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of weed seed in the soil seed bank was determined. Regression analysis indicated that crop seeding rate influenced the response of canola and barley yield, and weed seed production to herbicide rate. At the lowest crop seeding rates, yield responses tended to be parabolic which suggested slight yield reductions at the highest herbicide rates. This was not evident at the higher crop seeding rates, where, in most cases yield reached a maximum between one half and the full recommended herbicide rate. The effects of the herbicides on weed seed production, especially at the lowest rate, were often superior at the higher crop seeding rates. The results indicate that seeding canola and barley at relatively high rates may reduce risk associated with herbicide induced crop yield reduction, and increased weed seed production at lower than recommended herbicide rates. (99)

Management practices influencing herbicide resistance in wild oat (*Avena fatua*). Beckie, H.J.[1,*], Hall, L.M.[2], Meers, S.[3], Laslo, J.J.[4] and Stevenson, C.[5] [1]Agriculture & Agri-Food Canada, Saskatoon, SK, [2]Alberta Agriculture, Food and Rural Development/, Edmonton, AB, [3]Alberta Agriculture, Food and Rural Development, Edmonton, AB, [4]Wheatland County Agricultural Service Board, Strathmore, AB, [5]142 Rogers Rd, Saskatoon, SK. A 3-yr study was conducted in Wheatland County, Alberta to determine if agronomic practices of growers influenced the occurrence of herbicide resistance in wild oat. Wild oat seeds were collected in 33 fields in 1997, and in 31 fields in each of 1998 and 1999 (one field per grower). Seedlings were screened for resistance to two acetyl-CoA carboxylase (ACCase) inhibitors, imazamethabenz, an acetolactate synthase (ALS) inhibitor, and triallate, a thiocarbamate herbicide. A questionnaire on herbicide resistance awareness and management practices was completed by each grower. Both ACCase and ALS inhibitor resistance in wild oat were linked to a lack of crop rotation diversity. In addition, ALS inhibitor-resistant wild oat was associated with conservation-tillage systems and recent use of herbicides with that mode of action. Results of this study suggest that timely tillage and inclusion of fall-seeded and perennial forage crops in rotations will effectively slow the selection of resistance in this grass species. (100)

Live and desiccated hairy vetch effects on weeds and yield in glyphosate-resistant corn. Reddy, K.N.[1,*] and Koger, C.H.[1] [1]USDA-ARS, Southern Weed Science Research Unit, Stoneville, MS. A 2-yr field study was conducted during 2002-2003 on a Dundee silt loam soil at the Southern Weed Science Research Unit farm, Stoneville, MS, to examine the effects of hairy vetch cover crop and banded application of glyphosate on weed control and yield in glyphosate-resistant corn. The experiment was conducted in a split plot arrangement of treatments in a randomized complete block design with hairy vetch (HV-K, hairy vetch desiccated at planting; HV-B, hairy vetch desiccated in a 38-cm band over crop row; HV-L, hairy vetch live; and no hairy vetch) as main plot and glyphosate (applied in a 38-cm band over crop row, broadcast, and no herbicide) as subplot with four replications. Each subplot consisted of eight rows of corn spaced 102-cm apart and 15.2 m long. Hairy vetch was drilled in October of each year and desiccated as per treatment with paraquat at corn planting. Plots with no hairy vetch were also desiccated to kill existing vegetation. Corn was planted on April 5, 2002 (AG RX 738RR) and April 1, 2003 (DKC 69- 72RR). Glyphosate EPOST (0.84 kg ae/ha) and LPOST (0.84 kg ae/ha) was applied 3 and 5 weeks after planting (WAP) corn, respectively. Hairy vetch dry biomass was higher in HV-L (4,420 kg/ha) and HV-B (4,180 kg/ha) than in HV-K (1,960 kg/ha) plots at 7 WAP. Hairy vetch reduced densities of pitted morningglory, prickly sida, and yellow nutsedge in HV-B and HV-L compared with HV-K and no hairy vetch plots, but hairy vetch had no effect on densities of barnyardgrass, carpetweed, large crabgrass, johnsongrass or southwestern cupgrass regardless of desiccation type at 7 WAP. Total weed dry biomass at 7 WAP was lower in HV-B and HV-L than in HV-K and no hairy vetch plots. Corn yield was higher in HV-K (10,280 kg/ha) than HV- B (9,440 kg/ha) and HV-L (9,100 kg/ha), and yields were similar between HV-K and no hairy vetch (9,960 kg/ha). Broadcast application of glyphosate produced highest yield (11,300 kg/ha) compared with band application (10,160 kg/ha). These findings indicate that hairy vetch cover crop has potential for reducing density of certain weed species in glyphosate-resistant corn production systems; however, optimum weed control was obtained when glyphosate was used. (101)

