CONTROL OF INVASIVE EXOTIC PLANTS IN THE GREAT PLAINS
Annotated Bibliography

Scientific Name: Agropyron repens
Common Name: Quackgrass
Family: Poaceae
Location: NE IA MN MO SD ND WI MI WY AB
Control: Burning Mechanical Chemical

Habitat: Quackgrass grows in a wide variety of soils, especially fertile, moist soils. Quackgrass requires sun or partial shade, and is found in disturbed sites, such as old fields, ditch banks, drainageways, wet pastures.

Detail: BURNING

Curtis, John T. and Max L. Partch (1948). Effect of fire on the competition between blue grass and certain prairie plants. The American Midland Naturalist 39:437-443.

Location: Old cultivated field planted to prairie plants at the University of Wisconsin Arboretum at Madison.

Objective: To study the effects of fire on prairie plants and non-native sod.

Summary: Between 1941 and 1946, experimental plots were burned annually on a definite schedule, in March, May, or October. The number of fruiting stems of quackgrass in the burned plots remained the same as in the unburned plots, except in the May burn, where the reproductive stems increased from 1/sq.m to 31/sq.m.

BURNING CHEMICAL

Woehler, Eugene E. and Mark A. Martin (1976). Establishment of prairie grasses and forbs with the use of herbicides. Proceedings of the Midwest Prairie Conference 5:131-138.

Location: Dense quackgrass stand on an alluvial site in Waterloo Wildlife Area in Dodge and Jefferson counties of Wisconsin.

Objective: To test the ability of the herbicides Casaron and Roundup to eliminate quackgrass (Agropyron repens) prior to establishment of native prairie plants.

Summary: A dense quackgrass stand was treated with granular Casaron 4-G in December 1973. Application of Roundup was made in May 1974 to quackgrass in a rapid growth stage. Prairie plant seeds were sown three weeks later, and plots were then left undisturbed until late April 1976, when plots were burned to discriminate against quackgrass. In 1976, sampling indicated that, although Casaron and Roundup initially controlled quackgrass, recovery was rapid; the quackgrass in the Roundup treatment had a relative dominance of 38% and 66% in the Casaron treatment.

BURNING MECHANICAL

Diboll, Neil (1984). Mowing as an alternative to spring burning for control of cool season exotic grass in prairie grass plantings. Proceedings of the Ninth North American Prairie Conference, July 29-August 1, 1984, pp. 204-209.

Location: Prairie remnant in the University of Wisconsin-Green Bay Cofrin Memorial Arboretum.

Objective: To compare the effectiveness of mowing and burning for control of cool season grasses and promotion of warm season grasses.

Summary: In May of 1980, study plots were either mowed and raked or burned. Burning reduced total cool season grass production 78% for both dates, and mowing averaged a 48% reduction. Quackgrass biomass was reduced by about 50% in both mowing and burning treatments.

CHEMICAL

Nepstad, Daniel C. (1984). Quackgrass eradication in preparation for prairie restoration (Michigan). Restoration and Management Notes 1(1):18.

Location: Fernwood, Inc. in Niles, Michigan

Objective: To prepare the ground by eliminating quackgrass prior to planting of prairie plants.

Summary: In June 1980, 13-17 cm-high quackgrass plants were sprayed with a recommended dilution of Roundup. By mid-July less than 15% cover remained. Plowing to control quackgrass has been unsuccessful.

Davidson, Craig G., Donald L. Wyse, and Robert L. McGraw (1985). Quackgrass (Agropyron repens) control and establishment of three forage legumes with three selective herbicides. Weed Science 33(3):376-380.

Location: Field plots near Roseau, Minnesota.

Objective: To test the efficacy of various herbicides for control of quackgrass in legumes.

Summary: Plots were established in legume plantings in two sites, and experiments were conducted between 1981 and 1983. Herbicides used were sethoxydim, fluazifop, EPTC, and RO-13-8895, applied at various rates and various stages of crop and weed growth. The best season-long quackgrass control was obtained when quackgrass was treated in the three- to four-leaf stage and when applications were made twice during the growing season. Sethoxydim and RO-13-8895 appeared to be the best herbicides for this use, although the actual herbicide used was of less importance than the time of application.

Wyse, Donald L., Laddie J. Elling, Donald B. White, and Robert L. McGraw (1985). Quackgrass (Agropyron repens) control in red fescue seed production. Weed Science 34(1):94-97.

Location: Field plots near Roseau, Minnesota.

Objective: To test the efficacy of various herbicides for control of quackgrass in commercial grasses.

Summary: Plots of red fescue were established in June 1980. Sethoxydim, KK-80, and RO-13-8895 herbicides were applied at four rates in June 1981 and May 1982, at the 3-4 and 2-3 leaf stage of quackgrass, respectively. Results indicate that RO-13-8895 and sethoxydim can prevent seed head formation of quackgrass, while not actually killing the plant, so repeat applications are necessary.

Drake, K.R. and T.D. Whitson (1989). Quackgrass (Agropyron repens) control in established alfalfa. Research Progress Report of the Western Society of Weed Science, Honolulu, HI, 1989, p. 201.

Location: A dense quackgrass stand in established alfalfa near Emblem, WY.

Objective: To evaluate various herbicides for control of quackgrass without damage to alfalfa.

Summary: Herbicides were applied to experimental plots in May of 1988, evaluations were taken in August of the same year. Quizalofop applied at 0.5 lbs ai/A provided the best control (78%), with no damage to the alfalfa. Amitrol provided the worst control of quackgrass combined with the greatest alfalfa damage.

Vanden Born, W.H. (1965). The effect of dicamba and picloram on quackgrass, bromegrass and Kentucky bluegrass. Weeds 13:309-312.

Location: Greenhouse and field plots at the University of Alberta, Edmonton, Alberta.

Objective: To evaluate the response of bromegrass and quackgrass to picloram and dicamba applied at various rates, under various conditions, and to assess the importance of rhizome depth in relation to herbicide effectiveness.

Summary: Quackgrass and bromegrass rhizomes were planted at depths from 1 to 13 cm, and sprayed with dicamba or picloram immediately afterwards. In general, deeper planting decreased the effectiveness of the herbicides, unless water was added, whereupon increase in watering increased effectiveness of the herbicides. Potted pieces of Kentucky bluegrass sod infested with quackgrass were sprayed with picloram or dicamba, reducing quackgrass shoot numbers 67-84%, 50 days after treatment, and not damaging the bluegrass. Clipping the sod to less than 1 cm prior to spraying and watering the herbicide in virtually eliminated quackgrass. In field experiments, quackgrass treated with dicamba at 20 lb/A or picloram at 7 lb/A was controlled very well.

Gillette, Laurence N. (1983). Controlling quackgrass with Roundup in established warm-season prairie grasses (Minnesota). Restoration and Management Notes 1(3):27.

Location: A field of warm-season prairie grasses in Crow-Hassan Park Reserve, near Minneapolis, MN.

Objective: To control quackgrass infesting a new planting of native grasses.

Summary: The field was burned in April of 1981, to prepare for spraying. Roundup was sprayed on the test plots on May 1. Quackgrass disappeared by mid-July, but the spaces it left were filled by other annual grasses, and the native plants were injured. A second plot was sprayed in the spring of 1982, and this time, exotic forbs filled the gaps left by the killed quackgrass. Roundup can be an effective tool in controlling quackgrass, but additional methods must be used to control other weedy species.

ADDITIONAL REFERENCES:

CHEMICAL

Akhavein, A.A. and D.L. Linscott (1970). Effects of paraquat and light regime on quackgrass growth. Weed Science 18:378-382.

Baird, D.D. and G.E. Begeman (1972). Postemergence characterization of a new quackgrass herbicide. Proceedings of the Northeast Weed Control Conference 26:100-106.

Behrens, R. and M. Elakkad (1972). Quackgrass control with glyphosate. Proceedings of the North Central Weed Control Conference 27:54.

Bhomik, P.C. and J.D. Doll (1980). Postemergence quackgrass control in soybeans. Proceedings of the North Central Weed Control Conference 35:45.

Hallgren, E. (1986). Selective grass herbicides for control of Agropyron repens in different crops. Weeds and Weed Control 1:141-152.

Kells, J.J., W.F. Meggitt, and D. Penner (1981). Factors influencing grass control with selective postemergence herbicides. Proceedings of the North Central Weed Control Conference 36:21-22.

Leroux, G.D. and R.G. Harvey (1981). Field evaluation of grass herbicides for quackgrass control in alfalfa. Proceedings of the North Central Weed Control Conference 36:40.

Rioux, R., J.D. Bandeen, and G.W. Anderson (1974). Effects of growth stage on translocation of glyphosate in quack grass. Canadian Journal of Plant Science 54:397-401.

Sprankle, P. and W.F. Meggitt (1972). Effective control of quackgrass with fall and spring applications of glyphosate. Proceedings of the North Central Weed Control Conference 27:54.

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Scientific Name: Amaranthus retroflexus
Common Name: Redroot pigweed, Rough pigweed

Family: Amaranthaceae
Location: NE IA MN MO KS ND MS SD NC IL CO WY UT
Control: Biocontrol Mechanical Chemical

Habitat: Redroot pigweed is found in cultivated fields, gardens, roadsides, and waste places. It prefers rich soils.

Detail: BIOCONTROL

Hall, Anthony B., Udo Blum, and Roger C. Fites (1983). Stress modification of allelopthy of Helianthus annuus L. debris on seedling biomass production of Amaranthus retroflexus L. Journal of Chemical Ecology 9(8):1213-1222.

Location: Laboratory and greenhouse experiments in Raleigh, North Carolina.

Objective: To study the effects of H. annuus plant debris, produced under varying conditions, on A. retroflexus seedlings grown under various conditions.

Summary: A. retroflexus seeds were sown in soil mixed with (1) ground H. annuus debris from plant grown under different nutrient regimes; (2) soil mixed with straight chlorogenic acid, the allelopathic agent in H. annuus debris; and (3) soil with one of the above and an additional nutrient solution. H. annuus debris and chlorogenic acid both inhibited seedling growth, and plant debris also inhibited seed germination. Addition of nutrients to the A. retroflexus seeds eliminated effects of both allelopathic agents, apparently by supplementing nutrients whose uptake was inhibited in the first two treatments.

CHEMICAL

Anderson, Monte D. and W. Eugene Arnold (1984). Weed control in sunflowers (Helianthus annuus) with desmedipham and phenmedipham. Weed Science 32(3):310-314.

Location: Field plots near Watertown, South Dakota.

Objective: To test the efficacy of two herbicides for control of redroot pigweed and wild mustard in sunflower crops.

Summary: The herbicides desmedipham and phenmedipham were applied to redroot pigweed-infested emergent sunflowers, in late spring of 1981 and 1982. Phenmedipham provided no significant control of this weed, and the level of control provided by desmedipham, with or without phenmedipham, was unacceptable.

Dobbels, Anthony F. and George Kapusta (1993). Postemergence weed control in corn (Zea mays) with nicosulfuron combinations. Weed Technology 7(4):844-850.

Location: Cornfields at Carbondale and Belleville, Illinois.

Objective: To test the efficacy of various postemergent herbicide combinations for control of weeds, including redroot pigweed, in corn.

Summary: Experimental plots were established in new corn plantings. The herbicide nicosulfuron was applied alone or in combination with several other herbicides in late spring of 1991 and 1992. Control was evaluated 28 days after application. Nicosulfuron at 24 and 35 g/ha and in combination with the other herbicides provided complete control of redroot pigweed at both sites, in both years.

Anderson, R.L. (1989). Effect of plant size on DPX-V9360 bioactivity on field sandbur and redroot pigweed. Research Progress Report of the Western Society of Weed Science, Honolulu, HI, 1989, pp. 408-409.

Location: Cornfields in Akron, CO.

Objective: To determine the effect of plant growth size and rate of application of DPX-V9360 on field sandbur and redroot pigweed.

Summary: DPX-V9360 was applied at four rates and on two dates to corn infested with redroot pigweed and field sandbur. Corn size classes were 4-6 leaves exposed and 8-10 leaves exposed. When applied at 53 and 70 g/ha, the herbicide inhibited growth of redroot pigweed in both size classes more than 90%.

Miller, S.D. and J. Lauer (1988). Broadleaf weed control in barley. Research Progress Report of the Western Society of Weed Science, 1988, p. 208.

Location: Research plots at the Powell Research and Extension Center, Powell, WY.

Objective: To test the efficacy of several herbicide treatments for control of broadleaf weeds in barley.

Summary: In May 1987, several herbicide treatments were applied to weed-infested plots planted to barley a month earlier. Control of redroot pigweed, treated at the seedling stage, was excellent with all herbicide treatments.

Evans, J.O. and B.M. Jenks (1989). Broadleaf and green foxtail control with DPX-M6316 and primisulfuron in corn. Research Progress Report of the Western Society of Weed Science, Honolulu, HI, 1989, p. 280-281.

Location: Young cornfields at Logan, UT.

