herbicide Screens: A Framework for Teaching Herbicide Mode of Action Principles and Product Discovery. Andrew G. Hulting*, Daniel W. Curtis, Kyle C. Roerig, Carol A. Mallory-Smith; Oregon State University, Corvallis, OR (119)

Abstract not available.

Rstats4ag.org - A New Website to Help Agricultural Researchers Learn R. Andrew R. Kniss*[1], Jens C. Streibig[2]; [1]University of Wyoming, Laramie, WY, [2]University of Copenhagen, Copenhagen, Denmark (120)

Abstract not available.

PROJECT 5: BASIC BIOLOGY AND ECOLOGY

Genetic Variation of Downy Brome from Small Grain Production fields in the Pacific Northwest. Nevin Lawrence*, Ian C. Burke; Washington State University, Pullman, WA (121)

Previous research on downy brome (*Bromus tectorum* L.) genetics has focused on accessions collected from natural areas and rangeland. The study objective was to assess downy brome genetic variation within accessions collected from small grain production fields in the Pacific Northwest (PNW). A genotype-by-sequence approach was used to call single nucleotide polymorphisms (SNPs) from 95 downy brome and one ripgut brome (*Bromus diandrus* Roth.) accessions. SNP variation among accessions was used to investigate heterozygosity, departures from Hardy-Weinberg Equilibrium (HWE), spatial influences on genetic variation, and to group accessions into clusters of like genotypes. Average heterozygosity was 0.07%, within the range reported by previous literature. Although 12% of loci departed from HWE, as a whole, the entire population met conditions of HWE. Global versus local patterns of spatial clustering was investigated using a Monte-Carlo simulation and nearest neighbor distances. Global patterns of loci distribution were found to be significant and a genetic cline was identified separating the eastern and western portion of the small grain production region. A discriminate analysis of principle components method was employed to group downy brome accessions in six population clusters. Analyzing phenotypic data by population clusters simplified interpretation of phenotypic data along with spatial and environmental influences. Site specific management strategies, such as timing of herbicides applications, may be improved by making use of phenotypic differences between genetically similar population clusters.

Tritrophic Relationships at Crop Boundaries: Can Smooth Brome Serve as a Trapcrop for a Wheat Insect Pest? Tracy M. Sterling*[1], Ryan Bixenmann[2], Barb K. Keith[1], David K. Weaver[1]; [1]Montana State University, Bozeman, MT, [2]National Science Foundation, DC, DC (122)

Smooth brome (*Bromus inermis*) is a cool-season, perennial grass that spreads by rhizomes and was introduced in the 1880s as a livestock forage and for erosion control; it grows across North America in proximity to wheat growing regions, and is considered weedy in some habitats. The major wheat pest, wheat stem sawfly (*Cephus cinctus*) causes $300 million of annual damage in wheat fields throughout the Northern Great Plains. Insecticides are not effective in this pest system, but smooth brome may be an alternate host and serve as a perimeter trap; however, no empirical data exist to demonstrate its effectiveness. We used a combination of laboratory analysis and field sampling to evaluate smooth brome's role as an alternate host. In the lab, we identified and quantified attractive volatile compounds from wheat and smooth brome using GC-MS. In the field, we sampled smooth brome adjacent to wheat fields and monitored the number of eggs, larvae, and parasitoids in each species through the growing season. Smooth brome produced the same attractive green leaf volatile compounds as wheat, but at 4- to 8-fold higher concentrations. In the field, a greater proportion of smooth brome stems were infested with wheat stem sawfly eggs than wheat stems in adjacent fields. Among infested stems, smooth brome had more eggs per stem than wheat. These results suggest that smooth brome could be an effective trap for wheat stem sawfly management.

Giant Reed is an Alternate Host for Barley Yellow Dwarf Virus. Laura L. Ingwell[1], Robert S. Zemetra[2], Carol Mallory-Smith*[2], Nilsa A. Bosque-Perez[3]; [1]Purdue University, West Lafayette, IN, [2]Oregon State University, Corvallis, OR, [3]University of Idaho, Moscow, ID (123)

Giant reed (*Arundo donax*) has been approved as a renewable feedstock in several states and the Environmental Protection Agency ruled that it qualifies as a cellulosic renewable fuel under the Renewable Fuels Standard program. Giant reed has been reported to produce up to 25 metric tons of biomass per ha and is being considered as a replacement for coal at a Portland General Electric

power plant near Boardman, Oregon. In Oregon, giant reed must be grown under a permit issued by the Oregon Department of Agriculture. One of the objections to use of giant reed as a biofuel is its invasiveness in many environments including watersheds in California, Florida, and Texas. Although the potential for giant reed to be invasive is recognized, an issue not previously considered is its potential to serve as a host for pathogens. Therefore, a study was conducted to determine if giant reed could be infected with barley yellow dwarf virus (BYDV-PAV) and if so, would it serve as an inoculum source for the virus. Giant reed was infected under controlled conditions using aphids to vector the virus. The infected plants displayed no differences in growth from the non-infected plants indicating that giant reed may be tolerant to the disease. Multiple shoots produced from the same rhizome were infected demonstrating that the virus was systemic. Further, aphids vectored the disease from giant reed to barley plants. The results of this study are of concern because of the estimated 20,000 to 35,000 ha needed to provide enough feedstock to supply the power plant in Boardman. Giant reed could provide an overwintering inoculum source in Oregon's most important wheat growing region.

The Influence of Experimental Methods on R:S Ratio in Herbicide Resistance Studies. Carl W. Coburn*, Andrew R. Kniss; University of Wyoming, Laramie, WY (124)

Research has demonstrated the R:S ratio in dose response studies may be affected by experimental methods. Greenhouse experiments were conducted to determine the effect of pot size, experimental replication, and response variable on the R:S ratio of glyphosate-tolerant and -susceptible common lambsquarters (*Chenopodium album*). Lambsquarters were planted in the greenhouse in five different pot sizes (750, 1200, 1500, 1700, and 3800 cm^3) and were treated at the 6 to 10 true-leaf stage with glyphosate at 0, 105, 210, 420, 630, 840, 1260, and 1680 g ae ha^{-1}. The experiment was repeated. The log-logistic model was used to quantify the response of common lambsquarters biotypes to glyphosate. Visual control at 14 and 21 days after treatment (DAT), above ground biomass, below ground biomass, and mortality were assessed to determine the effect of response variable on the R:S ratio. Replication of the experiment did not greatly alter the R:S ratio for all response variables. The estimated R:S ratio for above ground and below ground biomass ranged 0.6 to 27.3 and 0.6 to 3.1, respectively, depending on pot size and experimental run. The estimated R:S ratio for visual injury at 14 and 21 DAT ranged from 1.0 to 2.8 and 1.0 to 3.6, respectively. The estimated R:S ratio for mortality ranged from 1.3 to 2.9. The results of this study show that the R:S ratio can be affected by experimental factors like pot size when dry weight is used as the response variable. Visual injury and mortality appear less susceptible to experimental variables.

The History and Status of Herbicide Resistance in Kochia in North America. Philip Westra*[1], Phillip W. Stahlman[2], Mithila Jugulam[3], Todd Gaines[1]; [1]Colorado State University, Ft. Collins, CO, [2]Kansas State University, Hays, KS, [3]Kansas State University, Manhattan, KS (125)

In 1976, atrazine resistance in kochia is first reported in Kansas; resistance reports for numerous other states then follow (eg. CO in 1982); it is now considered common and widespread.

In 1987, sulfonylurea resistance in kochia is first reported in Kansas; resistance reports for numerous states follow and now it is considered widespread including in Canada

In 1995, dicamba resistance in kochia is reported in Montana; other states follow with limited examples of resistance, but the issue never really "blows up".

In 2007, glyphosate resistance in kochia is reported in Kansas; multiple other states follow over the next 7 years and glyphosate resistant kochia is documented in 3 provinces of Canada. Research shows that in all cases, glyphosate resistance in kochia is due to gene amplification of the EPSPS gene with elevated copy numbers ranging from 3 to 25.

Recent Kansas kochia research may have uncovered a kochia population exhibiting resistance to all 4 herbicides listed above.

Genomic Variability in Kochia and its Potential Impact on Weediness. Eric L. Patterson*[1], Philip Westra[2], Patrick Tranel[3], Suzanne Royer[1], Todd Gaines[2]; [1]Colorado State University, Fort Collins, CO, [2]Colorado State University, Ft. Collins, CO, [3]University of Illinois, Urbana, IL (126)

Weed biology sits at the crossroads of many lines of research including chemistry, biochemistry, agronomy, ecology, and more recently molecular biology, in part due to the evolution of herbicide resistance. Molecular biology itself is being revolutionized by next-generation and third generation sequencing techniques, allowing us to quickly generate nucleotide databases. To better integrate weed science with molecular biology, genetic tools including the transcriptomes and the genomes of model weedy organisms need to be developed and made available to the research community. Current "model" plant species do not have the same traits or complexity as many weedy species making them less effective models. Our research team has begun the ambitious effort of sequencing the genome of *Kochia scoparia*, an important weed in the west that has evolved multiple herbicide resistance mechanisms. *K. scoparia* is a member of the family Chenopodiaceae, a sister taxon to Amaranthaceae family. *K. scoparia's* relatedness to many other important weedy species (including Amaranthus spp.) as well as important crop species (sugar beet and spinach, both in Chenopodiaceae) makes it a good candidate for developing molecular biology research tools. However, the large, complex, and malleable genome of K. scoparia makes sequencing an interesting challenge. It appears that the large genome (haploid size of 1.0-1.3 Gb) is due to a recent polyploidy event in the Chenopodiaceae lineage, resulting in large highly repetitive regions that are difficult to resolve without more advanced approaches to sequencing. Our initial findings demonstrate the challenges in assembling the Kochia genome and show potential for using molecular biology to improve understanding of weed biology and weedy traits.

EPSPS Gene Amplification in Kochia from Sugar Beet Fields. Todd A. Gaines*[1], Abigail Barker[1], Eric L. Patterson[1], Philip Westra1, Scott J. Nissen[1], Robert G. Wilson[2], Andrew R. Kniss[3]; [1]Colorado State University, Fort Collins, CO, [2]University of Nebraska, Scottsbluff, NE, [3]University of Wyoming, Laramie, WY (127)

Glyphosate-resistant kochia has been identified in multiple Great Plains states ranging from Colorado and Kansas to the Canadian prairie provinces of Alberta and Saskatchewan, and poses a particular challenge to glyphosate-resistant sugarbeet production systems. Recent research has shown that glyphosate resistance in kochia is due to gene amplification in which resistant plants contain 3 to 9 times more functional copies of the gene encoding 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). We evaluated 27 kochia populations collected from sugarbeet fields for glyphosate resistance and EPSPS gene copy number. Eight of 27 populations were classified as resistant, and 13 of 27 populations were classified as susceptible. Six populations were classified as developing resistance (LD_{50} close to the label rate and >2 times higher than susceptible). The resistant populations had on average LD_{50} 6 times higher than the susceptible populations, and 2.3 times higher than the label rate. All highly resistant populations (>2 times the label use rate) had increased EPSPS copy number ranging from 5-10. No samples had EPSPS copy number higher than 10. All susceptible populations had the normal EPSPS copy number. Four populations with developing resistance (low-level, <2 times the label use rate) had increased EPSPS copy number, ranging from 3-5. Glyphosate resistant kochia populations from sugarbeet fields exhibit EPSPS gene amplification similar to what is observed in kochia from corn, wheat, soybeans, and fallow. Determining the EPSPS copy number is a valuable assay for diagnosing glyphosate resistance in kochia.

Evaluating Bare Ground Herbicide Treatments for Kochia, Field Bindweed, and Downy Brome Control. Derek J. Sebastian*[1], Scott J. Nissen[1], Philip Westra[1], James R. Sebastian[1], Bobby Goeman[2]; [1]Colorado State University, Fort Collins, CO, [2]Larimer County Weed District, Fort Collins, CO (128)

Weeds found along railways, roadsides, and utilities can damage infrastructure, increase fire danger, and obstruct visability. In the past, imazapyr + diuron (Sahara) and bromacil + diuron (Krovar) have been the bases of total vegetation management (TVM). Weeds that favor these disturbed sites include field bindweed (*Convolvulus arvensis* L.), downy brome (*Bromus tectorum* L.), and kochia (*Kochia scoparia* L.) being the most widespread and problematic. TVM applications are most commonly made in the spring; however, very little information is available about the efficacy of other application timings. Research is needed to evaluate new tank-mix options that increase application flexiblity and efficacy, as well as provide alternative herbicide modes of action for resistance management. The objective of this research was to evaluate the efficacy of new bareground tank mix treatments compared to the standards, Sahara and Krovar, at two application timings. In 2014, two field experiments were conducted in a randomized complete block design. Visual bare ground evaluations indicated that across both sites and with different weed species compositions, fall treatments out performed spring treatments. Treatment costs ranged from $194 to $496 per hectare; however, cost was not correlated with efficacy. A number of treatments provided better weed control than Sahara and Krovar at lower cost per hectare. Combination treatments that contained aminocyclopyrachlor, indaziflam, or topramezone improved kochia control, while combinations that included aminocyclopyrachlor or picloram provided the best field bindweed control. Treatments including imazapic or indaziflam improved downy brome control. Sahara and Krovar represent two modes of action, acetolactate synthase (ALS) and Photosystem II (PSII), that already have numerous examples of evolved resistance.

These newer products can be useful in reducing the spread of herbicide resistance by including new modes of action for TVM.

Influence of Irrigation Timing on Disturbance-Induced Reductions in Soil Seedbank Density. Brian J. Schutte*, Nina Klypina; New Mexico State University, Las Cruces, NM (129)

Shallow soil disturbances can reduce population densities in seedbanks of weed species with positively photoblastic seeds. Enhanced understanding of the causes of disturbance-induced reductions in weed seedbank density will help guide improved management approaches. The objectives of this study were to: 1) determine the effects of increasing time between soil disturbance and irrigation on disturbance-induced reductions in weed seedbank density, and 2) identify specific soil moisture levels that accelerate weed seedbank reduction under flood irrigation. Weed species in this study included two species for which germination is considered light sensitive (junglerice [*Echinochloa colona*] and Palmer amaranth [*Amaranthus palmeri*]) and one species for which germination is thought to occur independent of light (yellow foxtail [*Setaria pumila*]). For Objective 1, artificial seedbanks were established under field conditions at a university research farm near Las Cruces, NM. Factorial combinations of species and disturbance treatments were arranged in a randomized complete block design with four replications in each of two runs. Disturbance treatments included undisturbed controls and soil disturbances at 10, 3 or 0 days prior to irrigation. Each soil disturbance treatment was applied twice to a given seedbank during early summer. Soil disturbance was implemented by hand-mixing for 30 sec. Seedbanks were retrieved in autumn. Viable seeds were then recovered and detected using elutriation and tetrazolium staining assays, respectively. Seed viability data were used to determine the percentages of buried seeds that survived for one year ("1-yr seedbank persistence"). For Objective 2, seeds were buried in soil mesocosms that were hydrated to specific soil water potentials (0 kPa, -30 kPa, -60 kPa and -180 kPa). An additional soil moisture treatment included saturated soil under 1 cm of standing water ("flooded"). Hydrated mesocosms were placed in a growth chamber set to 35 C day / 25 C night, 12 hr photoperiods; conditions considered favorable for germination of the study species. At the conclusion of the incubation period (35 days), seeds were recovered and assessed for viability using a tetrazolium staining assay. Results of the field study indicated that soil disturbances reduced 1-yr seedbank persistence of Palmer amaranth, but, soil disturbances did not affect seedbank densities of junglerice and yellow foxtail. Disturbance-induced reductions in Palmer amaranth seedbanks were greater when soil was disturbed 0 and 3 days prior to irrigation compared to 10 days prior to irrigation. Although the field study utilized flood irrigation, the laboratory study indicated that a saturated soil was not required for accelerated seedbank reductions. Specifically, saturated soil treatments (0 kPa and flooded) were not found to induce seedbank losses of Palmer amaranth and yellow foxtail (80 to 95% seedbank persistence), but, soil moisture treatments -30 kPa, -60 kPa and -180 kPa greatly reduced seedbank persistence of these species. Junglerice exhibited moderate rates of seedbank persistence (55 to 73%) across all soil moisture treatments.