***Aceria malherbae* feeding improves suppression of field bindweed with herbicides.** Williams, M.M.[1,*] and Boydston, R.A.[2] [1]USDA-ARS, Urbana, IL, [2]USDA-ARS, Prosser, WA. Feeding effects of the gall mite, *Aceria malherbae*, followed by sublethal doses of 2,4-DB or glyphosate on field bindweed were evaluated under laboratory conditions. Symptoms of *A. malherbae* feeding were malformed, fused, and folded leaves that increased in severity three weeks after treatment with either herbicide. Mite feeding reduced field bindweed shoot and root biomass 37% and more. 2,4-DB at 0.07 to 0.14 kg ae ha^{-1} or glyphosate at 0.14 to 0.28 kg ai ha^{-1} reduced field bindweed root biomass 25 to 52%. Mite feeding followed by either 2,4-DB or glyphosate application reduced root biomass of field bindweed 72 to 76% compared to nontreated plants. Combining *A. malherbae* feeding with sublethal herbicide doses may allow for field bindweed suppression while reducing herbicide use. (102)

Organic Weed Management Research in Southwestern Minnesota. Harbur, M.M.[1,*], Evans, E.E.[1], Nickel, L.M.[1], Sheaffer, C.C.[2], Wyse, D.L.[2], Allan, D.L.[2], Nickel, P.[1] and Forcella, F.[3] [1]University of Minnesota, Southwest Research and Outreach Center, Lamberton, MN, [2]University of Minnesota, St. Paul, MN, [3]North Central Soil Conservation Research Laboratory, USDA-ARS, Morris, MN. The University of Minnesota received funding in 2002 from the CSREES Organic Conversion Program (OCP) to investigate several weed management strategies for application to organic cropping systems. The first objective is to compare the effects of two organic management systems on annual weed populations (predominantly *Setaria* spp.) and crop productivity. Experiments are being conducted corn-soybean and corn-soy-

bean-oat-alfalfa rotations. The two organic management systems differ in the form of organic amendments (heap manure or compost), schedule of rotary hoeing, and use of fall cover crops. The effectiveness of systems will be determined from crop yield, weed biomass 8 weeks after planting, and weed seed production. The second objective is to evaluate the effects of species composition and planting date effects on the establishment, biomass production and weed suppression potential of fall cover crops. The two species compositions included in the experiment are hairy vetch / winter rye and red clover / annual rye grass. Cover crops are broadcast following the last row cultivation in early summer, in early August or following crop harvest in fall. Cover crops performance is evaluated in both corn and soybean. Treatments will be compared based on cover crop stand, biomass production, and weed seedling recruitment and growth in the following crop. The third objective is to compare three-year organic Canada thistle (*Cirsium arvense (L.) Scop.*) management systems. Management phases within systems include repeated tillage, row crops, smother crops and fall cover crops. Repeated tillage will be initiated either in mid-May or in mid-June, in order to evaluate the effect of tilling Canada thistle that is in the bud stage. Smother crops include green pea, buckwheat, cowpea, pearl millet, winter wheat and alfalfa. Cover crops are winter rye and oilseed radish. The sequences of management phases within the system are varied between treatments in order to identify the best strategy for Canada thistle management. Treatment effectiveness will be evaluated based on crop yield (where applicable), Canada thistle biomass, Canada thistle population density and Canada thistle patch size. (103)