Objective: To evaluate eight herbicide treatments for control of broadleaf weeds and green foxtail in corn.

Summary: Herbicides were applied June, 1988, and visual evaluations were made three weeks later. The herbicide treatments were DPX-M6316, atrazine, primisulfuron, and 2,4-D, alone or in combination. All treatments provided good-excellent control of redroot pigweed, with DPx-M6316 + atrazine at 0.0078 lb ai/A providing 100% control.

MECHANICAL CHEMICAL

Egley, Grant H. (1990). Ethephon reduction of redroot pigweed (Amaranthus retroflexus) seed populations. Weed Technology 4(4):808-813.

Location: Field plots at Stoneville, Mississippi.

Objective: To test the efficacy of ethephon in increasing germination of redroot pigweed seeds in soil, thus depleting the weed seed bank.

Summary: In November of 1984, 1985, and 1986, redroot pigweed seeds were mixed with soil, placed in mesh bags, and buried shallowly in experimental plots. Treatments were combinations of granular potassium nitrate, ethephon (as ethylene source) and a transparent plastic soil surface cover. Seed germination was determined every other month, from February to October of the year following initiation of each run of the experiment. The combination of ethephon with a soil cover, with or without potassium nitrate, was very successful in enhancing germination and depleting the seed bank. Most of the germination of seeds sown in October occurred by the following June.

ADDITIONAL REFERENCES:

CHEMICAL

Egley, G.H. (1989). Some effects of nitrate-treated soil upon the sensitivity of buried redroot pigweed (Amaranthus retroflexus L.) seeds to ethylene, temperature, light, and carbon dioxide. Plant Cell Environment 12:581-588.

Picman, A.K. (1986). Aqueous solubility of isoalantolactone and its effect on germination and biomass production of redroot pigweed and late-flowering goosefoot. Biochemical Systems and Ecology 14(4):361-364.

Rojas-Garciduenas, M. and T. Kommedahl (1960). The effect of 2,4-D on germination of pigweed seed. Weeds 3:1-5.

Taylorson, R.B. (1989). Responses of redroot pigweed (Amaranthus retroflexus) and witchgrass (Panicum capillare) seeds to anesthetics. Weed Science 37(1):93-97.

MECHANICAL

Blackshaw, Robert E., Francis O. Larney, C. Wayne Lindwall, and Gerald C. Kozub (1994). Crop rotation and tillage effects on weed populations on the semi-arid Canadian prairies. Weed Technology 8(2):231-237.

Egley, G.H. (1983). Weed seed and seedling reductions by soil solarization with transparent polyethylene sheets. Weed Science 31:404-409.

MISCELLANEOUS

Egley, G.H. (1983). New methods for breaking seed dormancy and their application in weed control. pp. 143-151 in: A.E. Smith, ed., Wild Oat Symposium Proceedings. Canadian Plains Proceedings 12, Agriculture Canada.

Egley, G.H. (1988). Factors regulating two distinct stages of redroot pigweed seed germination. Plant Physiology Supplement 86:140.

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Scientific Name: Bromus inermis

Common Name: Smooth brome
Family: Poaceae
Location: NE IA MN MO KS SD ND SK AB
Control: Burning Chemical

Habitat: Smooth brome tolerates a wide variety of soils and environmental conditions, preferring sun and soils lower in organic content. It is very widespread in rangeland and disturbed prairie.

Detail: BURNING

Blankespoor, Gilbert W. and Eric A. Larson (1994). Response of smooth brome (Bromus inermis Leyss.) to burning under varying soil moisture conditions. The American Midland Naturalist 131:266-272.

Location: Makoce Washte Prairie, a 16-ha tallgrass prairie remnant in Minnehaha County, South Dakota.

Objective: To assess the effects of burning and varying moisture regimes on the success of smooth brome in a tallgrass prairie.

Summary: In April 1989, plots were established in an area in which smooth brome was essentially the only grass species. In May 1989, 16 plots were burned and all 32 plots were then fitted with rain-out shelters. During the growing season, eight plots in each of the burned and unburned treatments were given twice the normal amount of precipitation, and eight in each were given half the normal precipitation. Smooth brome biomass decreased in the burned, high-water treatment, and decreased somewhat less in the burned, low-water treatment. Brome increased in the unburned treatments by the same amount. It appears that burning is detrimental to brome, and that additional water during the growing season allows native warm-season grasses to compete well enough to significantly reduce the presence of smooth brome.

Grilz, P.L. and J.T. Romo (1994). Water relations and growth of Bromus inermis Leyss (smooth brome) following spring or autumn burning in a Fescue Prairie. The American Midland Naturalist 132:340-348.

Location: University of Saskatchewan's Kernen Prairie, a relict Fescue Prairie 1 km east of Saskatoon, Saskatchewan.

Objective: To determine the impact of a single burn in the autumn or spring on the growth and water relations of smooth brome in Fescue Prairie.

In each of two replicates, two plots of mixed fescue and smooth brome grassland were burned in October 1986 and April or May of 1987, and two in October 1987 and April 1988, with samples taken the summers after the burns. Two plots were unburned and served as the reference. Burning of the study plots resulted in increased water stress in smooth brome, but did not reduce growth of the grass. Therefore, it appears that burning of Fescue Prairie invaded by smooth brome may not help control the brome, while earlier research indicates that burning may negatively effect native species.

Willson, Gary D. (1990). Morphological characteristics of smooth brome used to determine a prescribed burn date. Proceedings of the Twelfth North American Prairie Conference, 1990, pp. 113-116.

Location: A planted field dominated by smooth brome and big bluestem, at the University of Nebraska Agricultural Research and Development Center, near Mead, Nebraska.

Objective: To assess the effect on smooth brome of burning at different morphological growth stages.

Summary: Experimental plots were subjected to one of four treatments during the spring of 1989. Plots were burned at tiller emergence, tiller elongation, or at heading, or were kept unburned. Changes in tiller density were then determined in the fall of 1989. Burning when tillers were elongating and at tiller heading reduced fall tiller density by about 50%, whereas early spring burning, when tillers were emerging, produced no tiller reduction.

Willson, G.D., and J. Stubbendieck (1997). Fire Effects on 4 Growth Stages of Smooth Brome (Bromus inermis Leyss.). Natural Areas Journal, 17(4): 306-312.

Location: University of Nebraska, Agricultural Research and Development Center, near Mead, Nebraska.

Objective: To evaluate the suppression of smooth brome tiller density with controlled burns conducted at 4 different stages of smooth brome development.

Summary: The study area contained Bromus inermis codominant with big bluestem. Six by six meter plots were delineated and burns conducted within 2- to 3-days of detection of the specified morphological stage. The stages were as follows: B. inermis tiller emergence, elongation, heading, and flowering. Of course, some plots were left unburned for controls. Burning when B. inermis is just producing new shoots (tillers) did not effect tiller density or biomass in years where precipitation was at or below normal. In years that precipitation was above normal, burning at tiller emergence resulted in more than doubling biomass the following year. All other treatments (burning during tiller elongation, heading, and flowering) resulted in a reduction of B. inermis tiller density and biomass. The latter effect was maintained with repeated burns, but at least partial recovery was observed when only one late-stage burn was implemented.

BURNING CHEMICAL

Grilz, Perry L. and J.T. Romo (1995). Management considerations for controlling smooth brome in fescue prairie. Natural Areas Journal 15:148-156.

Location: The University of Saskatchewan's Kernen Prairie, in the transition zone between Mixed Prairie to the south and Fescue Prairie to the north.

Objective: To test the efficacy of burning and glyphosate treatments for reduction of brome grass density in fescue prairie plots.

Summary: The study was conducted between 1987 and 1989. A block of fescue/brome grassland in each of two replicate sites (Sites 1 and 2) was burned with headfires in October, and likewise in April; Site 2 was burned a year after Site 1. One plot of brome in each replicate was then treated with glyphosate when smooth brome was in the boot stage. Burning alone had no significant effect on stem density of smooth brome, but spring burning combined with glyphosate application caused the greatest reduction in brome density of all treatments, eliminating brome completely in the combined spring burn/glyphosate treated plot at one site, and reducing it by 98% at the other. Native species densities were also somewhat reduced by applications of glyphosate, although not as much as smooth brome. Seedbank tests also indicated that smooth brome was not likely to be restored by seed sprouting in the test plots, although importing of seed from surrounding areas was considered very likely.

Masters, Robert A., Kenneth P. Vogel, and Robert B. Mitchell (1992). Response of Central Plains Tallgrass Prairies to fire, fertilizer, and atrazine. Journal of Range Management 45:291-295.

Location: Six prairie range sites near Virginia, Lincoln, and Bloomfield, Nebraska.

Objective: To evaluate the use of burning, herbicide, and fertilizer for improvement of tallgrass prairie pasture.

Summary: Research plots were established from 1987 through 1989. Plots were burned, and treated with nitrogen fertilizer and atrazine in different combinations, at different times throughout the course of the study. Smooth brome was generally unaffected by atrazine, in this study. Burning combined with fertilization generally increased production of native species and suppressed exotics such as smooth brome.

BURNING CHEMICAL MECHANICAL

Willson, G. D., and J. Stubbendieck (1996). Suppression of Smooth Brome by Atrazine, Mowing, and Fire. Prairie Naturalist, 28(1): 13-20.

Location: Pipestone National Monument, a national park in the prairie couteau region of southwest Minnesota.

Objective: To compare the effects of atrazine, fire and mowing on the suppression of smooth brome. Additionally, the project assessed the effectiveness of sod suppressing treatments on seedling establishment of big bluestem.

Summary: The study area was dominated by Bromus inermis and Poa pratensis at 60% and 23% cover, respectively. Plots were established for various treatments and controls, and they were spaced to prevent herbicide drift. Atrazine was applied 19-20 May, 1990, and 22-23 May, 1991, at 2.2 Kg/ha. "Mow and rake" plots were cut to 4-cm stubble height and raked to remove debris. Plots that were burned were done so with a back fire. The day following treatment application plots were sod-seeded with big bluestem seed. Sod suppression was determined by counting smooth brome tillers in September of 1990 and 1991. The only treatment to significantly reduce smooth brome tiller density was atrizine (-77% in 1990; -70% in 1991). Other treatments failed to significantly reduce stem density compared to controls (burning -16% in 1990, -37% in 1991; and mowing -16% in 1990; +10% in 1991). Sod-seeding big bluestem failed to establish significant numbers of plants in all treatments in both years.

CHEMICAL

Vanden Born, W.H. (1965). The effect of dicamba and picloram on quackgrass, bromegrass and Kentucky bluegrass. Weeds 13:309-312.

Location: Greenhouse and field plots at the University of Alberta, Edomonton, Alberta.

Objective: To evaluate the responses of bromegrass and quackgrass to picloram and dicamba applied at various rates and under various conditions, and to assess the importance of rhizome depth in relation to herbicide effectiveness.

Summary: A number of experiments were carried out in this study. Bromegrass was eliminated from mixed plots of legumes and grasses by fall applications of picloram at 3.5 and 7 lb/A and dicamba at 20 lb/A.

Waller, S.S. and D.K. Schmidt (1983). Improvement of eastern Nebraska tallgrass range using atrazine or glyphosate. Journal of Range Management 36(1):87-90.

Location: Overgrazed rangeland in Gage County, southeastern Nebraska.

Objective: To evaluate atrazine and glyphosate treatments for suppression of exotic grasses species and restoration of native range plants.

Summary: Research plots were treated with atrazine or glyphosate in April of 1979. Subsequent sampling indicated that both herbicides effectively reduced smooth brome in native rangeland and maintained the reduced population throughout the second growing season after treatment. Native species increased correspondingly in the treated plots.

CHEMICAL MECHANICAL

Wilson, S.D. and A.K. Gerry (1995). Strategies for Mixed-Grass Prairie restoration: Herbicide, Tilling, and Nitrogen Manipulation. Restoration Ecology, 3(4): 290-298.

Location: Agropyron cristatum and Bromus inermis dominated old field at the University of Regina, Regina, Saskatchewan, Canada.

Objective: To develop techniques for the restoration of prairie dominated by introduced grasses to prairie supporting native plants. The techniques examined here are herbicide use, tilling, and nitrogen manipulation.

Summary: A previously uncultivated field dominated by Agropyron cristatum and Bromus inermis was divided into 120 separate 5- by 15-m plots where 12 treatments were applied with 10 replications. Nitrogen was manipulated by addition of fine sawdust (400 g/m2/year) intended to encourage microbes to tie up nitrogen. Otherwise, nitrogen was added at a rate of 5g or 15g/m2/year or none added at all. Tilling was conducted so that the plots were at one of three conditions: complete tillage for 100% bare soil, or partial tillage for about 50% bare soil, or no till. All plots were mowed to a length of 15-cm prior to seeding with a native grass drill. Forty one (41) species of native plant seed were planted in the spring of the first year. The herbicide, glyphosate, was applied to a portion of each plot in the second year after dismal germination rates were observed in the first year. The density of native seedlings in sprayed plots after 2 years was 20 times that of unsprayed plots. High nitrogen availability yielded the least in terms of density and cover of native plants. Plots treated with sawdust (lowest nitrogen) had the highest mean cover of native plants. The highest level of tilling yielded the highest level of native seedling density. The authors conclude that it is important to have a neighbor-free environment for the successful introduction of native prairie plants. Only a few of the 41 planted species established sizable populations. This could be explained by the fact that most of them exhibit a life-history strategy that favors efficient use of resources and slower development over a more rapid development aimed at a high rate of reproduction. It has been observed that most of the native prairie plants do not respond to disturbance with rapid reestablishment by seed.