Evaluation of Physical Drift and Vapor Drift of Several Dicamba and 2,4-D Formulations and the Impact of Volatility Reduction Adjuvants. Scott K. Parrish*[1], Philip Westra[2], Jim

Daniel[3]; [1]AgraSyst Inc, Spokane, WA, [2]Colorado State University, Fort Collins, CO, [3]Agricultura Consultant, Keenesburg, CO (130)

Increased vapor injury was documented with the addition of ammonium sulfate (AMS) to the spray solution of 2,4-D Dimethyl amine salt (DMA), dicamba DMA salt and dicamba diglycolamine salt (DGA). A series of greenhouse volatility studies were undertaken to explore what effects different spray solution additive components had on the volatility of phenoxy herbicides. Additive components tested were salts, acids, oils, surfactants and emulsifiers. These components were tested with 2,4-D (DMA), 2,4-D low volatile ester (LV6), 2,4-D acid formulations, dicamba DMA, dicamba DGA and dicamba acid formulations. Slats other than AMS generally decreased vapor injury. Acid generally increased vapor injury. Surfactants had effects depending upon surfactant type. Emulsifiers were mostly neutral. The best reductions in vapor injury were seen with a combinations of ingredients. Field studies were conducted to see in if the greenhouse results translated to field conditions.

Can Foliar Fertilizer Applications Prevent Glyphosate Drift Injury in Almond? Bahar Yildiz Kutman*, Bradley D. Hanson; University of California Davis, Davis, CA (137)

Due to its systemic mode of action, relatively short environmental half-life and low mammalian toxicity, glyphosate is widely used worldwide as a post-emergent herbicide. In almonds and other orchard crops, glyphosate may be applied to orchard floors several times each year. Crop safety in orchards usually is achieved by directing applications below the crop canopy and using trunk protectors to minimize glyphosate application to green tissues. However, despite these precautions, minor spray drift or major misapplications of glyphosate occasionally occur and can result in serious crop injury and economic losses. Because of its chemical properties, glyphosate has a high affinity to divalent cations and can form complexes with minerals including Ca, Mg, Fe, Mn, Zn and Ni. These glyphosate-mineral interactions have implications for both plant nutrition and herbicidal efficacy of glyphosate and could provide a mechanism for reducing crop injury from glyphosate drift. This study was conducted to investigate the possibility of using foliar micronutrient applications to prevent and/or correct injuries caused by glyphosate drift in almonds.

A model pot experiment was conducted in summer 2014 to simulate glyphosate drift to grafted almond nursery trees (Nonpareil almond on Lovell peach rootstock). Divalent micronutrients (Mn, Ni and Zn) were investigated for potential protective or corrective effects against glyphosate injury. One third of the trees served as control while the others were sprayed with either 3% or 6% of a commonly applied glyphosate rate, which is 1.12 kg ae/ha (1 lb ae/A). Five days before or after the glyphosate application, almond foliage was sprayed with Mn (0.1% Mn as $MnSO_4.H_2O$), Ni (0.01% Ni as $NiSO_4.6H_2O$) or Zn (0.1% Zn as $ZnSO_4.7H_2O$) solutions containing 0.01% Tween20 as surfactant. There were 5 pot replicates for each treatment. Two weeks after glyphosate application, shikimate accumulation in young leaves was determined spectrophotometrically. In trees not treated with foliar micronutrients, mineral concentrations of young leaves were measured. Visual injury symptoms were recorded and chlorophyll levels were quantified by using a SPAD meter.

Foliar applications of Mn and Zn salts prior to glyphosate exposure had a marked protective effect whereas post-glyphosate exposure micronutrient applications did not have any benefit and even aggravated glyphosate injury in some cases. The protective effect of the pre-glyphosate Ni application was not as strong as those of the pre-glyphosate Mn or Zn applications. In trees treated with glyphosate, young leaves exhibited chlorosis and pre-glyphosate applications of Mn and Zn totally prevented this symptom at the 3% glyphosate rate. Pre-glyphosate applications of these elements also significantly reduced the gummosis symptom, which was observed on the rootstock trunks of trees that were subjected to 6% glyphosate. In agreement with these visual observations, protective micronutrient applications reduced the shikimate accumulation in shoot tips by up to 60% and 30% at the lower and higher glyphosate rates, respectively. When the glyphosate injury symptoms of shoot tips, rootstock trunks and roots were evaluated 45 days after glyphosate application, it was observed that post-glyphosate applications of micronutrients exacerbated the injury symptom. Finally, the nutrient analysis of young leaves revealed that glyphosate applications reduced the Mn concentration about 25% and increased the Ni concentration about 15% while it did not have any effect on tissue concentration of Zn, indicating that the observed protective effects of micronutrients cannot be ascribed to the correction of glyphosate-induced micronutrient deficiency. Possibly, divalent micronutrient cations interact with glyphosate on the leaf surface or within the leaf tissue and thereby reduce its toxicity.

Using foliar applications of micronutrients can be a practical management strategy to minimize glyphosate drift injury to almonds but the timing appears to be critical. If there is a predictable risk of glyphosate drift, foliar micronutrients should be applied to orchard crops before the herbicide treatment. These results suggest that growers should avoid post-glyphosate drift applications of micronutrients as this may worsen the situation. Further research needs to be conducted to validate these results under field conditions and to elucidate the mechanisms behind the observed effects.

Examining the Impact of Endophtyic Communities on Competition and Demography of the Invasive Annual Grass Ventenata. Nicholas A. Norton*; University of Idaho, Moscow, ID (138)

Ventenata dubia (ventenata) is an invasive annual grass that is an emergent problem across a variety of agricultural production systems in the Inland Pacific Northwest. Anecdotal evidence suggests that part of the reason for its expansion and success is due to release from native pathogens. This presentation reports on preliminary studies addressing this hypothesis through the use of observational and manipulative experiments. We find that ventenata does harbor strains of the common fungal pathogen *Fusarium*, which may help facilitate invasion through its differential effects on ventenata versus native bunchgrass species. In addition, we report evidence that ventenata litter microbiota delays emergence and has a negative effect on seedling biomass. These findings indicate that ventenata invasion may be facilitated by interactions with specific endophytic functional groups, but that litter microbiota as a whole may be deleterious in early life stages.

Effects of Clearcutting, Debris Treatments and Vegetation Control by Herbicide on the Composition and Diversity of a Western Washington Plant Community. David H. Peter*[1],

Timothy B. Harrington[2]; [1]U.S. Forest Service, PNW Research Station, Olympia, WA, [2]USDA Forest Service, Olympia, WA (139)

We compared plant community development for 3 years following clearcut logging under high (20 Mg ha^{-1}) or low (9 Mg ha^{-1}) levels of uncompacted logging debris and 4 vegetation control treatments (none, triclopyr, aminopyralid, and triclopyr+aminopyralid) to identify effects of logging debris and herbicides on community organization. Our study site was 47 km northwest of Olympia, WA and before clearcutting was dominated by Douglas-fir (*Pseudotsuga menziesii*). We estimated canopy cover by species before clearcutting and then annually for 3 years on 100 m^2 plots. We used a randomized split plot arrangement of treatments replicated in 6 blocks. Each block had 2 debris treatments as main plots and 4 herbicide treatments as split plots. An excavator and clamshell bucket were used to create the two levels of debris. Yarding alone did not work because branches broke during felling. We analyzed plant species composition and diversity and report third year post logging herbicide and debris effects for 12 species groups based on growth habit, lifespan, shade tolerance and taxonomy. We used graphical methods to examine time trends and ANOVA to examine third year treatment effects. Exotic perennial grasses and herbs had higher cover in light debris where there was more light and exposed mineral soil. Vines had higher cover in heavy debris where they could climb over debris to avoid shading by competing vegetation. Annuals and exotic perennial herb covers increased when triclopyr was used in response to suppression of dicotyledonous shrubs and vines. Evenness was higher in light debris reflecting a more equal representation among species compared to the heavy debris treatment. Shannon's Index was higher in heavy debris due to a greater number of rare species exploiting scattered microsites among the debris. Simpson's Index was higher in light debris except when triclopyr and aminopyralid were combined when it was higher in heavy debris. Effects of aminopyralid were small compared to triclopyr, but the combination broadened the range of affected species. We hypothesize that the effect of triclopyr+aminopyralid was less where spray was intercepted by debris, thereby reducing the effective dose.

Moose Winter Damage to Native Trees and Shrubs in Relation to the Relative Abundance of Non-Native Chokecherry Trees. Gino Graziano*; University of Alaska Fairbanks, Anchorage, AK (140)

Colonization of new habitats by non-native species sometimes leads to alterations of habitats that do not favor native species. In Alaska, cyanogenic non-native chokecherry trees (*Prunus padus* and *virginiana*) have spread from ornamental plantings into forests used by moose, and *P. padus* dominates some areas of urban forests. We studied variations in impacts winter foraging moose have to native trees and shrubs in areas of varying relative abundance of chokecherry trees. Data was collected with Anchorage schools and volunteers. Data accuracy was ensured with a combination of training, mandatory field checking of data, and easy to use electronic forms for data submission. Data collected included the ratio of bites to available browse, tree architecture, diameters of bites and current annual growth and relative abundance of chokecherry trees in plots. In 2013 and 2014, relative abundance of chokecherry trees in plots ranged from 0-91%. Data collected in 2013 and 2014 shows that when the relative abundance of chokecherry is high (>25%) native tree species showed a 7% increase in the bite ratio, and exhibited a broomed architecture twice as often as in plots with low (<25%) chokecherry abundance. These data suggest that moose may more quickly over browse habitat when chokecherry are abundant. Eradication of chokecherry trees from urban forests is unlikely. However, communities with few planted and wild chokecherry should consider eradication. To maintain quality moose habitat the relative abundance of chokecherry trees should be kept to a minimum, and we should encourage establishment of native trees and shrubs.

EDUCATION & REGULATORY SECTION

Quantifying Outcomes of a FIFRA 24c SLN Herbicide through the Adoption of Herbicide Ballistic Technology. James Leary*; University of Hawaii at Manoa, Kula, HI (115)

In January 2012, the FIFRA 24(c) Special Local Need registration HBT-G4U200 with Garlon® 4 Ultra was approved and vetted by the Hawaii Department of Agriculture and US EPA, respectively, to be used for individual plant treatments of miconia (*Miconia calvescens*) and strawberry guava (*Psidium cattleianum*) in forested watersheds and natural areas of Hawaii. The basic concept of HBT-G4U200 is the encapsulation of 200 mg triclopyr in a 0.68 caliber soft-gel capsule (i.e., paintball) for long-range pneumatic delivery to target. Miconia is a priority species of the Maui Invasive Species Committee with a 25-year management legacy across the 55,000 ha East Maui Watershed. Starting in 2012, The HBT platform became the primary utility in helicopter surveillance operations focused on an accelerated intervention schedule targeting high-value incipient miconia populations occupying the most extreme boundaries of the invasion. In three years of operations, we have conducted 72 missions, with 300 hours of operational flight time (OFT), treating 12,746 miconia targets, including 193 mature targets, covering a total net area >6900 ha (e.g., >17,000 acres). The basic unit of measure in this project is target density, which serves as an absolute value of progress, but also serves as a direct influence on operational efficiency values. According to the best fit exponential decay function, target densities encountered are reducing at a rate of 0.7% hr^{-1}_{OFT} (R^2= 0.479). Thus, search efficiency and herbicide use rates are improving with lower target densities. Net area of coverage is expanding 24 ha hr^{-1}_{OFT}, while herbicide use rate has been reduced to < 20 g ae ha^{-1}, which incidentally, is equivalent to <0.5% of the maximum allowable use rate. This is contributed by the expansion of net area and also to a measurable reduction of dose rate over time as a result of encountering smaller target recruits. Variable costs of operation, by definition, correlate to production volume. In this study, the variable cost per unit area is directly proportional to target densities encountered. These costs include contracted helicopter services with three-person crew (e.g., estimated total at \$0.298 USD sec^{-1}) and projectile consumption (e.g., \$0.31 USD $projectile^{-1}$) to treat targets. Variable costs of HBT operations show a negative exponential cost reduction over time that is highly congruent to target density reduction with a decay rate of 0.6% hr^{-1}_{OFT}. In 2014, the average variable cost of operations was \$21.20 USD ha^{-1}. The approach for an accelerated intervention schedule via mobilization of the HBT platform is demonstrating progress with metrics in target density reduction, protected area expansion and cost optimization. Consistency of a high-frequency intervention strategy has accommodated strong mathematical fits of the empirical data, which allows for critical assessments of projected future outcomes and establishes an institutional need for HBT in natural area weed control.

Biologic and Economic Benefits from the Use of Phenoxy Herbicides in the United States, a 2015 Update. Sandra K. McDonald*[1], James Gray[2]; [1]Mountain West Pesticide Education & Safety Training, Fort Collins, CO, [2]2,4-D Task Force, Kansas City, MO (115a)

The 2,4-D Research Task Force is working with weed scientists around the United States to update and expand the 1996 NAPIAP report "Biological and Economic Risk Assessment of Benefits Phenoxy Herbicides in the United States. 2,4-Dichlorophenoxyacetic acid (2,4-D), the most common of the chlorophenoxy herbicides, was introduced 1945. 2,4-D is widely used to provide economical, selective, postemergence control of broadleaf weeds in a large variety of crops and non-crops. Rigorous analysis of the relevant scientific data by expert panels and government agencies mandated with protecting human health and the environment all reach the same conclusion: 2,4-D is acceptable for use according to label directions. Chapter authors have identified the economic benefits of the labeled uses for the selected market sectors; summarized the benefits of 2,4-D by use sector; and, discussed the environmental benefits. Authors surveyed weed scientists, conducted interviews, and utilized pesticide use data. Retaining 2,4-D and the phenoxy herbicides for broadleaf weed control in crops and non-crops is critical to ensure that farmers and weed managers will have a wide array of management strategies. Eliminating 2,4-D or an entire class of herbicides will severely limit the alternatives. 2,4-D and the phenoxy herbicides play a major role in an integrated approach for herbicide resistance management. It is essential that 2,4-D and the phenoxy herbicides remain available to farmers and weed managers to maintain a cost effective and sustainable weed management program.

A Tool You Can Use: The National Pesticide Information Center at Oregon State University. Kaci J. Buhl*; Oregon State University, Corvallis, OR (116)

Wouldn't it be nice if someone could take calls from the general public, take the time to hear their stories, and answer their questions about herbicide use, toxicity, and environmental fate? Someone *other* than a busy researcher? The National Pesticide Information Center (NPIC) can do just that. NPIC handles over 10,000 inquiries each year from a nationwide audience, in multiple languages, by explaining science-based information in an objective, audience-appropriate way. Based on inquiries, NPIC publications include herbicide fact sheets, frequently asked questions, podcasts, videos, and mobile apps. Selected resources will be highlighted, including a pesticide product search tool (pest-crop combinations), short stewardship videos, and literature reviews available for 2,4-D and glyphosate. Participants will be invited to use NPIC services to find obscure data points about active ingredients, and make referrals to NPIC. NPIC is a tool that can save you time.

Discussion – Pesticide incidents, the stories people tell, and how to use them in education programs.

SYMPOSIUM: The Use of Available Laboratory Tests to Help Diagnose Suspected Herbicide Problems

Consulting Ethics; Providing the Best Available Science for Your Clients. Kassim Al-Khatib*; University of California, Davis, CA (001)

Abstract not available.

Available Laboratory Testing and Techniques to Aid in the Diagnosis of Suspected Herbicide Problems. William T. Cobb*; Cobb Consulting Services, Kennewick, WA (002)

Historically, herbicides constitute greater than 85 % of the crop protection market. Herbicides, by design, will usually impact the physiology of a susceptible plant and as a result, produce visible changes in the morphology and anatomy of the susceptible plant; these changes are termed "symptoms." Webster defines symptoms "as a sign or indication of something, especially something undesirable." Botanically, symptoms can be termed as a visual indication that the plant is under stress. A susceptible plant's exposure to an herbicide is but one stress; a growing plant can be exposed to a myriad of stresses simultaneously (environmental, disease, insects, nutrient imbalances, etc.), all of which may induce some sort of symptom expression. The symptoms from these other stresses may mask, exacerbate or mimic herbicide symptoms. Simply stated, the same plant symptom can and often do have multiple causes. Different herbicides may produce symptoms that are very similar to one another. Currently there are many commercially available diagnostic laboratories and laboratory tests which can help sort out the difference and similarities between various herbicide and non-herbicide symptoms. The first step in employing these available laboratory tests is to utilize a well thought out diagnostic sampling scheme. The advantage of using a diagnostic sampling scheme is that quantitative and qualitative comparisons can be made between symptomatic v. non-symptomatic or treated v. non-treated areas simultaneously.