Control of tree-of-heaven (*Ailanthus altissima*) in riparian areas. DiTomaso, J.M.[1,*] and Kyser, G.B.[1] [1]Weed Science Program, UC-Davis, Davis, CA. Tree-of-heaven is native to China and was introduced to North America as a landscape ornamental and a culturally important medicinal plant of Chinese immigrants. It has since spread rapidly in many areas of the United States, particularly in urban and riparian regions. In October 2001 we tested several treatment methods using three herbicides for control of tree-of-heaven in a riparian area near Davis, California. Treatments were made shortly before tree-of-heaven leaf drop. Herbicides treatments included imazapyr, triclopyr ester, and glyphosate applied using cut stump, stem injection, cut and hack (cut stem followed by stem injection below cut surface), and basal bark methods. Trees were chosen in three size classes (trunks $<$ 8 cm diameter, trunks $>$ 8 cm, and multiple trunks) with 6 to 8 trees per treatment. Visual evaluations of percent control, canopy reduction, number and height of resprouts, and resprout vigor were made one and two years after treatment. First year data indicated that cutting alone was ineffective for control of tree-of-heaven. Resprouts on cut only trees averaged 7.3 per stump with a mean height of 1.1 m. In the cut stump treatments, stump surfaces were treated with either 20% imazapyr (+ 80% MSO), 20% triclopyr ester (+ 80% MSO), or 50% glyphosate (+ 50% water) 0, 15, 30 and 60 minutes after cutting. Only imazapyr produced excellent and consistent control (>99%). There were no differences in control at all application timings. All stem injection applications (one hack per 8 cm stem diameter) were made with undiluted formulations. Again, only imazapyr provided excellent control (>99%). Basal bark applications using imazapyr or triclopyr ester (each at 20% plus 80% MSO) gave 100% control. No cut and hack treatments were effective. Glyphosate was not effective in any of the treatments. Second year evaluations were similar to first year results. This study provides three very effective methods for selective control of tree-of-heaven in sensitive riparian areas and offers flexibility in the management of this woody species. (104)

Low temperature and pH effects on growth of Salvinia molesta Mitchell. Owens, C.S.[1,2,*], Smart, M.[1,3], Honnell, D.R.[1,4] and Dick, G.O.[1,4] [1]Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX, [2]ASI, Vicksburg, MS, [3]U.S. Army Engineer Research & Development Center, Vicksburg, MS, [4]University of North Texas, Denton, TX. Giant salvinia growing in three outdoor research ponds survived two north Texas winters. The first winter was mild, with only one major freezing event. The second winter had three major freezing events, but small numbers of plants survived. Results from acute low temperature exposure in a controlled study demonstrated that formation of ice results in a decrease in percent survival of giant salvinia. All giant salvinia plants exposed to air temperatures of -16C (48hr) were killed while those exposed to -3C (48hr) survived due to incomplete ice formation in the surface water of the container. Additionally, growth of giant salvinia under different pH regimes was examined in three outdoor research ponds. Giant salvinia grew to completely cover a research pond over a 15-week period when pH was less than 7.5. Growth was reduced in a second pond maintained at higher pH. Tank studies found that significantly greater giant salvinia biomass was produced at lower pH and that water chemistry of tanks changed when completely covered by the resultant mat. (105)

Phenology and carbohydrate allocation of curlyleaf pondweed in Minnesota. Madsen, J.D.[1,*] and Woolf, T.E.[2] [1]Mississippi State University, Mississippi State, MS, [2]USDA-ARS, Boise, ID. Curlyleaf pondweed is the most widespread nonnative invasive aquatic plant in Minnesota, and is a common nuisance in lakes of the northern tier states. Four southern Minnesota populations of curlyleaf pondweed were sampled monthly from January 2001 to November 2002 to determine phenological and carbohydrate allocation patterns. Samples were separated into shoots, roots, inflorescence, and turions; and then dried. Biomass (g m^{-2}) and percent total nonstructural carbohydrates (TNC) were determined for each plant component. Total plant biomass was highest in all four lakes in late May and early June, ranging from 122 to 190 g m^{-2}. Turion formation and flowering were observed to coincide with maximum biomass. Maximum turion TNC concentrations ranged from 44 to 66%. The low point of turion carbohydrate storage in all four lakes occurred between January and April 2002, suggesting that early spring may be the best time to initiate management. Long-term management of curlyleaf pondweed requires depletion of the turion bank by repeated annual treatments timed to occur