MISC. REFERENCES

CHEMICAL

McCarty, M.K. and C.J. Scifres (1966). Response of smooth bromegrass to several herbicides. Proceedings of the North Central Weed Control Conference, no pp. given.

MISCELLANEOUS

Paulsen, G.M. and D. Smith (1968). Influences of several management practices on growth characteristics and available carbohydrate content of smooth bromegrass. Agronomy Journal 60:375-379.

Teel, M.R. (1956). The physiological age of bromegrass (Bromus inermis) as it affects growth following defoliation. Ph.D. thesis, Purdue University, Lafayette, Indiana.

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Scientific Name: Carduus nutans
Common Name: Musk thistle, Nodding thistle
Family: Asteraceae
Location: NE MN MO KS SD ND VA ON CO MD MT
Control: Biocontrol Chemical Grazing

Habitat: Musk thistle is found in waste ground, old fields, pasture, and along roads and railroads, preferring well-drained and fertile soils, but tolerant of many conditions.

Detail: BIOCONTROL

Cartwright, Bob and Loke T. Kok (1985). Growth responses of musk and plumeless thistles (Carduus nutans and C. acanthoides) to damage by Trichosirocalus horridus (Coleoptera:Curculionidae). Weed Science 33:57-62.

Location: Pastures in Montgomery and Giles Counties, Virginia.

Objective: To determine the response of musk and plumeless thistle to the thistle rosette weevil.

Summary: In 1980, two sites were selected, each heavily infested with musk thistle, and each a site at which the thistle rosette weevil had become established. Fifty weevil-infested and 50 non-infested rosettes were sampled from each site. In 1981, 100 each of the infested and non-infested musk thistle plants were sampled. In 1982, rosettes between 10-15 cm in diameter (small) and 25-45 cm diameter (large) were collected from another site and transplanted into a total of 10 plots. In these plots, the rosettes in 5 plots were inoculated with weevil larvae, and the rest were kept insect-free.

A number of plant responses were measured from each of the study sites. Number of stems increased in large-rosette infested plants with crown damage, resulting in some increase in seed production. Small- and medium-rosette infested plants had a lower seed-yield because of reduced flower head size. This study suggests that the thistle head weevil may serve some purpose in reducing reproduction of musk thistle in conjunction with cultivation or another strategy to reduce rosette size.

Kok, Loke T., Thomas J. McAvoy, and Warren T. Mays (1986). Impact of tall fescue grass and Carduus thistle weevils on the growth and development of musk thistle (Carduus nutans). Weed Science 34(6):966-971.

Location: Field plots in Virginia.

Objective: To determine the effects of competing tall fescue combined with predatory weevils on musk thistle.

Summary: In September 1982, combined plantings of tall fescue and musk thistle were made. Treatments were various combinations of fescue, musk thistle and the two parasitic weevils, Trichosirocalus horridus and Rhinocyllus conicus. Tall fescue growth caused musk thistle rosettes to be significantly smaller than the controls, whereas the beetles alone did little damage. Tall fescue combined with the beetles provided the best control of musk thistle.

Laing, J.E. and P.R. Heels (1978). Establishment of an introduced weevil, Rhinocyllus conicus (Coleoptera:Curculionidae) for the biological control of nodding thistle, Carduus nutans (Compositae) in southern Ontario. Proceedings of the Entomological Society of Ontario 109:3-8.

Location: Open fields at Guelph, Ontario.

Objective: To determine the success of the seed-feeding weevil, Rhinocyllus conicus, in becoming established and reducing seed yield in nodding thistle, Carduus nutans.

Summary: In June of 1975, adults of R. conicus were released into the thistle-infested study sites. Over the next three years, the sites were monitored for successful establishment of the weevil. The weevil became well established, with infestation of plants at one of the sites increasing from 67% to 95% in two years. Seed yield of the thistle was significantly reduced.

Politis, D.J., A.K. Watson, and W.L. Bruckart (1984). Susceptibility of musk thistle and related Composites to Puccinia carduorum. Phytopathology 74(6):687-691.

Location: Greenhouse at the Plant Disease Research Laboratory at Frederick, MD.

Objective: To test the susceptibility of musk thistle (Carduus nutans) and related plants to the rust fungus P. carduorum.

Summary: Sixty-three species in the family Asteraceae were grown for 4-5 weeks, and then inoculated with one isolate of P. carduorum, by spraying with a spore suspension to run-off. Twelve species, including and closely related to musk thistle displayed some level of infection. Twenty-three out of 27 collections of musk thistle from France, Canada, and the U.S. were very susceptible to the same isolate and two additional isolates. Although the commercially important crop, globe artichoke, became infected by P. carduorum, the limited susceptibility of most plants other than musk thistle indicate that this fungus has potential as a biocontrol agent of musk thistle.

Rees, N.E. (1978). Interactions of Rhinocyllus conicus and thistles in the Gallatin Valley. In: Biological Control of Thistles in the Genus Carduus in the U.S.--A Progress Report (ed. Frick), pp. 31-38. Science and Education Admin. U.S.D.A. 50 pp.

Location: Sites of thistle infestation and thistle head weevil release in the Gallatin Valley of southwestern Montana.

Objective: To monitor the development of weevil populations and determine their impact on various thistle species.

Summary: Weevils were released at five sites between 1969 and 1973. Between 1975 and 1977, thistle seed heads were collected at regular intervals from study sites, and thistle and weevil populations were assessed. Results indicate that musk thistle is the preferred host of R. conicus. The population of musk thistle plants at study sites has been declining steadily. It appears that weevils will be able to maintain musk thistle populations at tolerable levels, while leaving enough seed to allow weevil populations to survive.

Sieburth, P.J., L.T. Kok, and M. Lentner (1983). Factors influencing the effectiveness of Trichosirocalus horridus (Panzer) in the control of Carduus thistles. Crop Protection 2(2):143-151.

Location: Greenhouse and field plots in a pasture near Blacksburg, Virginia.

Objective: To study the effects of larval density, plant size, thistle species, and environmental conditions on the impact of T. horridus on musk and plumeless thistles.

Summary: Thistle plants grown in the greenhouse were transplanted to the field in 1979. Thistle rosettes in the field were inoculated with T. horridus larvae either in the spring or winter. Plants maintained in the laboratory were also inoculated, in the fall of 1978. Results indicate that musk thistle is a better host for T. horridus than plumeless thistle. Under favorable conditions (spring rosettes) small thistle rosettes are more susceptible to larval damage than large ones; under winter conditions, larval density determines overall level of rosette injury. Stressed plants (such as those grown under lab conditions) are more liable to be killed by larval damage. All of these results suggest tactics for use of T. horridus in an integrated management program for musk thistle.

Surles, W.W. and L.T. Kok (1978). Carduus thistle seed destruction by Rhinocyllus conicus. Weed Science 26(3):264-269.

Location: Musk thistle-infested site in Pulaski County, Virginia.

Objective: To assess the impact of the weevil R. conicus on musk thistle seed production and viability.

Summary: Impact of the weevil was assessed by sampling seed heads in 1973 and 1974 at a site where R. conicus was already established. Results indicate that R. conicus greatly reduces seed production in early seed heads--those most likely to produce strongly viable achenes--of musk thistle. Also, total plant seed yield was reduced 34.5% and 36.3% for the two years. The researchers also found that seeds from infested axillary heads exhibited better germination than those from noninfested heads, indicating that a plant with heavily infested early heads directs nutrients instead to axillary heads. These, however, are likely to produce less viable seeds.

CHEMICAL

Beck, George K., Robert G. Wilson, and M. Ann Henson (1990). The effects of selected herbicides on musk thistle (Carduus nutans) viable achene production. Weed Technology 4(3):482-486.

Location: Field plots at Evergreen and Longmont, Colorado and McGrew, Nebraska.

Objective: To test the efficacy of various herbicides applied at various growth stages for the reduction of achenes in musk thistle.

Summary: Chlorsulfuron, metsulfuron, clopyralid, 2,4-D, picloram, and dicamba plus 2,4-D were spring-applied at various rates to musk thistle at four stages of growth. Terminal inflorescences were harvested just before achene dissemination, and achene viability was determined. At Longmont, CO and McGrew, NE, all treatments reduced viable achene production at all growth stages. Variable results obtained at Evergreen, CO: dicamba + 2,4-D, picloram and metsulfuron at 21 g ai/ha applied during the rosette stage offered prevented achene development; chlorsulfuron and metsulfuron at 21 g ai/ha applied during bolting offered the same control; and chlorsulfuron applied during early bloom reduced viable achene production over 99%

Beck, K.G. and J.R. Sebastian (1988). Musk thistle control with spring and fall applied herbicides in Colorado rangeland. Research Progress Report of the Western Society of Weed Science, 1988, pp. 70-71.

Location: Musk thistle-infested rangeland near Wetmore, Colorado.

Objective: To evaluate musk thistle control with several herbicides applied in fall and spring.

Summary: Herbicide applications were made in October of 1986 and May of 1987. Picloram, dicamba, 2,4-D LVE, and chlorsulfuron were applied either in the fall only or in spring and fall. Plots were visually evaluated in November of 1986 and July of 1987. Both mature plants and seedlings were best controlled by picloram at both of the rates used and times sprayed. Other herbicides and rates provided excellent control less consistently.

CHEMICAL GRAZING

Feldman, Israel, M.K. McCarty, and C.J. Scifres (1968). Ecological and control studies of musk thistle. Weed Science
16:1-4.

Location: Various pasture types in southeastern Nebraska.

Objective: (1) To determine the best herbicides, rates of application and dates of application for control of musk thistle. (2) To investigate the ability of the thistle to become established in different pasture types at different levels of management.

Summary: (1) Plots were established in smooth bromegrass pastures with moderate to heavy infestations of musk thistle. Applications at various rates of 2,4-D, 2,4,5-T, 2,4-DB, picloram, or dicamba were made either in the spring or the fall. Picloram gave good control of thistle at all rates and dates, while in general, the best application dates for all herbicides were April 30 and May 10. Conditions at these dates are favorable for growth, which increases the effectiveness of herbicides. No herbicide was effective enough to eliminate the need for a second treatment, as musk thistle has high seed yield.

(2) In each of four different types of pasture, one portion was protected from grazing, one was subjected to rotational grazing, and one was continuously grazed. One square meter in each of the 12 pasture treatments was sown with 100 musk thistle seeds. Best germination of thistle was found in brome and intermediate wheatgrass pastures, where litter helped retain moisture and the canopy was relatively open. Worst germination occurred in Kentucky bluegrass and mixed warm season grass. Worst survival of thistle occurred

in pasture protected from grazing; survival became successively better as grazing increased.

ADDITIONAL REFERENCES:

BIOCONTROL

Dunn, P.H. and G. Campobasso (1993). Field test of the weevil Hadroplonthus trimaculatus and the fleabeetle Psylliodes chalcomera against musk thistle (Carduus nutans). Weed Science 41(4):656-663.

Kok, L.T. and R.L. Pienkowski (1985). Biological control of musk thistle by Rhinocyllus conicus (Coleoptera:Curculionidae) in Virginia from 1969 to 1980. Proceedings of the Sixth International Symposium for Biological Control of Weeds, 19-25 August 1984, Vancouver, Canada. Delfosse, E.S. (ed.). Agriculture of Canada, pp. 433-438.

Kok, L.T. (1986). Impact of Trichosirocalus horridus (Coleoptera:Curculionidae) on Carduus thistles in pastures. Crop Protection (In press).

Kok, L.T. and W.W. Surles (1975). Successful biocontrol of musk thistle by an introduced weevil, Rhinocyllus conicus. Environmental Entomology 4:1025-1027.

Trumble, J.T. and L.T. Kok (1980a). A bibliography of Ceuthorhynchidis horridus (Panzer) (=Trichosirocalus Panzer), and introduced weevil for the biological control of Carduus thistles. Bulletin of the Entomological Society of America 26:464-467.

BIOCONTROL CHEMICAL

Trumble, J.T. and L.T. Kok (1980). Impact of 2,4-D on Ceuthorhynchidius horridus (Coleoptera:Curculionidae) and their compatibility for integrated control of Carduus thistles. Weed Research 20:73-75.

CHEMICAL

DeLahunty, E. (1961). Nodding thistle control with chemicals. New Zealand Journal of Agriculture 109:23-25.