University of California Herbicide Symptoms Website: A New Tool to Investigating Herbicide Damage on Nontarget Plants. Kassim Al-Khatib*; University of California, Davis, CA (003)

Unintended injury symptoms from herbicides could occur from herbicide drift, residues left in the soil from a previous crop, accidental spray or herbicide contaminated tank. Herbicide symptoms varied depending on the herbicide concerned, the rate of application, stage of growth, type of exposure, and the plant species receptor involved. Herbicides with the same mode of action produce similar injury symptoms, because the outward appearance of injury is a function of the effect the chemical is having on the plant at the cellular level. Therefore, it is much easier to diagnose symptoms belong to different herbicide modes of action. In addition, herbicide symptoms can look very similar to symptoms caused by diseases, nutrient deficiencies, environmental stress, and soil compaction. A new interactive herbicide symptoms website has recently launched by the University of California IPM program. The website include photos and educational materials to diagnose and assess herbicide symptoms to help farm advisors, consultants, PCAs, and others identify if the symptoms they are observing are from herbicides. While other online resources with herbicide symptoms exist, they cover only a few crops or herbicides. The new website has over 1000 pictures of 19 different herbicide modes of action, 37 chemistry, 67 herbicide active ingredients, over 45 crops and 80 ornamentals. This searchable database will enable users to view pictures by crop/ornamentals, herbicide active ingredient, and herbicide mode of action, chemistry, and symptoms. The new website has the largest and most comprehensive repository of herbicide symptom pictures. We also developed on-line educational materials describing symptoms progression and recovery. Combined with UC IPM’s current repository of disease and nutrient deficiency pictures, this database will be a valuable resource for IPM community. This repository will help users identify the potential causes of their crop damage so it can be managed appropriately.

Available Laboratory Testing and Techniques to Aid in the Diagnosis of Suspected Herbicide Problems (Continued). William T. Cobb*; Cobb Consulting Services, Kennewick, WA (004)

Historically, herbicides constitute greater than 85 % of the crop protection market. Herbicides, by design, will usually impact the physiology of a susceptible plant and as a result, produce visible changes in the morphology and anatomy of the susceptible plant; these changes are termed "symptoms." Webster defines symptoms "as a sign or indication of something, especially something undesirable." Botanically, symptoms can be termed as a visual indication that the plant is under stress. A susceptible plant's exposure to an herbicide is but one stress; a growing plant can be exposed to a myriad of stresses simultaneously (environmental, disease, insects, nutrient imbalances, etc.), all of which may induce some sort of symptom expression. The symptoms from these other stresses may mask, exacerbate or mimic herbicide symptoms. Simply stated, the same plant symptom can and often do have multiple causes. Different herbicides may produce symptoms that are very similar to one another. Currently there are many commercially available diagnostic laboratories and laboratory tests which can help sort out the difference and similarities between various herbicide and non-herbicide symptoms. The first step in employing these available laboratory tests is to utilize a well thought out diagnostic sampling scheme. The advantage of using a diagnostic sampling scheme is that quantitative and qualitative comparisons can be made between symptomatic v. non-symptomatic or treated v. non-treated areas simultaneously.

Laboratory Test Strips for Quick Analysis of Plant Diseases Whose Symptoms May Mimic or Mask Herbicide Symptomology. William T. Cobb*; Cobb Consulting Services, Kennewick, WA (005)

Abstract not available.

DISCUSSION SESSIONS

Project 1 Discussion Session: Weeds of Range and Natural Areas

Moderator: Jane Mangold; Montana State University, Bozeman, MT

Topic: *Outcome-based Research and Extension: Building Collaborative Research and Management Efforts between Scientists and Practitioners*

A formal discussion was hosted by the section chair of the Weeds of Range and Natural Areas on March 12, 2015, with fifteen participants in the session. The purpose of this discussion was to identify how research scientists and resource managers might develop synergistic collaborations towards outcomes in scientifically valid invasive plant management and natural area restoration. Typically, research and management agendas function independently; where the transfer of technology is delivered from the top down. This approach has historically demonstrated success, but there may be opportunities which allow for more collaborative "hybrid" projects particularly focusing on the science of weed management. This offers management participants more intimate access to results specific to their area of jurisdiction. Researchers, on the other hand, can take advantage of resources (i.e., field technicians), that would be otherwise unavailable. Ultimately, the goal of all collaborating participants is to demonstrate effective science-based management employed at operational scales with confirmative (statistical) progress results.

Linking science with management has always been the mantra of land grant missions, but has been more subject to inquiry over the last decade regarding invasive plant species. McPherson (2004) identified some of the obstacles limiting opportunities for collaboration. First, researchers are often scrutinized among scientific peers to present broader implications of their studies, while managers are often focusing on more pragmatic solutions to specific, immediate problems. Second, managers and practitioners are often less obligated to scientific principles when other social, political and economic demands dictate their objectives and methods. With that, specific actions taken by both partners can lead to a highly successful collaboration (Table 1). Researchers need to design experiments relevant to their partners, with both spatial and temporal scales. For instance, treatment efficacy in the operational sense is proven through management adoption, which may not be proven within a small controlled setting. A participatory approach to treatment design gives such assurances that treatments and techniques are robust against variable and confounding conditions. Researchers should also consider experimental designs with more rapid interpretation in support of an adaptive management paradigm. Practitioners on the other hand, need to commit to the science-based objectives, knowing these efforts have long-term benefits to future management actions. Management programs must also build institutional knowledge and skills in data acquisition and management that facilitates proper scientific inquiry. Together, all participants must be assigned duties and responsibilities that maintain frequent communications ensuring quality control and progress. The novelty of this collaborative approach will come with new statistical methods having heuristic properties that validate operational performance.

Table 1*. Actions taken by participants in a collaborative project

Participants	Actions
Researchers	Design experiments at relevant (operational) scales Incorporate management participation into experimental design Produce immediate and long-term values of findings
Practitioners	Commit to science-based objectives Train practitioners in observation and data acquisition Develop and maintain database management skills
All	Develop professional rapport through frequent communications Delegate responsibilities and establish expectations Develop metrics with scientific integrity that validate progress

* Adopted from Ferguson (2004) with additions by chair and chair-elect

In 2006, the Midwest Invasive Plant Network conducted a survey on the perspectives of invasive plant research (Renz et al. 2006). Seventy percent of the 192 respondents (across thirteen states) were managers. Over 93% of the respondents (i.e., managers and researchers) thought it was a high priority to be working together in addressing invasive plant management issues. Yet, at the same time, 43% indicated that they were not currently working collaboratively with their counterparts. Interestingly, managers and researchers listed different impediments to developing better collaborations. Managers were most limited by time, while researchers were most limited by funding.

Case studies in the WSSA journal *Invasive Plant Science and Management* (IPSM) were introduced into the discussion as a venue for publishing management driven information. Case studies are peer-reviewed, original material with well-developed discussions that provide instructive information on specific invasive plant management projects. Example topics of published case studies include:

- Establishing Weed Management Areas
- Invasive plant monitoring and inventory
- Species-specific management outcomes
- Environmental quality

A published case study averages nine pages (<5000 words), two tables and three figures (Fig. 1). This would be typically a more modest, but succinct presentation relative to a peer-reviewed research article. Many of these case studies present descriptive map figures and supporting tabular data, often expressed over multi-year timelines. Efficacy of methods are usually not formulated from conventional, replicated designs, but often from management imposed in operational scales that may not even have untreated control check areas, but instead might deploy a more heuristic process of before/after observation. The intent of the IPSM case study was to be practitioner/manager driven with academic contributions in analytical confirmation. Since 2008, sixteen case studies have been published with over half co-authored by managers, and 100%

authorship by researchers (Fig. 1). Interestingly, half of the case studies are co-authored by students.

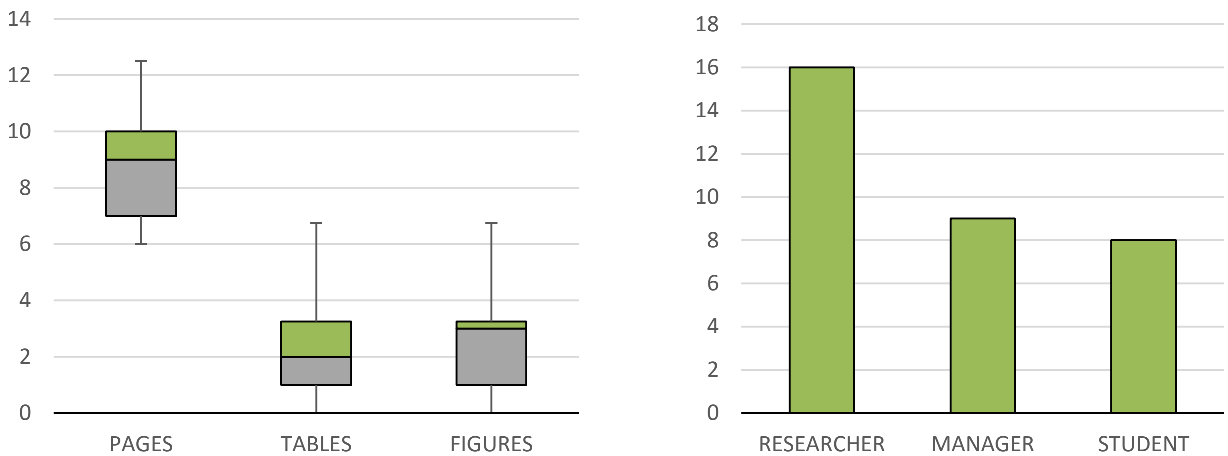


Figure 1. The 50th and 90th percentiles of page numbers, tables and figures published, along with author counts for IPSM case studies (n=16) published since 2008.

The discussion started with a quick poll of the participants with questions adopted from Renz et al. (2006) to identify their professional disciplines, along with positions on participating on collaborative cross-disciplinary projects (Table 2). Of the fifteen active participants, 40% were practitioner/managers; a good representation for a weed science meeting. Interestingly, only 40% of the total participants (researchers and practitioners) have participated in cross-disciplinary research, while it was 100% unanimous that all participants desire such opportunities for collaboration. This strongly coincides with some of Renz et al. (2006) findings, almost a decade later.

Table 2. Poll questions and results of discussion participants (n=15)

1. Are you a researcher (R), practitioner (P)?	R=9; P=6
2. Have you ever or are you currently engaged in participatory research with a manager/researcher?	R=4; P=2
3. If given the opportunity, would you engage with a manager/researcher in a participatory research project?	R=9; P=6

Adopted from Renz et al. 2006.

The discussion among participants was active and complementary, extending well beyond an hour and evolved into three basic topics: (i) Science-based Management, (ii) Weed Science Training for Practitioners and (iii) Building Collaborations (Table 3). Comments made on these topics were non-contentious and shared across research and management disciplines. It was identified that management projects are not typically hypothesis driven. However, managers are expected to show objectives being met and progress resulting from efforts. This is where data management and analyses become critical actions and where research collaboration can be more functional. With that, weed scientists need to think beyond their standard replicated experiments and work with managers to identify and validate experimental designs and statistical analyses that will be better adopted into management projects. Managers and practitioners in natural area conservation need more weed science training. It is apparent that weed science findings and publications are not immediately available to managers, largely due to the cost of journal subscriptions. Albeit, federal agency personnel do have access, others are reliant on extension to disseminate relevant information gleaned from scientific literature. There was strong agreement that the WSWS annual meeting should be a venue for building collaborations between researchers and managers, which ultimately suggests that stronger incentives are needed for attracting more manager participants. It was noted that the symposium on knotweed attracted a large audience from the management sector several years ago. Limits to funding is the major impediment to research programs. Applied research programs are often the first to be cut from budgets in an economic downturn. Thus researchers need to maintain working relationships with management projects and identify non-monetary resources that can leverage research functionality.

Table 3. Paraphrased excerpts from the participants highlighting themes of the discussion

1. Science-based Management

a. *Managers need to be invested in a project for multiple years… more quantitative data collection.*
b. *Management project goals are not typically hypothesis driven.*
c. *Counties (and other government agencies) make decisions (e.g., pesticide regulation) on published results from research or management projects.*
d. *Funded management projects are mandated to show progress with before and after monitoring.*
e. *There is a need for updating statistical analyses to better fit management projects.*

2. Weed Science Training for Practitioners

a. *Journal access limited to university libraries and federal agencies.*
b. *How valuable is to published scientific information to the land manager without access to the journal.*
c. *Extension is the bridge in disseminating new and relevant information to practitioners.*
d. *Cost of open access is extremely high.*
e. *Government agency personnel (e.g., biologists) lack weed science training.*
f. *There is a need for more training workshops for agency technicians and management.*
g. *Rstats4Ag.org becoming a more accessible and user-friendly statistics software.*

3. Building Collaborations

a. *Connections should be made at the WSWS. Federal presence.*
b. *WSWS needs to identify incentives for managers to attend and participate*
c. *Symposia draws interest (e.g., knotweed symposium attracted several hundred).*

d. *Managers and researchers have different goals. Researchers need to publish in high impact journals.*
e. *Create management projects that fund graduate students to develop solutions in the field.*
f. *Form a management research co-op that identifies needs for science and outreach.*
g. *Example: Vegetation Management Research Coop.*
h. *The Montana Noxious Weed Trust Fund another great model.*
i. *Stakeholders very receptive to solving their problems. How can we create experiments that are publishable as case studies?*
j. *Funding is a limitation to research progress.*
k. *Applied research is first to go on budget cuts.*
l. *Can acquiring non-monetary resources leverage research needs?*
m. *Best funding opportunities are through federal agency partnerships.*
n. *Researchers need to establish cooperative agreement with federal contacts. Be preemptive in projects.*
o. *Need a match from the university for a cooperative agreement, participatory agreement, joint venture plan, etc…*

In conclusion, there are opportunities for cross-discipline collaborations between research and management with unique and immediate beneficial outcomes. Decision support mechanisms can be customized to the immediate needs of a specific project, based on recommendations that have scientific merit. These research/management hybrid projects could be the impetus to producing a more intelligent, experienced weed science work force in natural area and rangeland conservation. The measures that the WSWS and/or WSSA could take to facilitate this concept include:

- Aggressively recruit stronger public agency participation and attendance to the annual meeting.
- Establish more species-specific symposia in future meetings.
- Introduce more workshops at the annual meeting to meet the needs of both managers and researchers (e.g., grant proposals, data management and statistics, GIS, etc…).
- Develop a new section in management-focused papers that highlight manager/researcher collaborations.
- Encourage more case study publications in IPSM.
- Identify solutions to making IPSM more accessible/affordable to management programs.

Renz et al. (2006) correctly identified the logistical challenges with managers short on time and researchers short on funding. As one participant so eloquently flipped it "*If the researchers have the time and managers have the money…Let's get it done.*"

Cited Literature

McPherson, G. 2004. Linking science and management to mitigate impacts of nonnative plants. Weed Tech. 18:1185-1188

Kniss, A. R. and J. C. Streibig (2015) Statistical Analysis of Agricultural Experiments with R. http://rstats4ag.org/. Accessed: March 16, 2015

Renz, et al. 2009. Land manager and researcher perspectives on invasive plant research needs in the Midwestern United States. IPSM 2:83-91.