Kates, A.H. (1968). Control of curled and musk thistle with 2,4-D. Leaflet of the Virginia Polytechnic Institute, Extension Division, #328.

McKellar, W.A. (1955). Hormone control of nodding thistle. New Zealand Journal of Agriculture 90:515-516.

GRAZING

Davidson, S. (1990). Goats help eliminate thistles. Rural Research of the Commonwealth Scientific and Industrial Research Organization--Quarterly 147:16-19.

MECHANICAL CHEMICAL

McCarty, M.K. (1975). Effects of herbicides or mowing on musk thistle seed production. Weed Research 15:363-367.

MISCELLANEOUS

Feldman, Israel (1965). "Some ecological and control studies on musk thistle in eastern Nebraska pastures". M.S. thesis, University of Nebraska, Lincoln, Nebraska.

Nilson, Erick B. (1968). Musk thistle identification and control. Publication of the Kansas Agriculture Experiment Station Extension Division, #231.

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Scientific Name: Centaurea maculosa
Common Name: Spotted knapweed
Family: Asteraceae
Location: SD ND MT WA ID OR CA BC
Control: Biocontrol Mechanical Chemical

Habitat: Spotted knapweed is found in dry, sterile, gravelly, or sandy pastures, old fields, and roadsides. It is widespread in the northeast third of the United States.

Detail: BIOCONTROL

Cox, James W. (1989). Observations, experiments and suggestions for research on the sheep-spotted knapweed relationship. Proceedings of the 1989 Knapweed Symposium, Plant and Soil Department and Extension Service, Montana State University, EB 45. Pp. 79-82.

Location: River bottom pastures 12 miles west of Missoula, Montana.

Objective: To verify observations made regarding the preference of sheep for spotted knapweed over pasture grasses and legumes.

Summary: Various small experiments were performed in which individual knapweed plants were counted before and after grazing by sheep, who also had access to pasture legumes or grasses. The effects of early-summer grazing on the knapweed plants were then determined. The results show that sheep in the study preferred knapweed, which is rich in nutrients into early summer, over other pasture plants. Also, seed production in knapweed was severely curtailed by early-summer grazing by sheep. A much smaller percentage of plants flowered in the grazed plots than in the control plots, and the number of flower heads per plant was greatly reduced. The results suggest that selective grazing of knapweed by sheep in early summer could prevent extensive invasions of grasslands by knapweed.

Harris, P. (1980). Effects of Urophora affinis Frfld. and U. quadrifasciata (Meig.) (Diptera:Tephritidae) on Centaurea diffusa Lam. and C. maculosa Lam. (Compositae). Zeitschrift fuer angewandte Entomologie 90:190-201.

Location: Diffuse and spotted knapweed-infested areas of dryland range in British Columbia.

Objective: To assess the effects of the gall flies on knapweed seed production and viability and plant vigor.

Summary: Several experiments were carried out between 1974 and 1979 on sites at which gall flies had been released in 1970 and 1971. The experiments compared infected and uninfected plants and seed heads. Results indicated that seed production was reduced by about 95% as a result of gall formation. The gall flies had a lesser effect on the biomass and seed head number of spotted than that of diffuse knapweed, possibly because spotted knapweed completes its vegetative growth and head development early relative to that of the gall larvae. The gall flies U. affinis and U. quadrifasciata have promise as part of a more extensive biocontrol program.

Maddox, Donald M. (1982). Biological control of diffuse knapweed (Centaurea diffusa) and spotted knapweed (C. maculosa). Weed Science 30:76-82.

Location: Several areas of diffuse and spotted knapweed infestation in Montana, Washington, Idaho, Oregon and California.

Objective: To evaluate the efficacy of Urophora affinis Frlfld. for control of diffuse and spotted knapweeds in the field.

Summary: Releases of U. affinis were made in the summers of 1973, 1974, 1975, 1976, 1977, 1979 and 1980, in five western states. The fly has become established in all areas where it has been released. In 1978, 56% of the flower heads of spotted knapweed were infested within about 31 m of the original release point in Bonner County, Idaho. This fly shows promise as part of a biocontrol program for spotted knapweed, although alone it can only suppress seed yield, without eliminating infestations of the weed.

Roze, Liga D. and B.D. Frazer (1978). Biological control of diffuse and spotted knapweed by Urophora affinis and U. quadrifasciata in British Columbia. Proceedings of the First International Rangeland Congress, pp. 664-666.

Location: Knapweed-infested sites at Pritchard and Chase, British Columbia.

Objective: To assess some effects of parasitism of knapweed by gall flies.

Summary: Between 1975 and 1977, galls were sampled at sites where gall fly releases were made in 1970 and 1972. Among the data collected were number of galls/seed head, numbers of the two fly larvae per seed head and number and location of aborted seed head buds. Gall densities on spotted knapweed quadrupled between 1975 and 1977. The data indicate that the fly U. affinis is more successful when competing with U. quadrifasciata, and U. affinis larvae are the ones that had the most impact on plants in this study. The study found that gall flies increase bud abortion, and when galls/seed head are less than four/head in spotted knapweed, the percentage of aborted proximal buds increases, but when galls/seed head are greater than four/head, the percentage of aborted distal heads increases, while proximal heads develop. Overall, the gall flies result in reduced seed yield, but do not noticeably decrease knapweed plant cover, and thus would need support from foliage- or root-attacking insects for better control of the knapweeds.

Story, J.M., K.W. Boggs, W.R. Good, and R.M. Nowierski (1989). The seed head moth, Metzneria paucipunctella: its impact on spotted knapweed seed production and the two seed head flies, Urophora spp. Proceedings of the 1989 Knapweed Symposium, Plant and Soil Department and Extension Service, Montana State University, EB 45. Pp. 172-174a.

Location: Spotted knapweed-infested locations on the Lee Metcalf National Wildlife Refuge in western Montana.

Objective: To assess the impact of the seed head moth on spotted knapweed seed production and on the seed head flies, Urophora spp.

Summary: A total of eight field cages were established at four knapweed-infested locations during 1987. Seed heads in half of the cages contained only fly larvae, and heads in the remaining cages also contained larvae of the seed head moth. Sampling dates were in August, November, and the following June. Dissected seed heads were examined for seed damage and injury to the fly larvae by the moth larvae. Results indicated that the moth larvae effectively destroy spotted knapweed seed, and that the moth and fly larvae combined are even more effective in reducing seed yield. Results also indicate that the moth larvae do much of their feeding in the late spring, at which time they also do the most damage to the competing fly larvae. However, the moths do not appear to seriously affect fly populations, whereas they should significantly contribute to the control of spotted knapweed.

Strobel, Gary A. (1991). Biological control of weeds. Scientific American 265(1):72-78.

Summary: A chemical, named maculosin, was derived from a strain of the fungus Alternaria alternata, found parasitizing a spotted knapweed plant in Montana. This phytotoxic chemical is being tested for its potential for controlling knapweed in the field.

BIOCONTROL CHEMICAL

Story, Jim M., Keith W. Boggs, and William R. Good (1988). Optimal timing of 2,4-D applications for compatibility with Urophora affinis and U. quadrifasciata (Diptera:Tephritidae) for control of spotted knapweed. Environmental Entomology 17(5):911-914.

Location: A site infested with spotted knapweed, north of Missoula, Montana.

Objective: To study the effects of the 2,4-D on the biocontrol agents Urophora affinis and U. quadrifasciata on spotted knapweed.

Summary: In 1983 and 1984, 2,4-D was applied to uniform stands of spotted knapweed, at three stages of development. The stages were spring rosette, flower-bud, and flowering. The spotted knapweed supported populations of U. affinis and U. quadrifasciata. Samples of seed heads (i.e., seed heads from the previous year's dead stems) were taken 2 weeks following treatment in the spring rosette spray plots, and in October for the other treatments. Results indicated that 2,4-D had no effect on the previous year's seed heads containing the overwintering larvae, from which the present year's fly population would arise. Thus, spraying during the spring rosette stage was not injurious to either fly population, whereas spraying at the two later stages was detrimental to U. affinis. The spring rosette stage is also the stage at which spotted knapweed is most susceptible to 2,4-D, according to earlier studies. Thus, spraying at this stage is best for that reason, and for the preservation of the important biocontrol agent U. affinis, the more persistent colonizer of the two species in this study.

CHEMICAL

Durgan, Beverly R. (1989). Spotted knapweed--distribution, spread and control in Minnesota. Proceedings of the 1989 Knapweed Symposium, Plant and Soil Department and Extension Service, Montana State University, EB 45. Pp.119-125.

Location: Mixed Kentucky bluegrass and smooth bromegrass pasture infested with spotted knapweed in Clearwater County, Montana.

Objective: (1) To determine the efficacy of spring-applied herbicides, (2) to determine the efficacy of fall-applied herbicides, and (3) to determine the stage of plant growth at which herbicides offer the best control.

Summary: (1) Various combinations of herbicides were applied to plots of pasture grass infested with spotted knapweed in May of 1985, and control was visually evaluated twice yearly from 1986 to 1988. Spring applications gave good to excellent control, even in the long term, and clopyralid/2,4-D ester + picloram and clopyralid +

2,4-D ester gave the best long-term control. (2) The same was done in September of 1986, with evaluations being performed twice yearly in 1987 and 1988. The results were the same as above, with clopyralid at 0.125 lb/A giving the best control. (3) 2,4-D ester and amine and MCPA ester and amine were applied in the spring of 1987 at four stages of spotted knapweed growth. Either herbicide applied at the 6-10 inch bolting stage or prebloom stage gave the best control.

Fay, P.K., E.S. Davis, T.B. Chicoine, and C.A. Lacey (1989). The status of long term chemical control of spotted knapweed. Proceedings of the 1989 Knapweed Symposium, Plant and Soil Department and Extension Service, Montana State University, EB 45. Pp. 43-46.

Location: (1) Improved pasture at the Blackfoot Clearwater Game Range in western Montana and (2) area of shallow soil in central Montana.

Objective: To assess the longevity of control of spotted knapweed by commonly used herbicides.

Summary: The herbicides 2,4-D, dicamba, and picloram were applied to plots at both sites in June of 1983. The performance of each herbicide was visually rated each year until 1988. The results indicated that 2,4-D requires annual application to remain effective, as regrowth from the roots occurs. The degree of control by dicamba decreases over 2-3 years, and reapplication is necessary. Picloram is extremely effective for 5 years, given the conditions of deep organic soil at the first site, but less effective in shallow soil, where it is subject to increased leaching and requires reapplication the third or fourth year.

Hubbard, William A. (1975). Increased range forage production by reseeding and the chemical control of knapweed. Journal of Range Management 28(5):406-407.

Location: Rangeland at Cache Creek and Pritchard, near Kamloops, British Columbia.

Objective: To study the control of knapweed and increase of forage through the use of herbicides.

Summary: Treatments involved combinations of two rates of picloram plus reseeding with crested wheatgrass or reseeding alone. Treatment was done in 1967 at Cache Creek and 1969 at Pritchard.

Sampling of plots was done during the fall of the subsequent four years at Cache Creek and two years at Pritchard. At Cache Creek, picloram at 4 oz and 8 oz/A plus reseeding succeeded in suppressing knapweed and increasing forage, when cattle were also excluded over the four years. Reseeding alone did a comparable job of improving forage in the absence of grazing. The Pritchard site did not benefit from the treatments, apparently because the site was too wet and sod too dense.

Lass, L.W. and R.H. Callihan (1989). Spotted knapweed control in pasture. Research Progress Report of the Western Society of Weed Science, Honolulu, HI, 1989, pp. 105-106.

Location: Pasture at Farragut State Park, west of Athol, ID.

Objective: To determine the effects of six different herbicides at three rates on established spotted knapweed in pasture.

Summary: Treatments were applied in June of 1986. Visual biomass estimates indicated that all rates of clopyralid and picloram controlled spotted knapweed more than 95% throughout the three years of the study. Metsulfuron, DPX-L5300, chlorsulfuron, and sulfometuron provided some control only through spring of the year following treatment.

McKone, M.B., C.A. Lacey, and D. Bedunah (1989). Evaluation of clopyralid rate and time of application on spotted knapweed (Centaure maculosa Lam.). Proceedings of the 1989 Knapweed Symposium, Plant and Soil Department and Extension Service, Montana State University, EB 45. Pp. 83-87.

Location: (1) Two gravelly range sites in southwestern Montana and (2) Two forb-rich sites in western Montana.

Objective: (1) To study the effect of different rates and times of application of clopyralid on spotted knapweed control and
(2) To determine the effect of clopyralid and picloram on forb diversity.

Summary: (1) Four rates of clopyralid and one of picloram, as a comparative treatment, were applied to study plots at three different knapweed developmental stages. Knapweed control was determined visually, one year following application. Clopyralid significantly reduced spotted knapweed density at rates above 0.07 kg/ha, and picloram at 0.28 kg/ha was comparable with clopyralid at 0.28 and 0.42 kg/ha, which were the most effective treatments. Effect of time of application appeared to depend on moisture differences between the two sites, with cloypyralid having a greater effect on the plant at seed dispersal stage at the drier site, and greater effect at the bolt stage at the other. Picloram provided better control at flower and seed dispersal stages at the dry site, with no difference seen in effects at the other site.

(2) Forb density was determined in study plots, which were subsequently sprayed with equal rates of picloram or clopyralid. Spotted knapweed density was significantly reduced, but only sulfur cinquefoil, which was eliminated by picloram, and western yarrow, which was reduced by both herbicides, were otherwise affected.

Renney, A.J. and E.C. Hughes (1969). Control of knapweed, Centaurea species, in British Columbia with TORDON herbicide. Down to Earth 24:6-8.

Location: Diffuse and spotted knapweed-infested grassland ranges in British Columbia.

Objective: To evaluate various herbicides for their ability to control diffuse and spotted knapweed and promote grass cover.

Summary: Experimental plots in spotted knapweed-infested pasture were sprayed with Tordon, 2,4-D amine, or 2,4-D ester, in May of 1966. Visual control ratings made 12 months after application indicated that all Tordon treatments gave excellent residual control of spotted knapweed, and also resulted in increased grass cover.

Story, Jim M., Keith W. Boggs, and Donald R. Graham (1989). Effects of nitrogen fertilization on spotted knapweed and competing vegetation in western Montana. Journal of Range Management 42(3):222-225.

Location: Two spotted knapweed-infested sites, located south of Stevensville, Montana.

Objective: To determine the effects of nitrogen application on spotted knapweed and competing vegetation.

Summary: Various rates of nitrogen fertilizer were applied to plots on Site 1 in April of 1981 and Site 2 in April of 1982. Subsequent sampling indicated that at both sites, nitrogen had a significant positive effect on biomass of spotted knapweed, a similar effect on competing vegetation at one site, and almost no effect on competing vegetation at the other site. The results indicate that nitrogen used alone may not be of value in controlling spotted knapweed.

MECHANICAL

Kennett, Gregory A., John R. Lacey, Curtis A. Butt, Kathrin M. Olson-Rutz, and Marshall R. Haferkamp (1992). Effects of defoliation, shading and competition on spotted knapweed and bluebunch wheatgrass. Journal of Range Management 45:363-369.

Location: Greenhouse at Montana State University, Bozeman, MT.

Objective: To evaluate response of spotted knapweed to defoliation, light, and competition, as a test of the value of grazing in controlling this weed.

Several combinations of plants were used to simulate different levels of inter-specific competition between individuals of knapweed and intra-specific competition between knapweed and bluebunch wheatgrass plants. Each planting combination was subjected to different defoliation and light treatments, each of which was replicated 5 times.

Increased light positively affected growth of root, crown and foliage of knapweed. Total knapweed biomass was not affected by defoliation, but several of the treatments adversely affected root, crown and final harvest foliage. Root and crown growth were also reduced by competition from bluebunch wheatgrass, but bluebunch wheatgrass suffered more through defoliation than knapweed. Evidence suggests grazing would have to be repeated often and be very selective in order to be feasible for control of spotted knapweed.

ADDITIONAL REFERENCES:

BIOCONTROL

Hodgson, J.M. and N.E. Rees (1976). Dispersal of

Rhinocyllus conicus for biocontrol of musk thistle. Weed Science 24(1):59-62.

Rees, N.E. (1979). Life history, habits, and success of Rhinocyllus conicus as a biocontrol agent of musk thistle in Montana. Proceedings of the North Central Weed Control Conference 34:21.

Story, Jim M., Keith W. Boggs, and Robert M. Nowierski (1989). Effect of two introduced seed head flies on spotted knapweed. Montana AgResearch 6(1):14-17.

CHEMICAL

Rice, Peter M., Donald J. Bedunah, and Clinton E. Carlson (1992). Plant community diversity after herbicide control of spotted knapweed. U.S. Department of Agriculture, Forest Service Research Paper INT-460.

MISCELLANEOUS

Baker, L.O., P. Fay, and M.J. Jackson (1979). Spotted knapweed and control. Cooperative Extension Service Folder 206. Bozeman, MT, Montana State University. 2 pp.

Harris, P. and R. Cranston (1979). An economic evaluation of control methods for diffuse and spotted knapweed in western Canada. Canadian Journal of Plant Science 59:375-382.

Lacey, C. (1989). Knapweed management: a decade of change. Proceedings of the 1989 Knapweed Symposium, Bozeman, MT Extension Bulletin 45. Bozeman, MT, Montana State University, Plant and Soil Department and Extension Service. Pp. 1-6.

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Scientific Name: Cirsium arvense
Common Name: Canada thistle
Family: Asteraceae
Location: NE IA MN KS SD ND AB WA SK MT WY BC ON NB
Control: Biocontrol Mechanical Chemical

Habitat: Canada thistle is found in disturbed areas, such as overgrazed pastures, old fields, waste places, roadsides, often invading meadows and wet prairies from disturbed sites. It does not do well in undisturbed prairie, requiring good sunlight to thrive.

Detail: BIOCONTROL

Brosten, Brenda S. and David C. Sands (1986). Field trials of Sclerotinia sclerotiorum to control Canada thistle (Cirsium arvense). Weed Science 34:377-380.

Location: Several locations in Montana.

Objective: To assess the ability of the fungus S. sclerotiorum to control Canada thistle in field trials.

Summary: In spring and summer of 1982, at six sites throughout Montana, two experiments were conducted. One examined the effect of two rates of inoculum of the fungus on Canada thistle at the rosette, vegetative, and flower bud stages. The second tested soil incorporation of inoculum, prior to thistle shoot emergence. Inoculum consisted of infected wheat kernels and fungal sclerotia. June inoculations resulted in more dead thistle shoots than May or July inoculations, when counted in August. At the Bozeman site, 52-73% of shoots died the first year at the high rate of inoculum. However, the second year little effect of the fungus could be observed in these plots, as the fungus apparently did not overwinter well. Soil incorporation dramatically reduced thistle density in the year following inoculation. S. sclerotiorum appears to have promise as a biocontrol agent.

Peschken, D.P. and A.T.S. Wilkinson (1981). Biocontrol of Canada thistle (Cirsium arvense): releases and effectiveness of Ceutorhynchus litura (Coleoptera:Curculionidae) in Canada. The Canadian Entomologist 113(9):777-785.

Location: 14 field sites in five Canadian provinces.

Objective: To monitor releases of the thistle weevil and its effect on Canada thistle.

Summary: Between 1965 and 1979, a total of 1480 C. litura adults were released in thistle patches throughout Canada. The weevils became established on 9 out of the 14 sites. There was no evidence that the weevils alone affected the Canada thistle population, nor did they spread the rust fungus Puccinia punctiformis among thistles, as was previously reported. Additional biological control agents will be necessary to supplement weevil damage for significant reduction in Canada thistles.

Peschken, D.P., D.B. Finnamore and A.K. Watson (1982). Biocontrol of the weed Canada thistle (Cirsium arvense): releases and development of the gall fly Urophora cardui (Diptera:Tephritidae) in Canada. The Canadian Entomologist 114:349-357.

Location: 24 field sites throughout Canada.

Objective: To assess the success of the gall fly in becoming established and reducing Canada thistle populations.

Summary: Between 1974 and 1977, a total of 4934 gall fly adults and 290 larval galls were released at 24 sites of Canada thistle infestation in six Canadian provinces. For unknown reasons, the fly became established in only one site in western Canada, as well as in Ontario, Quebec, and New Brunswick. Galls produced by fly larvae resulted in shorter thistles, in some cases, but the fly alone had no significant impact on thistle vigor. Additional control agents or methods would be necessary to supplement the gall fly.

Strobel, Gary A. (1991). Biological control of weeds. Scientific American 265(1):72-78.

Summary: A genetically modified strain of the fungus Sclerotinia sclerotiorum is being tested for use in controlling Canada thistle.

CHEMICAL

Carlson, Steven J. and William W. Donald (1988). Fall-applied glyphosate for Canada thistle (Cirsium arvense) control in spring wheat (Triticum aestivum). Weed Technology 2:445-455.

Location: Canada thistle-infested spring wheat fields at the North Dakota State University experimental farm, Fargo, ND.

Objective: To determine the effect of fall applications of glyphosate on Canada thistle, and to explore Canada thistle sampling procedures and problems.

Summary: Between 1982 and 1986, herbicides were applied in the fall after wheat harvest. The isopropylamine salt of glyphosate was applied either in one fall or in two consecutive falls, and thistle control was monitored each year thereafter. Some treatments also included a spring application of bromoxynil + MCPA for broadleaf weed control. A single fall treatment or two consecutive treatments of glyphosate did not control shoots adequately, nor reduce root and root bud growth, two growing seasons after the last treatment. When the bromoxynil was also applied in the spring, control was good.

Darwent, A.L. and J.C. Drabble (1989). Top-growth control of Canada thistle in barley with herbicides. Research Report, Western Canada Expert Committee on Weeds 3:120.

Location: A silty loam soil infested with Canada thistle, near Bezanson, Alberta.

Objective: To evaluate various herbicides and rates of application for their ability to control top growth of Canada thistle, without harm to a young stand of Heartland barley.

Summary: Herbicides were applied in June of 1989, a month after sowing of barley, when thistles were emerging to 15 cm in height. Control and crop tolerance were evaluated in August of 1989. All treatments, except SB 53482, at a rate of.025 kg/ha, gave satisfactory top-growth control, and no treatment damaged the crop.

Donald, W.W. (1991). Herbicidal control of Cirsium arvense (L.) Scop. roots and shoots in no-till spring wheat (Triticum aestivum L.). Weed Research 32:259-266.

Location: Spring wheat fields at the North Dakota State University experimental farm in Fargo, ND.

Objective: To evaluate various herbicide treatments for the control of Canada thistle through root damage.

Summary: Wheat was sown and herbicides were applied in mid- to late spring, from 1985 to 1988. Thistle root growth was measured from the second year of each trial, through analysis of soil core samples. Annual chlorsulfuron and clopyralid + 2,4-D treatments greatly reduced root mass and dramatically reduced Cirsium shoot densities over the course of the study.

Donald, William W. (1988). Fall-applied herbicides for Canada thistle (Cirsium arvense) root and root bud control in reduced-till spring wheat. Weed Technology 6:252-261.

Location: Spring wheat plantings at North Dakota

State University experimental farm, Fargo, ND.

Objective: To determine the efficacy of several herbicide treatments for reduction of Canada thistle, particularly through the impact on the thistle root system.

Summary: The herbicide treatments were begun in 1983 and consisted of dicamba, 2,4-D, glyphosate, chlorsulfuron, MCPA + bromoxynil, or 2,4-D + clopyralid. Herbicides were applied in the fall, or the spring, or in both fall and spring. Applications continued for four years. Chlorsulfuron, applied alone in the spring, decreased Canada thistle root bud numbers in most years after the second year. The results suggest that sulfonylurea herbicides, such as chlorsulfuron, should be rotated with other effective treatments, such as 2,4-D + clopyralid, to reduce Canada thistle root system and control the weed.

Fay, P.K. and E.S. Davis (1986). The effect of repeated application of chlorsulfuron on Canada thistle plant density. 1986 Research Progress Report of the Western Society of Weed Science, pp. 207-208.

Location: Field plots in Bozeman, Montana.

Objective: To evaluate repeated applications of various rates of chlorsulfuron for control of Canada thistle.

Summary: In June of each year from 1983 to 1985, chlorsulfuron was applied at four rates to Canada thistle-infested spring wheat plots. The labeled rate of 0.25 oz. ai/A resulted in a 65% decrease in the thistle population over the three years of the study. Treating plots at rates in excess of this labeled rate did not result in enough additional control to warrant consideration.

Lauridson, Thomas C., Robert G. Wilson, and Lloyd C. Haderlie (1983). Effect of moisture stress on Canada thistle (Cirsium arvense) control. Weed Science 31:674-680.

Location: Greenhouse and field plots at the University of Nebraska Panhandle Station near Scottsbluff, Nebraska.

Objective: To determine the effect of moisture stress on the control of Canada thistle achieved with three herbicides.

Summary: Greenhouse experiments were conducted to examine the movement of picloram, dicamba, glyphosate through the tissues of Canada thistle plants under three different moisture regimes. Moisture stress apparently reduced only the uptake of glyphosate in the greenhouse. Field experiments in 1980 and 1981 examined the effects of these herbicides on shoots and roots of Canada thistle under moisture stress, as an indicator of control. All herbicide treatments produced good control, regardless of moisture regime. Moisture stress did affect the plants in ways that bears further investigation.

Miller, S.D., J. Lauer, and A.W. Dalrymple (1989). Canada thistle and volunteer alfalfa control in barley. 1989 Research Progress Report of the Western Society of Weed Science, Honolulu, HI, pp. 259-260.