Chair 2015:

Jane Mangold, Montana State University, PO BOX 173120, Bozeman, MT 59717
jane.mangold@montana.edu

Chair-Elect 2015:

James Leary, University of Hawaii at Manoa, PO BOX 269, Kula, HI 96790
leary@hawaii.edu

Chair-Elect 2016:

Tim Harrington, United States Forest Service, PNW Research Station, 3625 93rd Ave SW, Olympia, WA 98512
tharrington@fs.fed.us

Attendees:

Name	Affiliation	Email
Rod Lym	North Dakota State University	Rod.lym@ndsu.edu
Joe DiTomaso	UC-Davis	jmditomaso@ucdavis.edu
Tracy Sterling	Montana State University	tracy.sterling@montana.edu
Bob Finley	Fremont County (WY) Weed & Pest	rfinley@dteworld.com
Corey Ransom	Utah State University	corey.ransom@usu.edu
Larry Lass	University of Idaho	llass@dteworld.com
Tim Harrington	US Forest Service	tharrington@fs.fed.us
Rochelle Desser	US Forest Service	dresser@fs.fed.us
Erik Lehnhoff	Montana State University	erik.lehnhoff@montana.edu
Tim D'amato	Larimer County (CO)	tdamato@larimer.org
Elise Gornish	UC-Davis	egornish@ucdavis.edu
Jason Adams	North Dakota State University	Jason.w.adams@ndsu.edu
James Leary	University of Hawaii	leary@hawaii.edu
Todd Neel	US Forest Service	toddaneel@fs.fed.us
Jane Mangold	Montana State University	jane.mangold@montana.edu

Project 2 Discussion Section: Weeds of Horticultural Crops
Moderator: Ed Peachey, Oregon State University, Corvallis, OR
Topic: *Pollinators, Weed Management, and New Roles for Weed Scientists*
.
Ed introduced Dr. Ramesh Sagili of OR State Univ., a honey bee nutrition and pollination expert. Ramesh gave a short introduction on the state of honey bee survival in the US. Thirty percent of hives are lost each year; less so in Oregon. Factors influencing bee survival are parasites, insecticides and other chemicals in hives (herbicides are often found in honey), malnutrition, migration (eg to almonds in CA in the spring), and lack of diversity in *Apis* genetics. Monocultures of hybrid crops are also causing loss of bee habit and restricted diets. A presidential memorandum was issued and a pollinator task force established to address the issue of improving pollinator habitat, but there is uncertainty about the impact of the memorandum or if anyone will act.

Following the introduction, a lively discussion ensued as those attending were asked to share projects that they are involved in that promote improvements in pollinator habitat. Much of the initial discussion included questions about bee behavior in general. In western Oregon bees frequent Himalayan blackberries. Should we be concerned about weeds in the landscape competing with crops for pollination services? Ramesh made the point that weeds can serve as a bridge for bees when crops are not flowering, and even during the crop season. Weeds may supply vital nutrients that crops will not. Mustards in CA almonds is a good example.

A number of factors and issues were discussed in regard to improving bee habitat and ultimately bee health and survival. It would be helpful to have lists of weedy plants that are good pollen sources so the weed managers could make selective decisions, if warranted. Honey bees are known to stick to one crop until the resource is exhausted, in contrast to bumble bees and other native pollinators that do not show this kind of 'fidelity'. Attraction to specific plants is influenced by previous foraging behavior. Hedgerows are one way to provide resource to beneficial insects including bees. Japanese knotweed is a good source of food for foraging bees. Perhaps waste areas on irrigation 'corners' could be used to improve pollinator habitat. CRP acres, though continuing to decline, sometimes provide resource to pollinators and could be designed to do so. Drainage ditches could be re-vegetated to include plants that provide habitat for bees. If wild flower mixes are used they should be free of noxious weeds. Providing diverse and continuous resources for bees in addition to the crop greatly improves winter survival.

One point reiterated several times is that little is known about the quality of pollen and nectar resources of weedy plants, and that before these resources can be managed, this information must be gathered. Certainly, public education is needed on the value of certain insects, specifically bees and other pollinators.

<u>Chair 2015:</u>
Ed Peachey, Oregon State University Department of Horticulture, 4017 Ag and Life Sciences Building, Corvallis, OR 97331
peacheye@hort.oregonstate.edu.

Chair Elect 2015:
Dennis Tonks, Isk Biosciences, 211 S. Platte Clay Way, Suite B Kearney MO 64060
tonksd@iskbc.com.

Chair Elect 2016:
Pam Hutchinson, Aberdeen Research & Extension Center, 1693 S 2700 W, Aberdeen, ID 83210.
phutch@uidaho.edu

Attendees:

Name	Organization	Email
Rick Boydston	USDA-ARS	rick.boydston@ars.usda.gov
Tim Miller	WSU	twmiller@wsu.edu
Carl Libby	WSU	libbey@wsu.edu
Jacob Jarret	Wyow & P	jake@parkcountyweeds.org
Emmett Phelan	WWP	emmett@parkcountyweeds.org
Andy Robinson	NDSU/U of M	aprobins@umn.edu
RodneyTocco	Winfield	rvtocco@landolakes.com
Alan Schreiber		aschreib@centurytel.net
Robert Norris	UC Davis	rfnorris@ucdavis.edu
Gabriel Flick	OSU	flickfarms@gmail.com
Carol Mallory-Smith	OSU	carol.mallory-smith@oregonstate.edu
Joel Felix	OSU	joel.felix@oregonstate.edu
Marty Williams	USDA-ARS	mmwillams@illinois.edu
Sandra McDonald	MW Pest	Sandra@MountainWestPEST.com
Pamela Hutchinson	U of Idaho	phutch@uidaho.edu
Kai Umeda	U of AZ	kumeda@cals.arizona.edu
Dan Curtis	OSU	daniel.curtis@oregonstate.edu
Joan Campbell	Univ. of Idaho	jcampbel@uidaho.edu
John Roncoroni	UC Cooperative Extension	jaroncoroni@ucanr.edu
Roger Nybner	NRCS	roger.hybner@mt.usda.gov
Edward S. Davis	Montana State Univ.	edavis@montana.edu
Ed Peachey	OSU	ed.peachey@oregonstate.edu
Ramesh Saghili	OSU	ramesh.saghili@oregonstate.edu

Project 3 Discussion Section: Weeds of Agronomic Crops
Moderator: Prashant Jha, Montana State University, Huntley, MT
Topic: *Developing a Herbicide Resistance Working Group in the Western US: Potential Research and Funding Needs.*

There was an hour discussion about a proposal to WSSA for organizing a symposium on "Herbicide Resistance Challenges in Western US" during 2017 WSSA meeting in Tucson, AZ. Weeds to consider in this symposium include green foxtail, jungle rice, kochia (throughout the Great Plains), horseweed in CA, *Panicum* Spp. in tree crops, downy brome, Italian ryegrass, and hairy fleabane in CA, AZ and NM.

The symposium was proposed to cover the following topics: 1) Geographical distribution, evolution, and mitigation of herbicide resistance in key weed species of Western US -Suggestion to have an industry rep. discuss their view on resistance. Suggestion to have a retail representative discuss their view on weed resistance (discussion around loyalty agreements and their impact on weed resistance development), 2) Molecular and genetic mechanisms of herbicide resistance evolution, 3) Economics and sociological aspects of herbicide resistance and adoption of BMPs- This issue was considered to be an important component of Herbicide Resistance Management Initiative and was well perceived by all attendees.

The proposal is due next June -"Weed Resistance Challenge" is set to go right after WSSA meeting, so Sandra has asked the WSSA not "steal their thunder."
Brian Jenks and Prashant Jha volunteered to lead the proposal team; they emphasized that they will need a lot of teammates willing to do what it takes to make it a success. They will contact folks to help.

<u>Chair 2014:</u>
Prashant Jha, Montana State University, Southern Agricultural Research Station, 748 Railroad Highway, Huntley, MT 59037, 406-348-3400
pjha@montana.edu

<u>Chair-elect 2015:</u>
Steve Eskelsen, MANA, 2915 Kent Brock Ct., Kennewick, WA 99338, 509-378-7349
seskelsen@manainc.com

<u>Chair-elect 2016:</u>
Caleb Dalley, North Dakoda State University, PO Box 1377, Hettinger, ND 58639
caleb.dalley@ndsu.edu

Attendees:

Name	Institution	Email
Steve Eskelsen	ADAMA	steve.eskelsen@us.adama.com
Brian Jenks	NDSU	Brian.jenks@ndsu.edu
Brad Hanon	UC Davis	bhanson@ucfavis.edu
Marie Jasieniuk	UC Davis	mjasien@ucdavis.edu
Bill McCloskey	Univ of AZ	wmcclosk@email.arizona.edu
Ryan Rapp	Monsanto	Ryan.e.rapp@monsanto.com
Mayank Malik	Monsanto	Mayank.s.malik@monsanto.com
Mithila Jugulam	KSU	mithila@ksu.edu
Joel Felix	Oregon State Univ	Joel.felix@oregonstate.edu
Roger Gast	Dow AgroSciences	regast@dow.com
Prashant Jha	Montana State Univ	pjha@montana.edu
Alan Helm	Gowan Company	ahelm@gowanco.com
Edward Davis	Montana State Univ	edavis@montana.edu
Joe Yenish	Dow Agro Sciences	jpyenish@dow.com
Caleb Dalley	NDSU	Caleb.dalley@ndsu.edu
Roland Schirman	-	schirman@innw.net

Project 4 Discussion Section: Teaching and Technology Transfer

Moderator: Byron Sleugh, Dow AgroSciences, West Des Moines, IA

Topic: *Training the Complete Weed Scientist.*

Introductions proved all people in the room have different jobs yet they all relate to weeds. While the perfect weed scientist may not exist, the closest we can get is by having an "appreciation" for physiology, botany, regulatory, chemistry, entomology, pathology, sociology, soils, water systems, economics, etc.

Entomologists and pathologists typically see themselves as integrated pest managers and weeds are a part of the "pest package." To be a successful weed scientist, we may need to see ourselves as weed managers.

A question often asked of weed scientists is "what is that plant and how do I kill it," but that may be the wrong question. We should be asking "what is that plant and WHY is it there" because the weed is a symptom of a problem. In the past the weed scientist motto was "spray and pray" and we have moved to "nozzle-heads" but we need to realize chemical is only a piece of the puzzle.

From a grad student perspective, we are learning the tools to understand the full system of weeds. The application of this knowledge is the most important thing. Being able to explain the decisions we make is critical. We are developing a professional network in order to ask questions since we aren't experts. The same is true for people already in the industry; the human network is a tool we have as weed managers.

How do we change the model in education to make it better? Students get bogged down in their own research and are then expected to be knowledgeable about an array of areas. While an internship may not be realistic considering time restrictions (research needs), job shadowing in a graduate program could give students an idea of different jobs and how to apply coursework. Participation in conferences is also beneficial to get a broad knowledge of what is happening. Two important parts of this is recruiting students into societies like WSWS earlier and recommending what courses will be most beneficial in creating the complete weed scientist. At Utah State University, the weed science course is a 5000 level class which is like a "capstone" course and students begin to see how all of their other courses fit together as a weed manager. **<u>It was suggested that societies such as WSSA and regional branches such as WSWS could provide guidance and influence to programs across the country in what should be a part of the training of the next generation of weed managers.</u>**

Three areas mentioned as the most critical to the complete weed scientist were 1) strategic planning (what does and doesn't work), 2) regulations (where to find them, what they mean), 3) education (continuing for existing scientists, education to the public sector). Even though some people might not have formal education in weed science, their experience and continuing education credits can allow people to become great weed managers. The "fire in the belly" is the most important aspect in this situation.

In general, society doesn't know basic science and it is becoming a huge detriment to agriculture. Regardless of the polarized belief of people, agriculture has ALL the prerequisites for a functioning society (economics, science, labor, etc.). Universities have a duty to members of the state (society) to train students in all disciplines. So while we see weed science as an all-encompassing endeavor, we need to expand and teach all students who move through the university system and agriculturalists, especially weed scientists, need to insert themselves into other sciences. Perhaps the name of courses is a block for students and departments because the end goal is feeding people; however, academia is very protective of courses and program of study, particularly names, so change from this angle may be difficult.

We would like to thank Roswita Norris for help taking notes and bringing an outside perspective to our discussion.

Chair 2015:
Byron Sleugh, Dow AgroSciences LLC, 7521 W. California Ave., Fresno, CA 93706, 559-494-3327
bbsleugh@dow.com

Chair-elect 2015:
Jenna Meeks, University of Wyoming, 1000 E. University Ave., Dept 3354, Laramie, WY 82071, 307-766-3103
Jmeeks8@uwyo.edu

Chair-elect 2016:
Casey McKee, Anadarko Petroleum Corp., 1368 S 1200 E Vernal, Utah 84078, 435-790-6897
casey.mckee@aggiemail.usu.edu

Project 5 Discussion Session: Basic Biology and Ecology

Moderator: Ian Burke, Washington State University, Pullman, WA

Topic: *Bridging the Gap Between Basic Biology Research and Weed Management.*

One of the largest problems facing basic weed biology is translating the findings into useable information for growers. In a field were the bottom line is paramount it is important that our research has value and that that value is translatable. In 1974 HG Baker put forth a list of characteristics that describe a weedy species. These characters can be studied, their range narrowly defined, ad theoretically this information can lead to control options for farmers. In this discussion Dr. Ian Burke asked three fundamental questions related to bridging the gap between basic biology and weed management:

1) What are some successful examples of applying basic biology for growers?
2) What are the weedy traits and can HG Bakers list be added to?
3) How do we get our information to the growers?

1. What are some successful examples of applying basic biology for growers?

- The first example brought up was the study of the weedy traits of jointed goat grass and how it led to the development of clear field wheat[1].
- The second example, provided by Marty Williams was the discovery of a cytochrome p450 that conferred resistance to multiple herbicides in sweet corn[2]
    - Though this discovery could be used by breeders to develop herbicide resistant crops, breeding programs are still failing to adopt breeding for this trait in all lines
- Weed seed germination studies are essential for advising growers about the timing of herbicide spray applications [3,4].
    - In addition to timing, the amount of water needed to activate the herbicide and cause seeds to break dormancy is essential
- Conyza has a diverse germination phenotype that can lead to seeds breaking dormancy in either fall or spring.
    - Discovery of the mechanism for this trait could lead to the ability to screen populations and advise on application timing [5,6,7]

2. What are the weedy traits and can HG Bakers list be added to?

- In addition to what was originally on the list these additional traits arose in conversation:
    1. Seed Output: Number of seeds, seed viability, seed persistence in seed bank, etc.
    2. Dispersal Mechanisms: Tumbleweeds?

3. Plant architecture: prostrate v. upright, branching v. single stem, leaf morphology, etc.
4. Competitiveness: Allelopathy, Shading, Germination timing, etc
5. Genetic Variability: Mutation rates, Genotype variability, mechanisms for breeding (outcrossing, inbreeding, dioecious, etc.)
6. Flowering: Flower and seed timing
7. Photosynthetic rates and energy production (Could be considered competition)

- Should we be breeding crops to be more competitive? What impacts will that have on yield? Will competition be more important in organic growing conditions where herbicides cannot be used?
- How can we quantify these traits? How can we screen for these traits? How can we get useful information to the growers and not superfluous information?
    - Seems to have to be on a case-by-case basis.

3. How do we get our information to the growers?

- Example: Flowering timing studies in downy brome could lead to the advice to rotating into winter wheat [8,9]
    - Turns out to be effective but not economically sound
- The advice has to be fiscally sound
    - Farmers only care about the bottom line
    - There seems to be a culture (especially in America) of only worrying about 1-5 years of farming. No thought of the big picture or long term land stewardship
        - Australia has been successful in teaching farmers about long term impacts of things like herbicide resistance. How?
- Farmers generally don't see weeds as their first concern.
    - Things like fertilizer, water, growing degree days, and insects often are more important
        - How can we justify potentially expensive (yet effective) weed control methods?
- Dr. Ian Burke suggests that University Weed Programs continue to offer weed diagnostics as part of our extension efforts and in so doing help disseminate information about basic biology and best practices.
    - Would growers be willing to pay small fees for screening and advice?

        - Farmers already pay large amounts of money for soil testing
    - Could there be centers to do this testing?
        - What would the product look like if it were monetized?

Bibliography

1) Hanson, D. Eric, Daniel A. Ball, and Carol A. Mallory-Smith. "Herbicide Resistance in Jointed Goatgrass (Aegilops cylindrica): Simulated Responses to Agronomic Practices1." (2009).

2) Williams, Martin M., et al. "Further evidence of a genetic basis for varied levels of injury to sweet corn hybrids from cytochrome P450-metabolized herbicides applied post-emergence." *HortScience* 43.7 (2008): 2093-2097.

3) Burke, Ian C., et al. "Influence of environmental factors on after-ripened crowfootgrass (Dactyloctenium aegyptium) seed germination." (2009).

4) Burke, Ian C., et al. "Influence of environmental factors on broadleaf signalgrass (Brachiaria platyphylla) germination." (2009).

5) Buhler, Douglas D., and Michael DK Owen. "Emergence and survival of horseweed (Conyza canadensis)." *Weed Science* (1997): 98-101.

6) Nandula, Vijay K., et al. "Factors affecting germination of horseweed (Conyza canadensis)." (2009).

7) Owen, Lucas N., et al. "Evaluation of spring and fall burndown application timings on control of glyphosate-resistant horseweed (Conyza canadensis) in no-till cotton." *Weed Technology* 23.3 (2009): 335-339.

8) Blackshaw, Robert E. "Rotation affects downy brome (Bromus tectorum) in winter wheat (Triticum aestivum)." *Weed technology* (1994): 728-732.

9) Rydrych, D. J. "Competition between winter wheat and downy brome." *Weed Science* (1974): 211-214.

Chair 2015:
Ian Burke, Washington State University, Pullman, WA 99164-6420, 509-335-2858
icburke@wsu.edu

Chair-elect 2015:
Todd Gaines, Colorado State University, Fort Collins CO 80523-1177, 970-491-6824
Todd.Gaines@colostate.edu

Chair-elect 2016:
?

List of Attendees not submitted

Discussion Section: Extension and Regulatory

Moderator: Kaci Buhl, Oregon State University, Corvallis, OR

Topic: *Pesticide incidents, the stories people tell, and how to use them in educational programs.*

The Education & Regulatory Section discussion in Portland was very lively and informative with 45 in attendance at times. Kaci Buhl, Project Coordinator, National Pesticide Information Center, led the discussion. The topic was "Pesticide incidents, the stories people tell, and how to use them in educational programs." The discussion was preceded by Kaci's presentation "A Tool You Can Use: The National Pesticide Information Center at Oregon State University."

- You can make referrals to NPIC (www.npic.orst.edu) (1-800-858-7378) when individuals contact you for non-emergency, science-based information about pesticides.
- You can use the expansive NPIC website to find talking points for consumer-oriented topics like food safety, low-risk pesticides, and residential pests.
- As a professional, you might enjoy our directories of chemical databases, manufacturer contacts, and our collection of technical fact sheets.

NPIC is operated at Oregon State University through a cooperative agreement with the US Environmental Protection Agency. Their mission is to promote informed decision-making, to translate technical information, and to facilitate access to sound science. NPIC does not make recommendations or levy opinions.

NPIC's toll-free phone service is available Monday – Friday, 11:00 – 3:00 Eastern (8:00 – 12:00 Pacific). Email inquiries and voice-mail messages will be returned within one business day. Send email to NPIC at this address: npic@ace.orst.edu. They're also active on Facebook, Twitter, and YouTube.

Several questions related to the operation of the Center were asked. The Center does not initiate investigations, but rather provides information for people to make their own decisions. Also, for active emergencies, individuals are directed to call 911 or a Poison Center. Service technicians have minimum of M.S. degree and receive additional training in communicating with the public. Lines are staffed with eight individuals: four dedicated to phone lines and four others to serve other media and prepare publications and responses. And they have access to a translation service to aid communication when English is not the primary language. This is a conferencing phone interface that is immediately available for many languages.

The Center is interested in receiving notices about new sensational claims and blog flares that elicit emotional response in the public so they may prepare for potential inquiries. For example, the Center had not received calls about glyphosate correlation with Autism, Celiac, or Alzheimers, but the membership had just started seeing inflammatory comments. Kaci illustrated past cases of informing the public that correlation does not conclude causation.

Kaci elaborated on difficulties of dealing with misinformation or myths and the general distrust of scientists. Many people have an information bias and an initial bias is very difficult to modify. She indicated that replacing a myth with truth is more likely when the truth and myth are about the same size. Replacing a small myth with a large amount of counter scientific evidence has not worked well. Also, mentioning the myth to debunk it lends credibility to the myth.

Kaci discussed why conversations with the public about Risk Assessment need to move beyond toxicity and exposure. These items are unknown or not understandable to the general public; things of unknown nature are suspect. Introducing control of the situation or discussing benefits can draw on commonality with the public and create more tangible reasoning or value. Given choices, some individuals have selected a higher risk situation because of familiarity and perceived control of the outcome.

As communicators with the public, we must first listen to and understand the question or concern. This may be different than the question actually asked. Short, succinct responses may be more effective than elaborate scientific explanations until the point when the person is ready to accept more information. Distrust of scientists is not easily overcome, but Kaci and the Center have a framework and ideas to help provide factual information and communicate effectively with the public. All are encouraged to use the Center as a resource for information and public communication training.

List of Attendees not available

WESTERN SOCIETY OFWEED SCIENCE NET WORTH REPORT

April 1, 2014 through March 31, 2015

ASSETS	
Cash and Bank Accounts	
American Heritage Checking	$66,074.17
American Heritage Money Market	$5,002.29
CD#1 1 yr @ 0.4%	$45,089.26
CD#2 2 yr @ 0.6%	$45,133.89
Checking Bank of the West (will be closed this year)	$1,761.74
Money Market Bank of the West (will be closed this year)	$7,362.20
TOTAL Cash and Bank Accounts	$170,423.55
Other Assets	
Asset (Weeds of the West unsold inventory)	$53,821.35
TOTAL Other Assets	$53,821.35
Investments	
RBC Dain Rauscher Acnt	$201,883.09
TOTAL Investments	$201,883.09
TOTAL ASSETS	$426,127.99
TOTAL LIABILITIES	$0
OVERALL TOTAL	$426,127.99

WSWS CASH FLOW REPORT

April 1, 2014 through March 31, 2015

INFLOWS ($)	
Annual Meeting Income	64,739.00
Bio Control Of Invasives Book	9.69
California Weeds Books	180.00
DVD Weed ID	54.00
Interest Inc	369.12
Proceedings	71.08
Renewal Membership	1,920.00
Royalty For Proceedings Or RPR	780.00
Student Travel Account	(1,304.00)
Sustaining Member Dues	10,850.00
Weed Control In Natural Areas	232.79
Weeds Of The West	42,767.27
TOTAL INFLOWS	120,698.95
OUTFLOWS ($)	
Annual Meeting Expense	45,562.19
CAST Annual Dues	1,500.00
Director Of Science Policy	8,832.00
Insurance	500.00
Merchant Account	3,105.12
Misc	(360.90)
Service Contract	25,000.00
Stipend	1,500.00
Supplies	28.70
Tax	167.00
Tax Preparation	451.76
Travel To Summer Meeting	4,197.02
Travel To WSWS Meeting	1,946.04
Web Site Host	4,000.00
TOTAL OUTFLOWS	96,428.93
OVERALL TOTAL	24,270.02

WSWS 2015 FELLOW AWARDS

Fellows of the Society are members who have given meritorious service in weed science, and who are elected by two-thirds majority of the Board of Directors.

Pete Forster

Pete Forster is a Senior Scientist in charge of product evaluation with Syngenta Crop Protection at Greeley, Colorado, where he has been stationed since 2000. Prior to this position, Pete was with Ciba in Sanger, California, beginning in 1988. He has presented many times at WSWS as well as at NCWSS. He has also contributed on the WSWS Sustaining Membership (2008-2010) and Site Selection (2013-Present) committees. Pete has been the Syngenta contact for the Graduate Student and Spouse Breakfasts at the WSWS Annual Meeting (2000-2010), coordinated multiple other sponsored events at Annual Meeting (2010-Present), and helped judge the Graduate Student Contests several times. Pete has served on the WSWS Board of Directors as Secretary (2003-2004) and Member-at-Large (2011-2013) and was named the WSWS Outstanding Weed Scientist in 2009.

Gil Cook

Gil Cook is currently a private consultant with Cook Ag Science Expertise in Spokane Valley, Washington. Most of our membership will remember Gil as serving with DuPont Crop Protection from 1976 until his retirement in 2004. Since then, Gil has conducted private research with BASF, Dow, DuPont, FMC, Gowan, Helena, NovaSource, Wilbur-Ellis, Walla Walla Farmers Co-op, and Loveland and has conducted trainings on herbicide resistance and forensic pathology. With DuPont Crop Protection, Gil received the Achievement Award (1984), the Leadership Award (1988), the Environmental Excellence Award (1992), the Project Stewardship Award (Sulfonylurea Herbicides) (1998), and the Accomplishment Award (2002). He was also one of the Washington State Weed Association's Honorary Members (1992) and Weed Warrior (2003). With WSWS, Gil has presented many times at the Annual Meetings and has served on the Necrology (1992-1994), Finance (1994-1996), Student Educational Enhancement (1996-1997), and Local Arrangements (1999-2001) committees. Gil was elected Chair of the Education and Regulatory Committee in 1998 and was the WSWS President in 2003.

WSWS 2015 Honorary Member

This award was not conferred in 2015

WSWS 2015 OUTSTANDING WEED SCIENTIST – Brian Mealor

Brian Mealor is an Assistant Professor & Extension Weed Specialist who joined the University of Wyoming in 2009. Brian is innovative in all aspects of his position including research, extension and teaching. His program focuses on the interaction between native and invasive plants, strategic weed management and cost-effective methods of managing invasive weeds in rangeland ecosystems. His efforts are focused on developing and improving management strategies to reduce the ecological and economic impacts of invasive weeds, on weed management strategies to restore disturbed rangelands and on understanding the resilience of native plant communities to biological invasion. He was the Director of Stewardship for The Nature Conservancy in Wyoming from 2007-2009. Brian has developed high-quality extension materials including a Cheatgrass Management Handbook and the The Wyoming Weed Watchlist field guide. Students in his Invasive Plant Ecology course contributed chapters to field guide. Brian presented more than 130 extension presentations in the past 5 years. He is an outstanding teacher who has participated in the Southwest Noxious Weed Short Course, the DuPont Invasive Plant Management Webinar Series, and the American Youth Leadership Program in Mongolia. Brian is an active member of the WSWS and served as the chair of the WSWS Finance Committee in 2012-2013. He and his students have presented papers and posters at the WSWS meetings. Brian has received a number of awards including the Outstanding Young Range Professional from the Society of Range Management in 2013 and Outstanding Advisor in 2012. He served as President of the Wyoming Section of the Society of Range Management.

WSWS 2015 WEED MANAGER AWARD

This award was not conferred in 2015

WSWS 2015 PROFESSIONAL STAFF AWARD – Brent Beutlers

Brent Beutler is a Research Support Scientist at the University of Idaho Aberdeen Research and Extension Center. Brent has worked with Dr. Pamela Hutchinson on weed control in potatoes for more than 10 years. In cooperation with Dr. Hutchinson, Brent oversees much of the field work conducted in the program. Brent is creative and innovative; he built a small plot chemigation system that can treat one plot at a time with precise amounts of water and herbicide. Brent has been especially important in the success of research being conducted to develop a weed management plan for the trap crop, Litchi tomato (Solanum sismbriifolium), used for control of the pale cyst nematode. He has been involved in developing weed control in the trap crop and well as controlling the trap crop so that it does not become weedy. He coordinated the on farm research for this project and worked closely with other agencies such as USDA-ARS, USDA-APHIS and the Idaho State Department of Agriculture. There was little information about the trap crop and Bent has been important in increasing the knowledge about the Litichi tomato. Brent has presented papers at the WSWS and the Potato Association of America. He has co-authored seven journal papers, 74 scientific notes/research reports and 25 proceedings/abstracts.

WSWS 2015 PRESIDENTIAL AWARD OF MERIT – Crol Mallory-Smith

Carol Mallory-Smith received the WSWS Presidential Award of Merit from Drew Lyon at the 2015 annual meeting in Portland, Oregon. Carol has not only provided the WSWS with outstanding service by serving on the Board of Directors and on numerous committees, she has also served the broader weed science community as President and Treasurer of the Weed Science Society of America and Secretary-Treasurer of the International Society of Weed Science. Carol has directed the graduate studies for 32 students. She has published more than 100 refereed journal articles and eight book chapters. She has given 30 invited professional presentations and she is a member of the National Research Council's Committee on Genetically-Engineered Crops. Carol has served our society well and she is a very deserving recipient of this award.

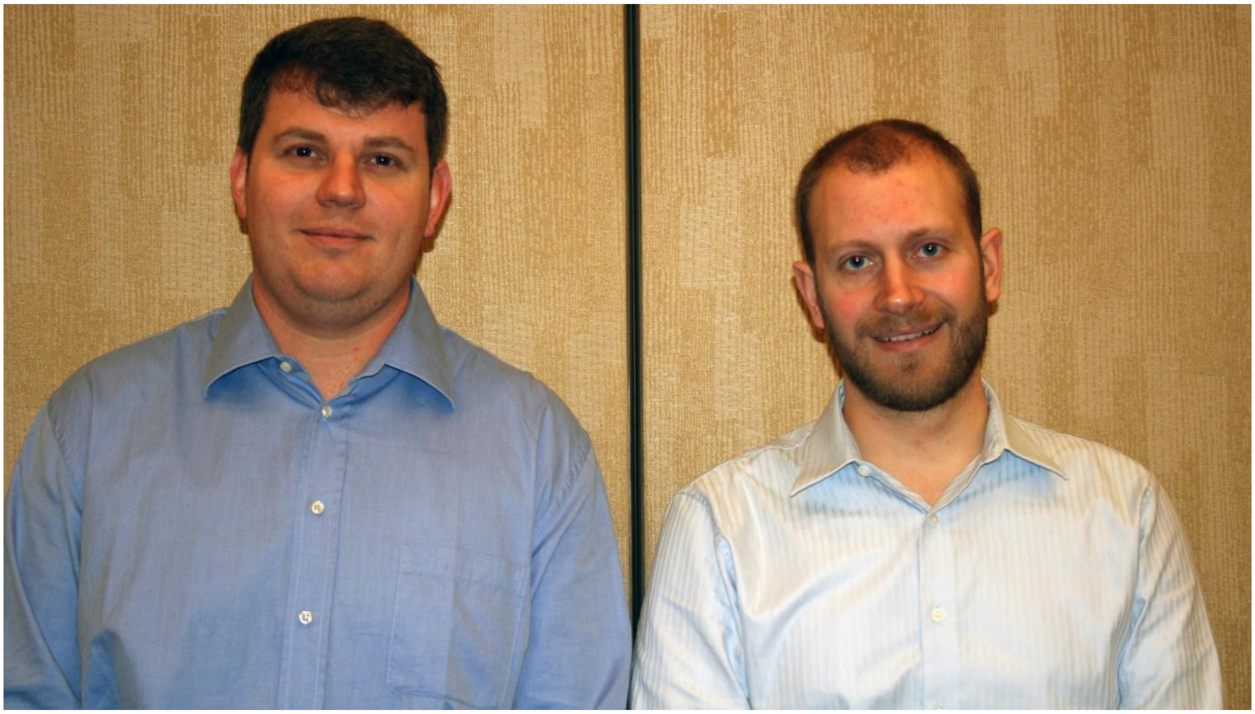
WSWS 2015 STUDENT SCHOLARSHIP RECIPIENTS

This year there were nine excellent applications for the Elena Sanchez Memorial Scholarship. Three graduate students were provided $1,000 each to support travel to the WSWS meeting. The awardees were Kelli Belmont (left), University of Idaho; Breanne Tidemann (middle), University of Alberta; and Vipan Kumar (right), Montana State University. We encourage all graduate students who have not previously received the award to apply next year.

WSWS 2015 GRADUATE STUDENT PAPER AND POSTER AWARDS

The 2015 WSWS Student Paper Contest included 17 poster presentations and 18 oral presentations. All of the students who participated are to be commended for their excellent presentations. As has been done previously, the students with poster and oral presentations were each divided into two groups. According to the rules of the student paper contest, the number of winning places in the four groups varied from two to three, depending on the number of students in each group.