Location: Barley field infested with Canada thistle near Powell, Wyoming.

Objective: To determine the best herbicide combinations for control of Canada thistle, without injuring barley.

Summary: Several postemergence herbicide treatments were applied in June of 1988. Visual weed control evaluations were made in July and August. Canada thistle control was 85% or better with all clopyralid + 2,4-D treatments.

Ogg Jr., A.G. (1975). Control of Canada thistle by soil fumigation without tarpaulins. Weed Science 23(3):191-194.

Location: Irrigated cropland, heavily infested with Canada thistle, in the Yakima Valley of Washington.

Objective: To evaluate different fumigants and methods of fumigation without tarpaulins for the control of Canada thistle.

Summary: Fields were plowed, harrowed and packed with rollers prior to fumigation. Fumigation, using the fumigants 1,3-dichloropropene, 1,3-dichloropropene + chloropicrin, ethylene dibromide + chloropicrin, and ethylene dibromide alone, was conducted in 1971, 1972 and 1973. Plots were not cropped, but were kept watered. Treatment was most effective when chisel spacing was closer and injections were made to a greater depth. Treatment with high rates of 1,3-dichloropropene provided the most consistently good and economic control of Canada thistle, without the use of tarpaulins.

MECHANICAL CHEMICAL

Darwent, A.L. and J.C. Drabble (1989). Tillage plus fall application of herbicides for Canada thistle control. Research Report, Western Canada Expert Committee on Weeds 3:121-122.

Location: Canada thistle-infested site near Bezanson, Alberta.

Objective: To evaluate various fall-applied herbicides in combination with deep tillage for control of Canada thistle.

Summary: Herbicide treatments were dicamba, clopyralid, MCPA, and glyphosate, applied alone or in combination. Half of the experimental plots were cultivated and harrowed in May, June, and July of 1988, and herbicides were applied in August. Half of the plots were cultivated and harrowed in May, June, July and August, and herbicides were applied in September. In May of 1989, plots were disced and seeded to barley. All herbicides gave excellent reductions in the subsequent density of thistle shoots, which were counted in July of 1989.

Hunter, J.H. (1988). Control of Canada thistle (Cirsium arvense): Bud stage vs. August-rosette. Minutes, Expert Committee on Weeds, Western Canada Weed Conference. P. 38.

Location: Regina, Saskatchewan.

Objective: To test the efficacy of herbicide applied to Canada thistle at the bud stage, vs. herbicide applied to rosettes in late summer, after continuous summer tillage.

Summary: Half of the plants in this field experiment received summerfallow tillage through the summer until the end of July, 1986. The resulting rosettes were treated with dicamba in August. The other half of the plants were tilled once in the spring, and dicamba was applied at twice the initial rate in July, when the plants were at the bud stage. Plots treated at the rosette stage, after continuous tillage, had 88% fewer shoots when shoots were counted a year later in July 1987, even though treated with half the amount of herbicide.

ADDITIONAL REFERENCES:

BIOCONTROL

Peschken, D.P. (1977a). Biological control of creeping thistle: analysis of the releases of Altica carduorum in Canada. Entomophaga 2:425-428.

Watson, A.K. and W.J. Keogh (1981). Mortality of Canada thistle due to Puccinia punctiformis. Proceedings of the International Symposium on the Biological Control of Weeds 5:325-332.

CHEMICAL

Alley, H.P., N.E. Humburg, and R.E. Vore (1981). Selective control of Canada thistle in spring barley. Western Society of Weed Science Research Progress Report, pp. 188-189.

Brewster, B.D. and C.E. Stanger (1980). Bentazon for Canada thistle (Cirsium arvense) control in peppermint (Mentha piperita). Weed Science 28:36-39.

Bultsma, P.M., T.D. Whitson, and F. Lamming (1992). Comparison of several herbicides applied at different growth stages for control of Canada thistle. Research Progress Report of the Western Society of Weed Science. Pp. not given.

Darwent, A.L. and J.C. Drabble (1989). Preharvest applications of glyphosate for Canada thistle control. Research Report, Western Canada Expert Committee on Weeds 3:122.

Dunwell, W.C., A.A. Boe, and G.A. Lee (1978). Canada thistle control in selected junipers with fall-applied glyphosate. Horticulture Science 13:297-298.

Rasmusson, L.W. (1956). The effects of 2,4-D and 2,4,5-T applications on the stand density of Canada thistle. Weeds 5:343-348.

Zimdahl, R.L. (1981). Canada thistle control with Dowco 290 and DPX-4189. Western Society of Weed Science Research Progress Report, pp. 6-7.

Weaver, M.L., and R.E. Nylund (1965). The susceptibility of annual weeds and Canada thistle to MCPA applied at different times of the day. Weeds 13:110-113.

MECHANICAL

Timmons, F.L., and V.F. Burns (1951). Frequency and depths of shoot cutting in eradication of certain creeping perennial weeds. Agronomy Journal 43:371-375.

MECHANICAL CHEMICAL

Derschied, L.A., R.L. Nash, and G.A. Wicks (1961). Thistle control with cultivation, cropping, and chemicals. Weeds 9:90-102.

MISCELLANEOUS

Higgins, R.E., and L.C. Erickson (1960). Canada thistle--identification and control. Idaho Agriculture Extension Service Bulletin 338.

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Scientific Name: Euphorbia esula
Common Name: Leafy spurge
Family: Euphorbiaceae
Location: MN NE ND WI CO MD WY AB
Control: Biocontrol Burning Chemical Grazing

Habitat: Leafy spurge thrives in a wide range of soil conditions, especially dry situations where competition is less intense. Common sites are pastures, roadsides, abandoned fields, disturbed and undisturbed prairies. It is not commonly found in cultivated fields.

Detail: BIOCONTROL

Forwood, J.R. and M.K. McCarty (1980). Control of leafy spurge (Euphorbia esula) in Nebraska with the spurge hawkmoth (Hyles euphorbiae). Weed Science 28(3):235-240.

Location: Growth chambers and leafy spurge-infested pasture near Lincoln and O'Neill, Nebraska.

Objective: To study the establishment of the spurge hawkmoth and its effects on leafy spurge.

Summary: Several experiments were conducted from 1975 to 1977, to examine the environmental requirements and life cycle of the spurge hawkmoth. The effect of predators on the moth population was also studied. Results indicate that Nebraska winters may result in fairly high pupal mortality, but that environmental conditions should allow establishment of hawkmoth populations. Several predators of larvae and pupae were identified, and their impact was such that the spurge hawkmoth alone has little potential as a leafy spurge biocontrol agent in Nebraska. It may have potential in combination with other control agents.

Krupinsky, Joseph M. and Russell J. Lorenz (1983). An Alternaria sp. on leafy spurge (Euphorbia esula). Weed Science 31:86-88.

Location: Greenhouse and a leafy spurge stand at Mandan, ND.

Objective: To assess the pathogenicity of an Alternaria sp. fungus on leafy spurge under controlled conditions.

Summary: Leafy spurge plants grown in the greenhouse were inoculated with different concentrations of conidial suspensions from a fungus classified as Alternaria tenuissima f. sp. euphorbiae. Plants were also inoculated in a mature stand of leafy spurge in the field. In the greenhouse, spore concentrations above 1 x 10-5 spores/ml killed the majority of plant shoot systems. In the field, the tops of shoot systems were killed, preventing seed production and apparently reducing plant vigor. Further study is needed on the usefulness of this fungal strain as a biocontrol agent of leafy spurge.

Yang, Shaw-ming, D.R. Johnson, and W.M. Dowler (1991). Evaluating potential fungal pathogens for biological control of leafy spurge. Proceedings of the 1991 Leafy Spurge Symposium, Great Plains Agricultural Council Publication #136, pp. 21-25.

Location: Greenhouse and growth chambers in Frederick, MD.

Objective: To evaluate fungal pathogens for their potential as biocontrol agents of leafy spurge.

Summary: More than 350 fungal isolates, consisting of 15 genera, were obtained from leafy spurge plants from China, Maryland, Montana, Nebraska, and North Dakota. This report follows testing of 200 of the isolates for pathogenicity. Six inoculation methods were tested for the screening of fungal biocontrol agents for leafy spurge. Nineteen isolates in four genera were pathogenic to leafy spurge. One isolate of Alternaria alternata from Nebraska consistently caused moderate infections, and a Myrothecium sp. from China consistently killed leafy spurge plants. The best of six screening methods for pathogenicity involves placing of an agar block with mycelium on leaves of intact leafy spurge plants. In an additional study, Alternaria alternata and A. angustiovoidea were found to be able to infect and kill leafy spurge when applied in a sprayed emulsion, without a dew period.

Yang, S. (1992). Can plant pathogens alone control leafy spurge? Eleventh Leafy Spurge Symposium, Great Plains Agricultural Council Publication #144, pp. 33-34.

Location: Greenhouse in Frederick, MD.

Objective: To test the efficacy of four fungal pathogens for control of leafy spurge.

Summary: Leafy spurge plants of different ages were sprayed with suspensions of fungal pathogens, and then each emerging shoot was inoculated, until no more shoots emerged. The pathogens were Alternaria angustiovoidea Simmons, Myrothecium verrucaria (Albertini & Schwein.) Ditmar:Fr, and one isolate each of Fusarium and Rhizoctonia. All pathogens were effective in infecting and killing leafy spurge, but when the plant was more mature with more viable root buds, many repeated inoculations were required. Thus, none of these pathogens alone would be feasible as biocontrol agents.

BIOCONTROL CHEMICAL

Jordahl, J.G., L.J. Francl, K.M. Christianson, and R.G. Lym (1991). Enhancement of herbicide activity by Alternaria angustiovoidea. Proceedings of the 1991 Leafy Spurge Symposium, Great Plains Agricultural Council Publication #136, pp. 71-77.

Location: Greenhouses at North Dakota State University, Fargo, ND.

Objective: To evaluate the pathogen Alternaria angustiovoidea as an additional stressor for the control of leafy spurge treated with herbicides.

Summary: Leafy spurge plants grown in the greenhouse were inoculated by spraying with conidia of the foliar pathogen A. angustiovoidea.

After a misting period, plants were treated with sublethal rates of eight different herbicides. Glyphosate + 2,4-D and 2,4-D alone caused a high rate of defoliation, without effect by the fungus. An additional four of the eight herbicides were enhanced by pretreatment with the fungus. In five of eight treatments, fewer shoots developed when the fungus was used in conjunction with herbicides.

In a separate test, plants were treated with 2,4-D at various rates one week prior to fungal inoculation. Reduced rates of 2,4-D, in conjunction with the fungus, were almost as phytotoxic as the full rate of the herbicide alone. These results suggest that the use of a biocontrol agent in combination with herbicides can reduce the amount of herbicides needed to produce the same effect, as well as increasing the number of options for control of leafy spurge.

BURNING

Masters, Robert A. (1994). Response of leafy spurge to date of burning. Proceedings of the Leafy Spurge Strategic Planning Workshop, Dickinson, ND.

Location: Remnant tallgrass prairie in Lancaster County, Nebraska.

Objective: To study the effects of time of burning on leafy spurge and associated prairie plants.

Summary: Experimental plots of spurge-infested tallgrass prairie were either unburned or burned on April 23, May 2, May 14, or May 26, 1990. Vegetation was sampled in July. Burning through mid-May stimulated leafy spurge stem density, but stem density of plots burned at the end of May was significantly less than that of plots burned the first week of May.

BURNING CHEMICAL

Masters, R.A., S.J. Nissen, R.E. Gaussoin, D.D. Beran and R.N. Stougaard (1996). Imidazolinone Herbicides Improve Restoration of Great Plains Grasslands. Weed Technology, 10(20): 392-403.

Location: University of Nebraska Agricultural Research and Development Center near Mead, NE, and the South Central Research and Extension Center near Clay Center, NE.

Objective: To evaluate the utility of the imidazolinone herbicide family in:

1. establishment of native perennial grasses on cropland
2. control of leafy spurge on rangeland
3. aiding the establishment of selected forbs.

Summary: Leafy spurge-infested rangeland reclamation: The rangeland was divided into study sites for various treatments. Herbicides used in the study included: sulfometuron at 100 g ai/ha, imazapyr at 280, 560, or 840 g/ha, and glyphosate at 630 g ae/ha applied on September 30 and October 1, 1992. The plots were burned April 21, 1993 then planted with big bluestem, little bluestem, and switchgrass using a drill with no tillage. Big bluestem stand frequencies were highest where imazapyr and sulfometuron were applied together. Little bluestem frequencies were low wherever sulfometuron was applied suggesting its susceptibility to the herbicide. Little bluestem frequency was greater on plot treated with Imazapyr at 840 g/ha than on non-treated plots. There was some success producing switchgrass with imazapyr and (or) sulfometuron. Reduction of leafy spurge herbage mass was achieved using imazapyr at 560 and 840 g/ha alone or at any rate used in concert with sulfometuron.