Oral Paper Contest Awards – Range and Natural Areas, Horticultral Crops and Basic Biology and Ecology

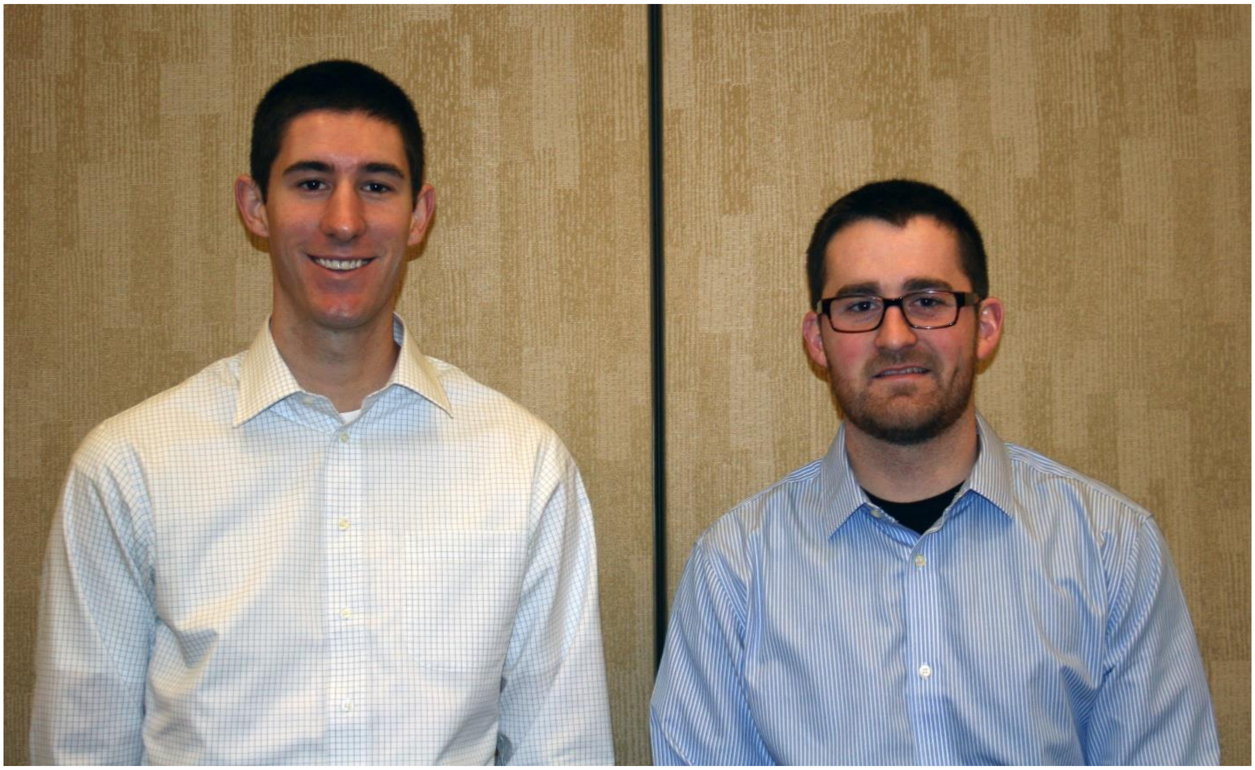


First place winner was Marcelo Moretti (left), University of California Davis. His presentation was *Mechanism of Glyphosate and Paraquat Resistance in Conyza Species*. Second place winner was Nevin Lawrence (right), Washington State University and his presentation was *Genetic Variation of Downy Brome from Small Grain Production fields in the Pacific Northwest*. Third place winner was William Rose (not pictured), University of Wyoming and his paper was *A Novel Method for Removing Downy Brome Contaminants from Reclamation Seed*.

Oral Paper Contest Awards – Agronomic Crops

In the oral presentations, the students were divided into two groups. The second group of oral presentations were in the Agronomic Crops project. First place winner was Thomas J. Schambow (left), University of Wyoming and his paper was *The Effects of Simulated Weed Canopies on Sugarbeet Growth*. Second place winner was Christopher Van Horn (right), Colorado State University and his paper was *Molecular Basis of Glyphosate Resistance and the Rapid Necrosis Response in Giant Ragweed*.

Poster Presentation Awards – Range and Natural Areas, Horticultural Crops and Agronomic Crops



Posters presented in the Weeds of Range and Natural Areas, Weeds of Horticultural Crops, and Weeds of Agronomic Crops projects had two winners. First place was Derek Sebastian (left) from Colorado State University. His winning poster was titled *Comparing Indaziflam and Imazapic for Downy Brome and Feral Rye Control in Range and Pasture*. Second place winner in the same group was Alan Raeder (right), Washington State University. His poster was titled *Field Carryover of Pyroxsulam, Sulfosulfuron, and Florasulam to Lentil, Chickpea, Canola, and Barley in the Inland Pacific Northwest.*

Poster Presentation Awards – Basic Biology and Ecology

The posters presented in the Basic Biology and Ecology project also had two winners. First place winner was Curtis Hildebrandt (left) from Colorado State University with his poster titled *Green Ash and Honey Locust Response to Aminocyclopyrachlor*. Second place winner was Gabriel Flick (right), Oregon State University with his poster titled *Impact of Seed Burial Depth on Radish Seedling Emergence*. Third place winner was Triston Hooks (not pictured), New Mexico State University with his poster titled *Salinity Responses of Three Invasive Lepidium Species*.

WSWS 2015 ANNUAL MEETING NECROLOGY REPORT

Obituary for Dr. John D. Nalewaja – 1930-2014

Dr. John D. Nalewaja of Fargo, ND and Osakis, MN 84 passed away peacefully on November 11, 2014 from prostate bone cancer in San Tan Valley, AZ.

John Dennis Nalewaja was born October 7, 1930 to Anthony and Hattie Nalewaja on a farm near Browerville, MN. After high school, he graduated in Vocational Agriculture from the University of Minnesota, served in the US Army, taught Ag education classes at Boyd, MN for one year, and obtained a Master of Science and Doctor of Philosophy in Agronomy from the University of Minnesota. He married Donna Lou Speer December 26, 1959. They moved to Fargo in July 1962 and raised four children-Stephen, Susan, Gregory and Anne. Dr. Nalewaja taught classes and conducted research in Weed Science at North Dakota State University until retirement in September 1998.

Dr. Nalewaja was major advisor to 24 Ph.D. and 34 Masters of Science students, major supervisor for 30 visiting scientists from various countries (mainly Poland) and post doctorate research associates. He served as President and in other offices for various regional and national Weed Science Societies. He was chairman and editor for American Standard Testing Method Symposium on Pesticide Formulations and Applications Systems, was a member of the National Pesticide Impact Assessment Program. Dr. Nalewaja was a manuscript reviewer for four professional journals, and reviewer of research programs in various Universities, Morocco and South Africa. Dr. Nalewaja was team leader of a research group visiting Siberia in the Soviet Union, and presented an adjuvant symposium in China.

Dr. Nalewaja had more than 200 publications in various scientific journals and he presented papers by invitation to South Africa, Australia (three times), Belgium, Poland, Yugoslavia, and Spain in addition to those in the USA. He worked with his graduate students, post doctoral scientists, and visiting scientists to study the biology and control of wild oats and develop systems for effective weed control in grain crops; which were successfully demonstrated across ND and other states. Dr. Nalewaja discovered and developed methylated seed oils (MSO) as an adjuvant for herbicides now commonly used throughout the world and also determined the chemical basis of salt antagonism of certain herbicides (like Roundup) and how to overcome the antagonism of many herbicides, which helped many weed scientists focus in this new area of surfactants and adjuvants.

He received several awards including an Honorary Doctorate from Poznan Agriculture University in Poland, the Fargo Moorhead Chamber of Commerce Distinguished NDSU Professor Award, Honorary Member North Central Weed Science Society, Fellow of the Weed Science Society of America for Outstanding Teacher and Outstanding Researcher Awards.

After retirement in 1998, Dr. Nalewaja served as Professor Emeritus at NDSU, continued to review research papers and give presentations on weed control. He and his wife, Donna, enjoyed summers at their cottage on Lake Osakis and at the Nalewaja family farm near Browerville, MN where he grew no-till soybeans and spent winters in Fargo, ND and AZ when not visiting children and grandchildren. John was a talented carpenter crafting kitchen cabinets and furniture.

John D. Nalewaja is preceded in death by his parents, brothers Paul, Benedict, Leo and Ignatius and sisters Catherine, Anna, Mathilda, Alvina and Philomene. He is survived by his wife of 54 years, Donna, sister Hattie of Maryland, and children Dr. Stephen (Jill) of Miles City, MT, Susan Van Voorhis (Tom, Gregory (Jennifer) of Charlotte, NC and Anne (Steve Ruebke) of Twin Valley, MN and ten grandchildren.

Obituary for Mr. Kent McKay – 1965-2014

Kent McKay age 49, Fargo and Lisbon, ND (formerly of Minot, ND died unexpectedly on Saturday, December 6th.

Kent was born to Wallace and Virginia McKay on June 24, 1965 in Williston, ND. He grew up in Fargo and graduated from North High School in 1983. Kent graduated from NDSU in 1988 (BS) and 1991 (MS) in Agronomy and Agricultural Science. Kent spent 17 years with the North Dakota State Extension Service Agricultural Research Station in Minot, ND. Kent's reputation as an award winning, knowledgeable and helpful agronomist reached far across much of North Dakota. Kent continued working in the field of Agriculture for various multi-national and local companies and as an independent consultant.

Kent was an avid hunter and fisherman and enjoyed each season with his family and Brittany bird dogs. He had a passion for birds and gardening and even spent time raising and racing thoroughbred race horses. Kent also had keen interest and enthusiasm for NDSU Bison athletics especially football.

Kent leaves behind a vast group of people who enjoyed his friendly smile, lively conversation, and amiable personality. Immediate family survivors include: wife Lori McKay (Carpio, ND); children Rylan (Abra) Sundsbrak, Devin Sundsbrak, John Sundsbrak, Megan McKay, Marisa McKay; granddaughter Laney Ann Sundsbak,; mother, Virginia McKay; brother, Kevin (Sandy) McKay; many nieces, nephews, in-laws, friends, farmers, classmates, colleagues, and neighbors.

Kent was preceded in death by his father.

Obituary for Dr. Earl Crittendon Spurrier – 1923-2014

Born on a dairy farm February 20, 1923 near Libertytown, MD. Passed away on May 23, 2014. Earl remained true to the study of science and agriculture throughout his life. Leaving the farm at 25 Earl completed his Bachelor and Masters studies in Agriculture ath the University Of Maryland. While at the University Of Maryland he was president of AGR fraternity and sang in several university choral organizations. Upon completion of his Doctoral studies in Agriculture at the University of Illinois, Earl started a long and fruitful career with Monsanto Company, in 1958. His devotion to the development of safe and effective crop production chemicals propelled him to many positions of leadership culminating in his designation as the Director Of Environmental Operation at Monsanto. Upon his retirement from Monsanto in 1982 he served as the Vice President for Regulatory Affairs and then State Affairs with the National Agricultural and Chemical Association until 1991. In 1993 Earl and his wife Dolores retired to Nokomis, FL. He was preceded in death by his parents, first wife Peggy, and his sister Dorothy. He is survived by his wife Dorothy of Nokomis, with whom he enjoyed 33 years of marriage; his brother Paul of Union Bridge, MD; daughters Kathy Freeze of Wamego, KS and Ann Doane of Germantown, MD; son Duane Spurrier of Greencastle, PA; stepsons Graig Fischer of Cary NC and Steven Fischer of Lexington Park, MD; eleven grandchildren and many nieces and nephews. Earl is listed as an Honorary Member to WSWS.

WSWS ANNUAL MEETING ATTENDEES – Portland, Oregon 2015

Jason Adams
North Dakota State University
1130 23rd St. S. Apt 11
Fargo, ND 58103
jason.w.adams@my.ndsu.edu

Joshua Adkins
Syngenta
4562 Barbera Street
Richland, WA 99352
joshua.adkins@syngenta.com

Craig Alford
Dupont Crop Protection
8850 NW 62nd Ave, P.O. Box 7000
Johnston, IA 50131
craig.alford@usa.dupont.com

Kassim Al-Khatib
University of California - ipm
Robbins hall annex, one shields ave.
Davis, CA 95616
kalkhatib@ucdavis.edu

JILL ALMS
South Dakota State University
235 AG HALL
Brookings, SD 57007
jill.alms@sdstate.edu

Monte Anderson
Bayer Cropscience
16304 South Yancey Lane
Spangle, WA 99031-9563
monte.anderson@bayer.com

Randy Anderson
USDA- ARS
2923 Medary Ave
Brookings, SD 57006
Randy.Anderson@ars.usda.gov

Arnold Appleby
Oregon State University
Crop Science Dept
Corvallis, OR 97331
arnold.p.appleby@oregonstate.edu

Rick Arnold
New Mexico State Univ. AG Sci Ctr
PO BOX 1018
Farmington, NM 87499
riarnold@nmsu.edu

Dirk Baker
Campbell Scientific, Inc.
815 West 1800 North
Logan, UT 84321
dbaker@campbellsci.com

Dan Ball
OSU Columbia Basin AG. Research Ctr.
2717 Swyers Drive
Hood River, OR 97031
daniel.ball@oregonstate.edu

Phil Banks
Marathon Agric & Environ Consulting
205 W Boutz BLDG 4 STE 5
Las Cruces, NM 88005
marathonag@zianet.com

Judit Barroso
Oregon State University
P.O. Box 370
Pendleton, OR 97801
judit.barroso@oregonstate.edu

Shawna Bautista
USDA Forest Service
1220 SW 3rd Ave
Portland, OR 97204
shawnabautista@fs.fed.us

TRAVIS BEAN
Univ. of Cali., Riverside
Dept of Botany and Plant Scis
Riverside, CA 92521
travis.bean@ucr.edu

Clint Beiermann
1528 Palmer Dr. Apt. 1
Laramie, WY 82070
cbeierma@uwyo.edu

Kelli Belmont
3806 N 3600 E
Kimberly, Idaho 83341
kellib@uidaho.edu

Steve Bergsten
AgraServ, Inc
2565 Freedom Lane
American Falls, ID 83211
steve@agraserv.com

Brent Beutler
University of Idaho
554 Hillcrest Avenue
American Falls, ID 83211
brent@libertyag.net

Rick Boydston
USDA-ARS
24106 N Bunn Road
Prosser, WA 99350
rick.boydston@ars.usda.gov

Fara Brummer
North Dakota State University
4824 48th. Avenue
Streeter, ND 58483
fara.brummer@ndsu.edu

Ian Burke
Washington State University
201 Johnson Hall
Pullman, WA 99164
icburke@wsu.edu

Marvin Butler
Oregon State University
850 NW Dogwood Lane
Madras, OR 97741
marvin.butler@oregonstate.edu

Joan Campbell
University of Idaho
875 Perimeter Drive MS2339
Moscow, ID 83844-2339
jcampbel@uidaho.edu

Dan Campbell
National Park Service
600 E Park Avenue
Port Angeles, WA 98362
dan_campbell@nps.gov

John Cantlon
Dupont Crop Protection
716 N. Tullshire Way
Eagle, ID 83616
john.d.cantlon@usa.dupont.com

James Carey
Hubbard Ag Science
6117 Cashmere Ln
Pasco, WA 99301
james@hubbardagscience.com

Leo Charvat
BASF Corporation
6211 Saddle Creek Trail
Lincoln, NE 68523-9227
leo.charvat@basf.com

Dean Christie
Bayer Cropscience
4402 South Glendora Lane
Spokane, WA 99223
dean.christie@bayer.com

Briana Claassen
Oregon State Univ.
2082 Cordley Hall
Corvallis, OR 97331
claasseb@onid.oregonstate.edu

Chad Clark
Larimer County Weed District
PO BOX 1190
FT Collins, CO 80522
cclark@larimer.org

Pat Clay
Valent USA Corporation
7498 N. Remmington Ave., Suite 102
Fresno, CA 93711
Pat.Clay@valent.com

Bill Cobb
Cobb Consulting Services
815 South Kellogg
Kennewick, WA 99336-9369
wtcobb42@gmail.com

Carl Coburn
University of Wyoming
Dept 3354, 1000 E University
Laramie, WY 82071
ccoburn2@uwyo.edu

Stephen Colbert
Dupont Crop Protection
1413 Sierra Drive
Escalon, CA 95320
stephen.f.colbert@dupont.com

Scott Cook
Hubbard AG Sciences
1320 N. Brookhaven ln
Post Falls, ID 83854
scott@hubbardagscience.com