Forb establishment: This portion of the project was conducted at the John Seaton Anderson Turfgrass Research Facility near Mead, Nebraska. In each research plot one of the following forbs were planted: blackeyed-susan, Illinois bundle flower, purple prairie clover, trailing crownvetch, and upright prairie coneflower. The herbicides used in the study were either imazethapyr or AC 263,222 applied at 70 g/ha. The results show that either chemical can benefit selected forb establishment.

Winter, B. (1992). Leafy spurge control in a tallgrass natural area. Eleventh Leafy Spurge Symposium; Great Plains Agricultural Council Publication #144, pp. 23-31.

Location: Bluestem Prairie, a tallgrass prairie nature preserve in Clay County, Minnesota.

Objective: To test a strategy for maximizing leafy spurge control while minimizing negative impact on native plants.

Summary: A consultation with weed control experts and land managers resulted in a leafy spurge control program, which began in 1985. As much of the prairie as possible is surveyed during the growing season each year, and patches of leafy spurge are marked with permanent markers to aid in further monitoring. Picloram is then applied on a yearly basis at a rate of 2 lbs/A with a blue dye, to aid in application accuracy. Fire is used to burn off litter before application, also. To date (1992), the leafy spurge patches found have amounted to 0.7% of the total prairie acreage. Treatment has resulted in apparent elimination of leafy spurge plants in 20% of the patches, with new patches being found and beginning treatment each year. This approach of intensive monitoring and treatment with picloram seems likely to result in elimination of leafy spurge as a major problem in the prairie.

Wolters, G. L., C. H. Sieg, A. J. Bjugstad and F. R. Gartner (1994). Herbicide and Fire Effects on Leafy Spurge Density and Seed Germination. Research Note RM-526. USDA forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO, USA.

Location: Little Missouri National Grassland, in southwestern North Dakota.

Objective: To evaluate the effect of picloram plus 2,4-D and (or) prescribed fire to reduce stands of leafy spurge.

Summary: Herbicides and fire were applied separately and in combination to identify the best protocol for controlling spurge in grasslands. Picloram and 2,4-D were applied together in all of the treatments. The treatments were as follows:

1. Herbicide only in the spring
2. Herbicide only applied in the fall
3. Herbicide applied in the spring followed by a fall burn
4. Herbicide applied in the fall followed by a spring burn
5. Spring burn only
6. Fall burn only
7. Untreated control.

Two treatments, springtime burn alone and herbicide applied in the fall followed by a spring burn, were the most effective treatments against leafy spurge germination. Both caused a 95% reduction in germination compared to the untreated plots. Herbicide alone did little to reduce germination. Herbicide treatments reduced density compared to untreated plots or burning alone. Burning did not reduce leafy spurge density, but stimulated vigorous sprouting. The best all-around treatment for reducing both germination and stem density would be a fall application of picloram plus 2,4-D followed by spring burning.

CHEMICAL

Beck, K.G. and J.R. Sebastian (1991). First year results of leafy spurge control with sequential spring and fall herbicide applications. Proceedings of the 1991 Leafy Spurge Symposium, Great Plains Agricultural Council Publication #136, pp. 61-64.

Location: Leafy spurge-infested pasture near Parker, Colorado.

Objective: To determine the efficacy of sequential spring and fall herbicide applications for leafy spurge control.

Summary: In spring of 1990, experimental plots of leafy spurge were sprayed with combinations of dicamba, picloram, glyphosate, and 2,4-D, at the early bract growth stage or at flowering. Plots were sprayed again during plant regrowth in the fall, with additional herbicide treatments. Visual evaluations were made in August 1990 and May 1991. All tank-mixes containing picloram provided greater than 80% leafy spurge control in May 1991, except picloram + dicamba at one rate, applied in spring. All 2,4-D + glyphosate treatments provided poor leafy spurge control in May 1991, although grass injury was less with this combination. Sequential applications provided no advantage over picloram or dicamba applied at flowering only. Only limited advantage is apparent with sequential applications of 2,4-D in spring followed by other herbicides in the fall.

Ferrell, M.A. and T.D. Whitson (1991). Control of leafy spurge with retreatments of picloram and 2,4-D LVE. Proceedings of the 1991 Leafy Spurge Symposium, Great Plains Agricultural Council Publication #136, pp. 65-68.

Location: Leafy spurge-infested range near Devil's Tower, Wyoming.

Objective: To evaluate the leafy spurge control attained by treatments of picloram and 2,4-D, and to assess the effectiveness of a monitoring and retreatment program for maintaining control at 80%

or better.

Summary: Initial herbicide applications were made in May of 1987, and retreatments were applied July of 1988, June of 1989, and June of 1990. Initial herbicide treatments and retreatments were picloram, picloram + ethyl hexyl ester (LVE), and 2,4-D + LVE, applied at various rates and in various combinations. Visual evaluations were made in late spring of each year following treatments. Results indicate that a yearly 2,4-D retreatment program would be the most effective and economical, but past research has shown this treatment to not be reliable. Picloram + 2,4-D would probably be the best treatment program.

Glass, Steve (1992). Fosamine shows promise in control of leafy spurge (Wisconsin). Restoration & Management Notes 10(2):198-199.

Location: Moist areas of Curtis Prairie, at the University of Wisconsin Arboretum in Madison, Wisconsin.

Objective: To test the efficacy of the bud-inhibitor fosamine for selective control of leafy spurge.

Summary: In May of 1991, 12 ha of Curtis Prairie was burned. Plots were established in moist, unburned sections of prairie that were infested with leafy spurge. Fosamine was applied to 7 of 10 plots, and stems were counted in the middle and at the end of May of the following year. Four of seven plots had no spurge, and the rest of the treated plots had very little. Emerging seedlings indicated, however, that follow-up treatments would be necessary. The surrounding vegetation suffered no immediately apparent damage.

Kidder, Daniel W. (1981). Low volume application methods with dicamba for leafy spurge control. Proceedings of the North Central Weed Control Conference 36:41.

Location: Dense leafy spurge stands at Sheldon and Valley City, ND.

Objective: To evaluate various rates of dicamba, applied using various methods, for control of leafy spurge.

Summary: In June of 1980, dicamba was applied at three rates, with or without additives, using four different methods. The highest rate of produced excellent control, as assessed the year following application. Conventional broadcasting was the best method, either in granular or solution form, apparently because the roots received more of the herbicide this way than with the roller or wick methods.

Lym, Rodney G. and Calvin G. Messersmith (1990). Leafy spurge control following nine years of herbicide treatment. North Dakota Farm Research Bimonthly Bulletin 47(6):12-14.

Location: Seven leafy spurge-infested sites in North Dakota.

Objective: To evaluate various herbicide treatments for long-term leafy spurge control.

Summary: Experimental sites were established in 1980. The treatments consisted of the various combinations of the herbicides 2,4-D, picloram, and dicamba applied in spring with subplots retreated in the fall. Control was 80% or better with most treatments every year, but no treatment eradicated leafy spurge over the nine years of the study.

Lym, R.G. and Calvin G. Messersmith (1985). Leafy spurge control with herbicides in North Dakota: 20-Year summary. Journal of Range Management 38(2):149-154.

Summary: Twenty years' worth of data from experimental plots established by North Dakota State University were summarized for the herbicides 2,4-D, dicamba, picloram and glyphosate, to determine the best combinations and application times for control of leafy spurge.

Lym, R.G., K.K. Sedivec and D.R. Kirby (1997). Leafy Spurge Control With Angora Goats and Herbicides. Journal of Range Management, 50(2): 123-128.

Location: Sheyenne National Grasslands and the Gilbert C. Grafton South State Military Reservation in North Dakota.

Objective: To evaluate herbicide treatments with goat grazing for long-term leafy spurge control.

Summary: The pastures were divided into the following treatments:

1. Grazing alone

2. Herbicide applied in the spring
3. Herbicide applied in the fall
4. Grazing following spring applied herbicides
5. Grazing following fall application of herbicide
6. Untreated control.

Grazing was season-long at Camp Grafton South, and rotational at Sheyenne National Grasslands. The authors used leafy spurge density, biomass and the quantification of root protein and carbohydrate to measure the effectiveness of each treatment. They reported that "grazing combined with fall-applied herbicides reduced leafy spurge density rapidly and maintained control longer than either method used alone." Their results also show that annual spring application of picloram plus 2,4-D reduces leafy spurge density as well or better than spring-applied herbicide and grazing combined. The effect of herbicide and (or) grazing treatment of root nutrients was a reduction in root protein, but only minimal effect on root carbohydrate.

Masters, R.A., R.N. Stougaard, and S.J. Nissen (1991). Leafy spurge response to rate and time of application of imidazolinone herbicides. Proceedings of the 1991 Leafy Spurge Symposium; Great Plains Agricultural Council Publication #136, pp. 79-83.

Location: A leafy spurge-infested meadow range site southeast of Ainsworth, Nebraska.

Objective: To evaluate type and rate of imidazolinone herbicide and time of application for control of leafy spurge.

Summary: Three imidazolinone herbicides (imazapyr, imazethapyr, and imazaquin) at three rates were applied by spraying in the spring and fall of 1989. Visual ratings were made in early June and September of 1990, and dry matter yield was determined in late June of 1990. Fall applications of all herbicides were more effective than spring applications. Herbicides applied at the highest rate provided good immediate control, but percent control dropped sharply by a year after application. However, leafy spurge dry matter was greatly decreased by the highest rate of application. Fall application of imazapyr at the two higher rates greatly reduced grass yields, while the other two did not affect grass yields. Repeated application of the imidazolinone herbicides in the fall may be an effective control method through herbicide uptake from the soil.

COMPETITION

Lym, R.G., and D.A. Tober (1997). Competitive Grasses for Leafy Spurge Reduction. Weed Technology, 11(4): 787-792.

Location: North Dakota State University Experiment Station in Fargo North Dakota, and near Pipestem Dam near Jamestown North Dakota.

Objective: To test the ability of 12 grass species to out-compete leafy spurge for use as a management tool for controlling leafy spurge.

Summary: The soil at Fargo is a silty clay soil, and at Jamestown a loamy sand soil. At both sites seedbeds were prepared by cultivation (to 15-cm depth) and plant residue was removed, then seeded with grass seed. Some broadleaf herbicides were applied to control weeds. In Fargo smooth brome, western wheatgrass, Russian wild rye, and Dahurian wild rye reduced leafy spurge stem density an average of 63% after three years. Intermediate wheatgrass reduced leafy spurge density every year for 3-years, including an 85% reduction the second year after planting, and consistently produced high herbage yields. In Jamestown smooth brome and intermediate wheatgrass averaged 72% leafy spurge reduction 3-years after seeding. Intermediate wheatgrass and pubescent wheatgrass provided the most consistent herbage production, which averaged about 2,000 Kg/ha annually for 3 years.

GRAZING

Johnston, A. and R.W. Peake (1960). Effect of selective grazing by sheep on the control of leafy spurge (Euphorbia esula L.). Journal of Range Management 13:192-195.

Location: A crested wheatgrass pasture near Pearce, Alberta that was severely infested with leafy spurge.

Objective: To determine the effects of grazing by sheep on the wheatgrass-spurge pasture.

Summary: From 1952 to 1956, A 30-acre field was stocked between the beginning of May to the end of September at a rate of one and one-half head of ewes per acre. A similar adjacent area of pasture was excluded from grazing for comparison. Until four years after the beginning of the study, the basal area of leafy spurge did not decrease significantly. After four years, the area decreased by 98%, and the remaining plants were much reduced in vigor. Observations indicated leafy spurge plants were selectively grazed by sheep unless allowed to become too mature, so mowing should be used to eliminate mature plants, if sheep are to be used in leafy spurge control.

Prosser, Chad W., K.K. Sedivec, and W.T. Barker (1995). Multi-species grazing using goats and cattle to control leafy spurge. North Dakota Academy of Science Proceedings 49:17.

Location: Leafy spurge-infested pasture at Camp Grafton South in southeastern Eddy county, North Dakota.

Objective: To test the efficacy of cattle and angora goats for control of leafy spurge.

Summary: Leafy spurge stems were counted in a spurge-infested pasture in May of 1993 and 1994. The pasture was divided into three treatment areas for grazing by cattle only, angora goats and cattle together, and goats only. Grazing occurred through the summer of 1993 and 1994. Sampling indicated that goats reduced spurge stem density significantly, while grazing by cattle only did not result in significant reduction.

Sedivec, K.K. and R.P. Maine (1993). Angora goat grazing as a biological control for leafy spurge: a three-year summary. Proceedings of the 1993 Great Plains Agricultural Council Leafy Spurge Task Force Symposium, Silvercreek, CO.

Location: Leafy spurge-infested pasture on Hawk's Nest Butte, southwest of Carrington, North Dakota.

Objective: To test the efficacy of angora goat grazing for control of leafy spurge and stimulation of grass regrowth.