Gil Cook
Novasource
303 S. Barker Rd
Spokane Valley, WA 99016
cookge@comcast.net

Massimo Cristofaro
BBCA Onlus
Via Del Bosco 10
Sacrofano, Rome 60
massimo.cristofaro.cas@enea.it

Chad Cummings
Dow Agrosciences
25600 Cr. 110
Perry, OK 73077
dccummings@dow.com

Dan Curtis
Oregon State University
107 Crop Science Bldg
Corvallis, OR 97331
Daniel.Curtis@oregonstate.edu

Greg Dahl
Winfield Solutions llc
2777 Prairie Drive
River Falls, WI 54022
gkdahl@landolakes.com

Caleb Dalley
NDSU Hettinger Research Extension Ctr
PO Box 1377
Hettinger, ND 58639
caleb.dalley@ndsu.edu

Tim D'amato
Larimer County Weed District
PO Box 1190
FT Collins, CO 80522
tdamato@larimer.org

Jim Daniel
29391 WCR 8
Keenesburg, CO 80643
Jimtdan@gmail.com

Ed Davis
Montana State University
334 Johnson Hall
Bozeman, MT 59717-3120
edavis@montana.edu

Caio De Castro Grossi Brunharo
University of California, Davis
625 Cantrill DR #268-A
Davis, California 95618
cabrunharo@ucdavis.edu

Rochelle Desser
USDA Forest Service
1220 SW 3rd Ave
Portland, OR 97204
rdesser@fs.fed.us

Tanguy Deveaud
UC Davis
One Shields Ave
Davis, California 95616
tanguy.deveaud@agroparistech.fr

Joe Ditomaso
University of California
Dept of Plant Sci, Mail Stop 4
Davis, CA 95616
jmditomaso@ucdavis.edu

James Dollins
USFS
3625 93RD AVE SW
Olympia, WA 98512
jdollins@fs.fed.us

Yushan Duan
Washington State University
16650 SR 536
MT Vernon, WA 98273
yduan@wsu.edu

Celestine Duncan
Weed Management Services
PO BOX 1385
Helena, MT 59624-1385
weeds1@mt.net

Kyle Effertz
Vision Research Park
317 1ST Avenue SE
Berthold, ND 58718
effertz@visionresearchpark.com

Chad Effertz
Arysta Lifescience
4551 HWY 41N
Velva, ND 58790
chad.effertz@arysta.com

Greg Endres
North Dakota State University
RES EXT Center Box 219
Carrington, ND 58421-0219
gregory.endres@ndsu.edu

Steven Eskelsen
ADAMA
2915 Kentbrook Ct
Kennewick, WA 99338

bigesky@gmail.com

Joel Felix
Oregon State University
595 Onion Avenue
Ontario, OR 97914
joel.felix@oregonstate.edu

Andrew Fillmore
West Central, Inc.
4643 36th Avenue South Apt 305
Fargo, North Dakota 58104
afillmore@westcentralinc.com

Bob Finley
Fremont County Weed & Pest
PO BOX 1171
Dubois, WY 82513
rfinley@dteworld.com

Gabriel Flick
Oregon State University
107 Crop Sciences Bldg.
Corvallis, OR 97331
gabriel.flick@oregonstate.edu

Peter Forster
Syngenta Crop Protection
35492 WCR 43
Eaton, CO 80615-9205
pete.forster@syngenta.com

Beth Fowers
Department of Plant Sciences,
3354 1000 E. University Ave
Laramie, WY 82071
bfowers@uwyo.edu

Kyle Frandsen
University of Idaho
3806 North 3600 East
Kimberly, Idaho 83341
kfrandsen@uidaho.edu

John Frihauf
BASF Corporation
26 Davis Drive
Research Triangle Park, NC 27709
john.frihauf@basf.com

Angela Gadino
United Phosphorus Inc.
1754 S. Miller St.
Wenatchee, WA 98801
angela.gadino@uniphos.com

Todd Gaines
Colorado State University
1177 Campus Delivery
Fort Collins, CO 80523
todd.gaines@colostate.edu

Mariano Galla
UC Davis
1 shields ave
Davis, California 95616
mfgalla@ucdavis.edu

Roger Gast
Dow Agrosciences
9330 Zionsville RD
Indianapolis, IN 46268
regast@dow.com

Jay Gehrett
Spray Tech
2338 Wainwright Place
Walla Walla, WA 99362
jgehrett@charter.net

Bobby Goeman
Larimer County Weed Dept
PO BOX 1190
FT Collins, CO 80524
goemanb@larimer.org

Elise Gornish
UC Davis
One Shields Avenue, Mail Stop 1
Davis, CA 95616
egornish@ucdavis.edu

Greta Gramig
North Dakota State University
166 Loftsgard Hall
Fargo, ND 58102
greta.gramig@ndsu.edu

Jim Gray
2, 4-D Task Force
9317 E. Pleasant Ave.
Kansas City, MO 64138
james.gray@24d.org

Gino Graziano
UAF Cooperative Extension Service
1675 C Street Suite 100
Anchorage, Alaska 99501
gagraziano@alaska.edu

Jessica Green
Oregon State University
4017 AG & Life Science Building
Corvallis, OR 97331
Jessica.Green@oregonstate.edu

Jamie Greer
Nevada Department of Agriculture
405 S. 21st St.
Sparks, NV 89431
jgreer@agri.nv.gov

Matthew Gregoire
Vision Research Park
317 1st Avenue SE
Berthold, North Dakota 58718
gregoire.matthew@gmail.com

Lloyd Haderlie
Agraserv INC
2565 Freedom Lane
American Falls, ID 83211
lloyd@agraserv.com

Mary Halstvedt
Dow Agrosciences
3311 Horton Smith LN
Billings, MT 59106
mbhalstvedt@dow.com

Brad Hanson
University Of California
Dept. Of Plant Sci. MS-4; 1 Shields Ave
Davis, CA 95616
bhanson@ucdavis.edu

Timothy Harrington
USDA Forest Service - PNW Res. Sta.
3625 93RD AVE SW
Olympia, WA 98512
tharrington@fs.fed.us

William Hatler
DuPont Crop Protection
326 Cactus Valley
Stephenville, Texas 76401
william.l.hatler@dupont.com

Alan Helm
Gowan Company
706 Union Drive
Union, NE 68455
ahelm@gowanco.com

Charlie Hicks
Bayer Cropscience
3008 Shore Rd.
FT. Collins, CO 80524
charlie.hicks@bayer.com

Tyler Hicks
Colorado State University

504 City Park
Fort Collins, CO 80524
Tylerh56@hotmail.com

Curtis Hildebrandt
Colorado State University
5381 North Highway 1
FT Collins, CO 80524
cuhilde@rams.colostate.edu

Harvey Holt
Green Systems Analytics, LLC
10203 47TH Avenue SW, B-9
Seattle, WA 98146
holth@purdue.edu

Triston Hooks
New Mexico State University
315 Fite Dr.
Las Cruces, NM 88001
tnh@nmsu.edu

Stott Howard
Syngenta Crop Protection
416 Foster Drive
Des Moines, IA 50312
stott.howard@syngenta.com

Kirk Howatt
North Dakota State University
NDSU DEPT 7670 PO BOX 6050
Fargo, ND 58108-6050
kirk.howatt@ndsu.edu

Michael Hubbard
Hubbard Agricultural Science
4181 District Five Road
Bonners Ferry, ID 83805
hubbard.kvfr@gmail.com

Pam Hutchinson
Univ Of Idaho Aberdeen R & E Ctr
1693 S. 2700 W.
Aberdeen, ID 83210
phutch@uidaho.edu

Roger Hybner
USDA-NRCS Bridger Plant Mat Center
98 S. River Rd
Bridger, MT 59014-9514
roger.hybner@mt.usda.gov

Jake Jarrett
Park County Weed & Pest Ctrl District
1067 Road 13
Powell, WY 82435
jake@parkcountyweeds.org

Marie Jasieniuk
University Of California
Dept Plant Sciences MS 4
Davis, CA 95616
mjasien@ucdavis.edu

Eric Jemmett
Jemmett Consulting & Res Farm
22826 Goodson Rd
Parma, ID 83660
ericjemmett@yahoo.com

Brian Jenks
North Dakota State University
5400 HWY 83 SOUTH
Minot, ND 58701
brian.jenks@ndsu.edu

Prashant Jha
Montana State University -Bozeman
Southern Ag Research Center
Huntley, MT 59037
pjha@montana.edu

Anjani Jha
Montana State University
Southern Ag Res Ctr
748 Railroad Hwy.
Huntley, MT 59037
anjanijha22003@gmail.com

Karissa Jones
BASF
26 Davis Dr
RTP, NC 27709
karissa.jones@basf.com

Mithila Jugulam
Kansas State University
2004 Throckmorton,
Dept of Agronomy
Manhattan, KS 66506
mithila@ksu.edu

Elizabeth Karn
University of California-Davis
One Shields Ave
Davis, CA 95616
evkarn@ucdavis.edu

Kyle Keller
BASF Corporation
6315 GUESS ROAD
Rougemont, NC 27572
kyle.keller@basf.com

Blake Kerbs
Oregon State University
2311 NW Grant Ave. #4
Corvallis, Oregon 97330
kerbsb@onid.oregonstate.edu

Kallie Kessler
Colorado State University
Campus Delivery 1179
FT Collins, CO 80523
kallie.kessler@gmail.com

Steven King
Bayer Cropscience
5415 Staysail Court
Raleigh, NC 27613
steven.king@bayer.com

Robert Klein
University Of Nebraska
402 West State Farm Rd
North Platte, NE 69101-7751
rklein1@unl.edu

Andrew Kniss
University Of Wyoming
1000 E. University Ave.
Laramie, WY 82071
akniss@uwyo.edu

Bill Kral
Dupont Crop Protection
1739 Julie Lane
Twin Falls, ID 83301
c-william.kral@usa.dupont.com

Jeffrey Krumm
DuPont
2815 S. Ridge Road
Hastings, NE 68901
jeffrey.t.krumm@dupont.com

Anita Kuepper
Colorado State University C129C Plt.Sci
Bldg 1177 Campus Delivery
Fort Collins, Colorado 80523-1177
akuepper@rams.colostate.edu

Vipan Kumar
Montana State University
748 Railroad HWY
Huntley, MT 59037
vipan.kumar@msu.montana.edu

Thomas Larsen
AMVAC Chemical Co.
10748 S Autumn Wind Way

South Jordan, Utah 84095-5981
toml@amvac-chemical.com

Larry Lass
University Of Idaho - PSES DEPT
875 Perimeter Drive ms2339
Moscow, ID 83844
llass@uidaho.edu

Nevin Lawrence
Washington State University
Johnson Hall Room 291
Pullman, WA 99164-6420
nevin.lawrence@wsu.edu

James Leary
University Of Hawaii at Manoa
PO BOX 269
Kula, HI 96790
leary@hawaii.edu

Erik Lehnhoff
Montana State University
334 Leon Johnson Hall
Bozeman, MT 59717
erik.lehnhoff@montana.edu

Shane Leland
Montana State University
Southern Ag. Res. Ctr
748 Railroad Highway
Huntley, MT 59037
shane.leland@montana.edu

Glenn Letendre
Syngenta Crop Protection
11852 W Oneida DR
Boise, ID 83709-3882
glenn.letendre@syngenta.com

Carl Libbey
Washington State University
16650 SR 536
Mt. Vernon, WA 98273-4768
libbey@wsu.edu

Charlemagne Alexander Lim
Montana State University
748 Railroad Highway
Huntley, Montana 59037
charlemagnealexa.lim@msu.montana.edu

Rachel Lindell
Washignton State University
Johnson Hall Room 164
Pullman, WA 99164
rachel.lindell@wsu.edu

Brad Lindenmayer
Syngenta Crop Protection
20 S Cedar Oak Ridge
Perkins, OK 74059
brad.lindenmayer@syngenta.com

Mingyang Liu
Oregon State Univ.
109 Crop Sciences Bldg.
Corvallis, OR 97331
mingyang.liu@oregonstate.edu

Kelly Luff
Bayer Cropscience
3554 East 4000 North
KimberlY, ID 83341
kelly.luff@bayer.com

Rod Lym
North Dakota State University
DEPT 7670 PO BOX 6050
Fargo, ND 58108-6050
rod.lym@ndsu.edu

Drew Lyon
Washington State University
PO BOX 646420
Pullman, WA 99164-6420
drew.lyon@wsu.edu

Justin Mack
BASF
3611 Bay Place SE
Mandan, ND 58554
justin.mack@basf.com

Robert MacPherran
Oregon State University
109 Crop Science
Corvallis, OR 97331
chasemacpherran@yahoo.com

Dorothy Maguire
Boise State University
Department of Biological Sciences
Boise, ID 83725-1515
maguire.dory@gmail.com

Mayank Malik
Monsanto Company
7551 Crystal Ct.
Lincoln, NE 68506
mayank.s.malik@monsanto.com

Carol Mallory-Smith
Oregon State University
107 Crop Science BLDG
Corvallis, OR 97331
carol.mallory-smith@oregonstate.edu

Jane Mangold
Montana State University
PO BOX 173120
Bozeman, MT 59717
jane.mangold@montana.edu

Richard Mann
DOW AGROSCIENCES
18285, 550 E
Franklin, IN 46131
rkmann@dow.com

Dean Maruska
Bayer Cropscience
408 E. Johnson AVE
Warren, MN 56762
dean.maruska@bayer.com

Bill McCloskey
University Of Arizona
Plant Sci - Forbes 303; PO BOX 210036
Tucson, AZ 85721-0036
wmcclosk@email.arizona.edu

Sandra McDonald
Mountain West Pest
2960 Southmoor Drive
Ft. Collins, CO 80525
sandrakmcdonald@gmail.com

Casey Mckee
Anadarko Petroleum Corporation
1368 S 1200 E
Vernal, Utah 84078
casey.mckee@aggiemail.usu.edu

Brian Mealor
University Of Wyoming
BOX 3354, 1000 E. UNIV. AVE.
Laramie, WY 82071
bamealor@uwyo.edu

Jenna Meeks
University of Wyoming
PO Box 331
Lingle, WY 82223
jmeeks8@uwyo.edu

Gary Melchior
Gowan Company
625 Abbott Rd
Walla Walla, WA 99362
gmelchior@gowanco.com

Suzi Miller
Conference Tribes Warm Springs
1601 NW
Hickory Place, Redmond 97756
suzi.miller@etwsbnr.org

Tim Miller
Washington State University
16650 State Route 536
Mt. Vernon, WA 98273-9761
twmiller@wsu.edu

Marcelo Moretti
University Of California
2550 Farmers Central rd
Woodland, CA 95776
mlmoretti@ucdavis.edu

Don Morishita
University OF Idaho
3806 North 3600 East
Kimberly, ID 83341
don@uidaho.edu

Sarah Morran
University of California, Davis
One Shields Avenue
Davis, California 95616
smorran@ucdavis.edu

Edward Morris
New Mexico State University
P.O. Box 30003, MSC 3BE
Las Cruces, NM 8803
edmorris@nmsu.edu

Adam Murdock
AgraServ, Inc
2565 Freedom Lane
American Falls, ID 83211
adam@agraserv.com

Todd Neel
USDA Forest Service
200 E. Broadway
Missoula, MT 59802
toddaneel@fs.fed.us

George Newberry
Gowan Company
1411 South Arcadia Street
Boise, ID 83705
gnewberry@gowanco.com

Scott Nissen
Colorado State University
115 Weed Research Lab
Ft. Collins, CO 80523-1179
scott.nissen@colostate.edu

Robert Norris
University Of California
25112 Central Way
Davis, CA 95616
rfnorris@ucdavis.edu

Nicholas Norton
University of Idaho
875 Perimeter Dr.
Moscow, Idaho 83844-2339
nnorton@uidaho.edu

Cara Noseworthy
1000 E. University Ave
Laramie, WY 82070
cnosewor@uwyo.edu

Stephen Novak
Boise State University
Department of Biological Sciences
Boise, Idaho 83725-1515
snovak@boisestate.edu

Alex Ogg
USDA-ARS
PO BOX 53
Ten Sleep, WY 82442-0053
ogga@tctwest.net

Heather Olsen
Utah State University
4820 Old Main Hill
Logan, Utah 84322-4820
heather.olsen@usu.edu

Brian Olson
Monsanto Company
76268 Hwy 47
Gothenburg, NE 69138
powercat79@gmail.com

Steve Orloff
University Of California
1655 S MAIN ST
Yreka, CA 96097
sborloff@ucanr.edu

Mike Ostlie
North Dakota State Univ. Exten Ctr
PO BOX 219
Carrington, ND 58421
mike.ostlie@ndsu.edu

Junjun Ou
2004 Throckmorton Hall,
Kansas State University
MANHATTAN, Kansas 66506
junjun@ksu.edu

James Parker
Big Island Invasive Species
Committee
23 E. Kawili St
Hilo, HI 96720
jameslp@hawaii.edu

Robert Parsons
Big Island Invasive Species
Committee
23 E. Kawili Street
Hilo, HI 96720
rparsons@hawaii.edu

Eric Patterson
Colorado State University
1177 Campus Delivery
Fort Collins, COlorado 80523
lloyd16@rams.colostate.edu

Ed Peachey
Oregon State University
Hort Dept ALS4017
Corvallis, OR 97330
ed.peachey@oregonstate.edu

Chelsey Penuel
North Dakota Dept. of Ag
600 E Boulevard Ave Dept 602
Bismarck, North Dakota 58505
cpenuel@nd.gov

David Peter
USDA Forest Service Pacific NW
Res Sta
3625 93rd Ave. SW
Olympia, Washington 98512-1101
dpeter@fs.fed.us

Ryan Peterson
Vision Research Park
317 1ST Avenue SE
Berthold, ND 58718
peterson@visionresearchpark.com

Dallas Peterson
Kansas State University
2014 Throckmorton Hall
Manhattan, KS 66506-5504
dpeterso@ksu.edu

Trevor Peterson
Utah State University
4820 Old Main Hill

Logan, Utah 84322-4820
trevor.peterson@aggiemail.usu.edu

Dean Pettinga
Colorado State University
1177 Campus Delivery
Fort Collins, COlorado 80523
deanpett@gmail.com

Emmett Phelan
Park County Weed and Pest Control Dis
1067 Road 13
Powell, WY 82435
emmett@parkcountyweeds.org

Tim Prather
University Of Idaho
875 Perimeter Dr.
Moscow, ID 83844
tprather@uidaho.edu

Steve Pyle
Syngenta Crop Protection
410 Swing Rd.
Greensboro, NC 27455
steve.pyle@syngenta.com

Harold Quicke
BASF CORPORATION
1140 Shoreline Dr.
Windsor, CO 80550
harold.quicke@basf.com

Alan Raeder
Washington State University
PO Box 1389
Pullman, WA 99163
araeder@wsu.edu

Curtis Rainbolt
BASF Corporation
4763 N Pacific AVE
Fresno, CA 93705
curtis.rainbolt@basf.com

Fred Raish
Alligare, LLC
617 Custer Ave
Akron, CO 80720
fraish@alligare.com

Corey Ransom
Utah State University
4820 Old Main Hill
Logan, UT 84322-4820
corey.ransom@usu.edu

Ryan Rapp
Monsanto Company
40660 252nd St
Mitchell, SD 57301
ryan.e.rapp@monsanto.com

Whitney Rapp
Malheur National Forest
431 Patterson Bridge Rd PO
John Day, OR 97845
whitneysrapp@fs.fed.us

Traci Rauch
University Of Idaho
875 Perimeter Drive, MS 2339
Moscow, ID 83844-2339
trauch@uidaho.edu

Ryan Rector
Monsanto Company
800 N Lindbergh Blvd
St. Louis, MO 63167
ryan.j.rector@monsanto.com

Chris Reeves
West Central, Inc.
PO BOX 114
Beaver City, NE 68926
creeves@westcentralinc.com

Bill Reynolds
Conference Tribes Warm Springs
4223 Holiday
Warm Springs, OR 97761
bill.reynolds@etwsbnr.org

Chuck Rice
BASF Corporation
725 N Center PKWY #R302
Kennewick, WA 99336
chuck.rice@basf.com

Jerry Ries
West CentraL Inc.
PO BOX 1270
Fargo, ND 58107
jries@westcentralinc.com

Andy Robinson
NDSU / U of M
PO BOX 6050, Loftsgard166, Dept 7670
Fargo, ND 58108
andrew.p.robinson@ndsu.edu

Kyle Roerig
Oregon State University
109 Crop Science Building
Corvallis, OR 97331
kyle.roerig@oregonstate.edu

John Roncoroni
UCCE Napa
1710 Soscol Ave suite #4
Napa, CA 94559
jaroncoroni@ucanr.edu

William Rose
1000 E University Ave
Laramie, Wyoming 82070
Wrose@uwyo.edu

Maryam Sabet
Oregon State University
133 NW 28th Streeet
Corvallis, OR 97330
sabetm@onid.oregonstate.edu

Ramesh Sagili
Oregon State University
4017 ALS Building
Corvallis, ORegon 97331
ramesh.sagili@oregonstate.edu

Gustavo Sbatella
University Of Wyoming
747 Road 9
Powell, WY 82435
gustavo@uwyo.edu

Thomas Schambow
University of Wyoming
1753 Fox Ridge Rd
Laramie, WY 82072
tschambo@uwyo.edu

Roland Schirman
Washington State Univ. - RETIRED
PO BOX 181
Dayton, WA 99328-0181
schirman@innw.net

Marty Schraer
Syngenta
152 E. Cassidy Drive
Meridian, ID 83646
marty.schraer@syngenta.com

Brian Schutte
New Mexico State University
945 COLLEGE AVENUE
Las Cruces, NM 88012
bschutte@nmsu.edu

Beth Sears
UPI

100 Wilson Dr.
Lincoln Univ., PA 19352
beth.sears@uniphos.com

Jim Sebastian
Colorado State University
258 Tiabi Drive
Loveland, CO 80523
jseb@lamar.colostate.edu

Derek Sebastian
CSU
1179 campus delivery Weed lab 114
Fort Collins, CO 80523
derek.sebastian@rams.colostate.edu

Rene Sforza
EBCL USDA-ARS Campus
International
CS90013 Montferrier sur Lez
Saint Gely du Fesc, Montpellier
34988
rsforza@ars-ebcl.org

Tye Shauck
BASF
3907 W 20th Ave
Kennewick, WA 99338
tye.shauck@basf.com

Byron Sleugh
DOW Agrosciences
7521 W. California AVE.
Fresno, CA 93706
bbsleugh@dow.com

Lynn Sosnoskie
University Of California
DEPT OF PLANT SCIENCES, UC
DAVIS
Davis, CA 95616
lynn.sosnoskie@gmail.com

David Spak
Bayer
2TW Alexander Dr.
RTP, NC 27709
davidspak@bayer.com

John Spring
Washington State University
PO Box 646420
Pullman, WA 99164
john.spring@email.wsu.edu

PHIL STAHLMAN
Kansas State University
1232 240TH AVENUE
Hays, KS 67601-9228
stahlman@ksu.edu

Tracy Sterling
Montana State University
PO BOX 173120
Bozeman, MT 59717
tracy.sterling@montana.edu

Bob Stougaard
Montana State University
4570 MONTANA 35
KalispelL, MT 59901
rns@montana.edu

Gail Stratman
FMC AG Products
12342 N ROAD
STROMSBURG, NE 68666
gail_stratman@fmc.com

Scott Swain
Utah State University
4820 Old Main Hill
Logan, UT 84322-4820
s.andrew.swain6@gmail.com

Siyuan Tan
BASF Corporation
3115 Bluff Oak Dr.
CARY, NC 27519
siyuan.tan@basf.com

Donn Thill
University Of Idaho - IAES
875 Perimeter Drive MS 2337
MOSCOW, ID 83844-2379
dthill@uidaho.edu

Curtis Thompson
Kansas State University
2014 THROCKMORTON HALL
Manhattan, KS 66506-5504
cthompso@ksu.edu

Michael Thornton
University of Idaho
3793 North 3600 East
Kimberly, Idaho 83341
mthornton@uidaho.edu

Breanne Tidemann
University of Alberta
116St and 85 Ave.
Edmonton, Alberta T6G 2R3
blaturnu@ualberta.ca

Rodney Tocco, Jr.
Winfield
1080 County Road F W
Shoreview, MN 55126
RVTocco@landolakes.com

Paul Tracy
WinField
15 Quail Run
Garden Valley, Idaho 83622
pwtracy@landolakes.com

Stu Turner
Turner & CO. INC.
5903 KILAWEA DRIVE
West Richland, WA 99353
agforensic@aol.com

Sasha Twelker
Oregon Dept. of AG
4766 NE Collins Dr.
Madras, OR 97741
Sasha.twelker@yahoo.com

Kai Umeda
University Of Arizona
4341 EAST BROADWAY
Phoenix, AZ 85040
kumeda@cals.arizona.edu

Jared Unverzagt
BASF
3772 Potosi Street
Bozeman, MT 59718
jared.unverzagt@basf.com

Stephen Valenti
Monsanto Company
5132 ROSECREEK PKWY
Fargo, ND 58104
stephen.a.valenti@monsanto.com

Christopher Van Horn
Colorado State University
1179 CAMPUS DELIVERY
Ft. Collins, CO 80523
christopher.van_horn@colostate.ed
u

Steve Van Vleet
Washington State University
Whitman County Extension
COLFAX, WA 99111
svanvleet@wsu.edu

Lee Van Wychen
WSSA-Director Of Science Policy
5720 GLENMULLEN PL
Alexandria, VA 22303

Lee.VanWychen@wssa.net

Jim Vandecoevering
BASF Corporation
104 E FAIRVIEW AVE #226
Meridian, ID 83642
jim.vandecoevering@basf.com

Kurt Volker
TKI Nova Source
7610 Science Dr.
Yakima, WA 98908
kvolker@tkinet.com

Dave Vos
South Dakota State University
910 17th Ave South
Brookings, SD 57006
dave.vos@sdstate.edu

Eric Walker
King County Noxious Weed
Control Program
201 S. Jackson ST, Suite 600
Seattle, WA 98104
noxious.weeds@kingcounty.gov

Allison Walston
Valent USA
921 Hull St.
Hood River, OR 97031
awals@valent.com

Jake Watt
Hubbard Agricultural Science
PO Box 688
Bonners Ferry, ID 83805
jake@hubbardagscience.com

Eric Westra
Colorado State University
401 N. SHERWOOD ST.
Ft. Collins, CO 80521
epwestra@rams.colostate.edu

Ralph Whitesides
Utah State University
4820 OLD MAIN HILL
Logan, UT 84322-4820
ralph.whitesides@usu.edu

Mike WIlle
Fremont County Weed & Pest Ctrl
Dist
450 NORTH 2ND ST. ROOM 325
Lander, WY 82520
mwille@wyoming.com

Marty Williams
USDA-ARS
N-325 Turner Hall1102S.Goodwin
Ave.
Urbana, IL 61801
mmwillms@illinois.edu

Gary Willoughby
North Dakota State University
5400 Hiway 83 S.
Minot, ND 58701
gary.willoughby@ndsu.edu

Julia Workman
Dept. of Plant Sciences 3354,
1000 E University Ave.
Laramie, WY 82071
jworkma2@uwyo.edu

Steve Wright
University Of California
4437 B SOUTH LASPINA ST
Tulare, CA 93274-9537
sdwright@ucanr.edu

Mark Wrucke
BAYER Cropscience
19561 EXCEPTIONAL TRAIL
Farmington, MN 55024
mark.wrucke@bayer.com

Joe Yenish
DOW Agrosciences
1001 CALENDULA CIRCLE
Billings, MT 59105
jpyenish@dow.com

Bahar Yildiz Kutman
UC Davis
ONE SHIELDS AVE 104
ROBBINS HALL
Davis, CA 95616
bykutman@ucdavis.edu

FRANK YOUNG
Washington State University-
USDA-ARS
161 Johnson Hall
Pullman, WA 99164-6416
youngfl@wsu.edu

Kelly Young
University Of Arizona
4341 E Broadway RD
Phoenix, AZ 85040
kyoung@arizona.edu

Travis Ziehl
Teton County Weed & Pest District
PO BOX 1852
Jackson, WY 83001
tziehl@tcweed.org

Rich Zollinger
North Dakota State University
DEPT OF PLANT SCI 7670
Fargo, ND 58108-6050
r.zollinger@ndsu.edu

WSWS 2015 ANNUAL MEETING – AUTHOR INDEX

This is an index of authors and their abstract numbers.

WSWS 2015 ANNUAL MEETING – KEYWORD INDEX

This is an index of keywords and the numbers of the abstracts where they appear.

WSWS 2015 ANNUAL MEETING – ABSTRACT NUMBER, PAGE NUMBER INDEX

076, 60

077, 61

078, 66

079, 67

080, 67

081, 68

082, 68

083, 69

084, 69

085, 70

086, 70

087, 71

088, 72

089, 72

090, 73

091, 73

092, 74

093, 74

094, 75

095, 75

096, 76

097, 76

098, 77

099, 77

100, 78

101, 62

102, 62

103, 63

104, 64

105, 65

106, 65

107, 66

108, 79

109, 80

110, 81

111, 81

112, 82

113, 82

114, 83

115, 97

115a, 98

116, 98

117, 86

118, 87

119, 88

120, 88

121, 88

122, 89

123, 89

124, 90

125, 90

126, 91

127, 91

128, 92

129, 93

130, 94

131, 83

132, 84

133, 84

134, 85

135, 86

136, 86

137, 94

138, 95

139, 96

140, 96

2014-2015 WSWS Standing and Ad Hoc Committees

Board contact/(year-rotating off)

<u>Awards</u> -*President*
Carol Mallory-Smith, Chair (2016)
Rick Arnold (2015)
Alan Helm (2017)

<u>Fellows and Honorary Members</u> - *Past President*
Tim Miller, Chair (2016)
Boydston (2015)
Jill Schroeder (2017)

<u>Finance</u> - *Member at Large – Public Sector*
Fara Brummer, Chair (2016)
Marvin Butler (2015)
Jesse Richardson (2017)

<u>Herbicide Resistant Plants</u>
Member at Large – Private Sector
Brian Jenks, Chair (2016)
Andrew Kniss (2015)
Prashant Jha (2017)

<u>Program</u> - *President-Elect*
Joe Yenish, Chair (2015)
Ed Davis (2015)
Kirk Howatt (2015)

<u>Publications</u> - *President-Elect*
Joe Yenish, Chair
Bill McCloskey, Proceedings
Traci Rauch, Research Prog. Report
Carl Libbey, Newsletter Co-Editor
Phil Banks, Website Editor

<u>Education</u>
Education & Regulatory Section Chair
Ian Burke, Chair (2015)
Scott Nissen (2015)
Sandra McDonald (2016)
Andy Hulting (2016)
Mayank Malik (2017)
Randall Violett (2017)

<u>Student Paper Judging</u> - *President-Elect*
Don Morishita, Chair (2016)
Kelly Young (2015)
Ryan Rector (2017)

<u>Legislative</u> - *WSSA Representative*
Chad Clark, Chair (2016)
Julie Kraft (2015)
Fred Raish (2017)
Lee Van Wychen, Ex-officio

<u>Local Arrangements</u> - *President-Elect*
Daniel Curtis, Chair (2016)
Tim D'Amato, (2015)
Brian Schutte (2017)

<u>Necrology</u> - *Secretary*
Steve Valenti, Chair (2016)
Greg Dahl (2015)
Ralph Whitesides (2017)

<u>Nominations</u> - *Past President*
Pam Hutchinson, Chair (2015)
Chad Cummings (2016)
Scott Nissen (2017)
Roger Gast, Past-President

<u>Poster</u> - *President-Elect*
Harry Quicke, Chair (2016)
Dirk Baker (2015)
Travis Ziehl (2017)

<u>Public Relations</u>
Education & Regulatory Section Chair
Stott Howard, Chair (2016)
Phil Stahlman (2015)
Ryan Rapp (2015)
Rita Beard (2016)
Todd Neel (2017)
Joan Campbell (2017)

<u>Site Selection</u> - *President*
Stephen Colbert, Chair (2016)
Pete Forster (2015)
Charlie Hicks (2017)

<u>Sustaining Membership</u> - *Past President*
Greg Dahl, Chair (2016)
Dennis Tonks (2015)
Wendell Rich (2017)