Summary: Goats were stocked at various rates from late spring to early fall during the years 1990 to 1992. Stem counts were made during mid-May of each year, as well as in 1993. Canopy cover was determined for each year as well. Leafy spurge stems were reduced by 23.5% throughout the course of the experiment. The percent of the cover due to leafy spurge was reduced by 44.1%, while the percentage due to grasses rose 57.2%. Angora goats appear to be effective for leafy spurge control. The recommended stocking rate is at least 6.7 goats/acre/month.

Williams, K.E., J.R. Lacey and B.E Olson (1996). Economic Feasibility of Grazing Sheep on Leafy Spurge-Infested Rangeland in Montana. Journal of Range Management, 49(4): 372-374.

Location: This research used a model ranch derived from demographics of southeastern Montana ranches.

Objective: To develop a model that will allow land managers to assess the feasibility of developing sheep enterprises to control leafy spurge.

Summary: This paper presents a model that can be used by land managers to predict the returns over total costs of operating sheep enterprises for the purpose of long-term control of leafy spurge. The input variables of this model are as follows:

1. Total number of hectares (ha) in each pasture that contains leafy spurge.
2. Ha AUM-1 on uninfested range.
3. Percent of land within the pasture infested with leafy spurge.
4. Number of months sheep grazed
5. Returns over variable cost per ewe.
6. Ewe cost
7. Value of a cull ewe.
8. Taxes per ewe.
9. Years ewe will be in flock.
10. Real interest rate.
11. Kilometers of fence needed (woven wire).
12. Cost per Km fence.
13. Projected life of fence.

The authors feel that their model is applicable to most conditions in the Northern Great Plains. The model can be adapted to ranches that have a broad range of spurge infestations, with returns being greater in pastures where spurge infestations are at a greater percentage. By altering the values of input variables one can calculate the predicted returns over total costs for a specific ranch. The model is available through the Phillips County Extension Office, Malta, Montana 59538.

CHEMICAL GRAZING

Beck, K.G. and J.R. Sebastian (1993). Progress on an integrated leafy spurge management system combining sheep grazing with fall-applied herbicides. Proceedings of the 1993 Great Plains Agricultural Council Leafy Spurge Task Force Symposium; July 26-28, 1993, Silvercreek, CO.

Location: Cherry Creek State Park in Aurora, CO.

Objective: To compare the efficacy of sheep grazing plus fall herbicide application with that of spring or fall herbicide application alone, for control of leafy spurge.

Summary: Herbicide treatments were picloram and picloram + 2,4-D at various rates and dicamba + 2,4-D. Treatments, applied in 1991, were herbicides applied at flowering, herbicides applied to fall regrowth, and herbicides applied to regrowth following 75 days of grazing. After two years of the study, results varied; spring-applied picloram at 0.25 lb/A reduced leafy spurge cover compared to other treatments. Most treatments of fall-applied herbicides preceded by grazing tended to decrease leafy spurge cover. Data from additional years will be collected.

Lacey, J.R., and R.L. Shelley (1996). Leafy Spurge and Grass Response to Picloram and Intensive Grazing. Journal of Range Management, 49(4): 311-314.

Location: Crazy Mountain Ranch near Clyde Park, Montana. In south central Montana near Bozeman, on well drained soils, moderately fine in texture (silty).

Objective: To study the effectiveness of picloram used in concert with short-duration grazing by cattle or sheep on control of leafy spurge.

Summary: Pastures were divided into areas that were either treated with picloram or left untreated. The study area was further divided into areas that either excluded or allowed grazing. The site had plants present at the following densities: Kentucky bluegrass 75%, leafy spurge 20%, and other plants 5%. Livestock were allowed to graze 1 or 2 times a year for 1 to 2 days. In each of five years about 1,100 targhee ewes with lambs grazed the 16-ha pasture for about 2 days in early July. They re-grazed for one day in early September during two of those years. About 500 cows with calves grazed the 24-ha pasture in the first two years, then 525 yearling heifers grazed in the last 3 years of the study. Both cattle herds grazed for 2 days in early July.

In the absence of sheep grazing or picloram, leafy spurge stem density doubled between the years 1990 to 1994. Leafy spurge stem density increases were reduced with picloram and sheep grazing treatments, but no significant interactions between grazing and picloram were observed. The authors do make a case for the potential for the interaction between grazing and herbicide to work for long-term control of leafy spurge. Poa pratensis biomass increased with picloram treatment due to decreased competition. P. pratensis production declined due to selective cattle grazing, although P. pratensis cover remained high because litter was decreased.

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BIOCONTROL

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BIOCONTROL CHEMICAL

Frank, J.R., S.M. Yang, and D.R. Johnson (1992). Effects of glyphosate and Alternaria angustiovoidea on Euphorbia esula. Eleventh Leafy Spurge Symposium, Great Plains Agriculture Council Publication #144, p. 35.

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CHEMICAL

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Messersmith, C.G. (1979). Leafy spurge chemical control. Page 78. Proceedings of the Leafy Spurge Symposium, North Dakota Cooperative Extension Service, Fargo. 84 pp.

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MISCELLANEOUS

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Noble, D.L. and D.C. MacIntyre (1979). Management program for leafy spurge. Rangelands 1(6):247.

Wood, H.E. (1945). Leafy spurge control. Manitoba Department of Agriculture Publication #200. 9 pp.

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Scientific Name: Lactuca serriola
Common Name: Prickly lettuce
Family: Asteraceae
Location: NE IA MN MO KS SD ND ID
Control: Memo Chemical

Habitat: Prickly lettuce is found in dry soils; along roadsides, railroads and sidewalks; in vacant lots, dumps, fencerows, degraded pastures, cultivated fields, orchards and vineyards. It is found throughout the United States.

Detail: CHEMICAL

Mallory, C.A., M.J. Dial, and D.C. Thill (1989). Alternative herbicide control of sulfonylurea resistant prickly lettuce. Research Progress Report of the Western Society of Weed Science, Honolulu, HI, 1989, pp. 383-385.

Location: Winter wheat field near Lewiston, Idaho.

Objective: To assess the efficacy of several herbicide treatments for the control of prickly lettuce (Lactuca serriola).

Summary: Experimental plots consisting of prickly lettuce-infested winter wheat were treated with various herbicide combinations in 1987 and 1988. None of the sulfonylurea herbicides used were effective in controlling a resistant biotype of prickly lettuce, and their addition to other herbicides did not increase control. All other herbicide treatments provided excellent control.

ADDITIONAL REFERENCES:

Messersmith, C.G. and R.G. Lym (1980). Herbicide evaluation for Canada thistle and prickly lettuce control. Proceedings of the North Central Weed Control Conference 37:63.

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Scientific Name: Lonicera tatarica
Common Name: Tatarian honeysuckle
Family: Caprifoliaceae
Location: IA MN IL
Control: Biocontrol Mechanical

Habitat: Tatarian honeysuckle grows in a wide variety of soils and environmental conditions, and can withstand extremes of temperature. It is found on river banks, roadsides, fencelines, wooded hillsides, in pastures and marshes.

Detail: BIOCONTROL

Voegtlin, David (1983). Tatarian honeysuckle aphid: possible role in control of its escaped host (Illinois). Restoration and Management Notes 1(3):27.

Summary: The aphid Hyadaphis tatariace (Aizenberg) is specific to the Tatarian honeysuckle. This aphid has been found spreading through the north central states. This aphid has been observed to severely damage this honeysuckle, producing a characteristic "witches' broom" on the growing tip, and European literature suggests that heavy infestations may kill the plant. This aphid has potential as a biocontrol agent of Tatarian honeysuckle, provided nurseries no longer sell cultivars of this tenacious weed as ornamentals.

MECHANICAL

Todd, Robert (1985). Honeysuckle controlled by hand pulling (Illinois). Restoration & Management Notes 3(1):41.

Location: School District 54 Nature Center, Schaumburg, Illinois.

Summary: Honeysuckle was removed by hand in the early spring of 1980. Large shrubs were pulled by hand when the ground was wet after rain, and larger shrubs were cut to 60 cm and pulled the next year. No regrowth has occurred. Pulling can also be done after fall rains.

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Scientific Name: Lythrum salicaria
Common Name: Purple loosestrife
Family: Lythraceae
Location: IA MA IL MB MN NY ON OH WI
Control: Mechanical Chemical

Habitat: Purple loosestrife occurs in wet habitats, such as marshes, sedge meadows, and wet pastures, as well as in roadside ditches, on streambanks and edges of lakes. It prefers moist, organic soils in full sun, but it is shade tolerant.

Detail: CHEMICAL

Balogh, Gregory R. (1986). Ecology, Distribution, and Control of Purple Loosestrife (Lythrum salicaria) in Northwest Ohio. Thesis, Ohio State University, pp. 35-39.

Location: The Little Portage Wildlife Area and Woods Marsh in Erie County, Ohio.

Objective: To test the efficacy of the herbicide Casoron for control of purple loosestrife.

Summary: In April of 1985, Casoron pellets were applied at three rates to plots established in stands of purple loosestrife. In March of 1986, Casoron pellets were applied to ice in purple loosestrife plots. Final evaluation of all plots was made in September 1986. Results were erratic, although visual examination indicated that treated plants were stunted, with less vigorous shoots, and their loss of vigor allowed native species to become evident in the plots. Casoron is not, however, worth the cost for control of purple loosestrife.

Balogh, Gregory R. (1986). Ecology, Distribution, and Control of Purple Loosestrife (Lythrum salicaria) in Northwest Ohio. Thesis, Ohio State University, pp. 40-64.

Location: Purple loosestrife stands in Bohling's Marsh, Ottawa County; Woods Marsh, Erie County; and the Little Portage Wildlife Area in Ohio.

Objective: To test the efficacy of various rates of the glyphosate-based herbicide Rodeo, applied at different portions of the growing season, for control of purple loosestrife.

Summary: Treatments were applied in the three research areas during the growing seasons of 1984 and 1985. Nine different dosages of Rodeo herbicide were applied at the following purple loosestrife growth stages: full flowering, late flowering, and post-flowering. In general, stem density decreased as herbicide solution concentration and spray volume increased. Stem density did not change between one and two years post-treatment. This study did not reveal any significant differences in plant response to spraying, according to stage of development.

Notestein, Anne (1987). Purple loosestrife managed with herbicides at Horicon National Wildlife Refuge (Wisconsin). Restoration & Management Notes 5(2):91.

Location: Meadows and marshes at Horicon National Wildlife Refuge in Wisconsin.

Objective: To test three herbicides for their ability to kill purple loosestrife when applied at different stages of the plant's life cycle.

Summary: The herbicides 2,4-D ester, 2,4-D amine, and glyphosate were applied to plots in mature stands of purple loosestrife. The herbicides were applied at the following stages: vegetative, early bloom, mid-bloom, and late bloom. Glyphosate performed excellently, regardless of time of application. 2,4-D amine gave excellent results at flooded experimental sites. Total results indicate that treatments should begin as early as recommended by the herbicide label to prevent seed production, and glyphosate should be used carefully, to avoid injuring nearby plants.

Smith, Ralph H. (1964). Experimental control of purple loosestrife (Lythrum salicaria). New York Fish & Game Journal 11:35-46.

Location: A pond in the Howland Island Game Management Area in New York state.

Objective: To test the efficacy of various herbicides for control of purple loosetrife.

Summary: Plots were laid out in a large area of purple loosestrife and treated in 1956-1961. Several different herbicides, times of treatment, and herbicide carriers and additives were used in the different years. Complete destruction of purple loosestrife plants did not result in any year; many plants resprouted the following year. Solutions of silvex and mixtures of 2,4-D and 2,4,5-T, applied heavily, generally provided the greatest control. Applications would need to be repeated for several years to fully control purple loosestrife.

Spinks, Preston and Stephen Packard (1988). Control of purple loosestrife (Illinois). Restoration and Management Notes 6(1):50.

Location: Forest preserve property in Illinois.

Summary: The first and second year of a purple loosestrife spraying program, a 6% solution of Ammate plus a surfactant was used successfully, but with some difficulty. The third through the fifth years, 3-gallon plastic backpack sprayers have been used to spray a coarse spray of a 1% solution of Roundup, when the plants are in flower. This spraying program has been very successful, and a diverse mix of native plants are growing in place of the purple loosestrife.

MECHANICAL

Balogh, Gregory R. (1986). Ecology, Distribution, and Control of Purple Loosestrife (Lythrum salicaria) in Northwest Ohio. Thesis, Ohio State University, pp. 66-79.

Location: Greenhouse at Ohio State University, and mudflats at the Crane Creek Wildlife Experiment Station, Ottawa National Wildlife Refuge, and Winous Point Shooting Club in Ohio.

Objective: To test the competitive abilities of four wetland plants, including L. salicaria.

Summary: Experiments were conducted in the greenhouse to study the competition between Polygonum lapathifolium and L. salicaria seedlings. L. salicaria is capable of germination under a wide variety of conditions, and apparently much more tolerant of variability in light and moisture than P. lapathifolium. Thus L. salicaria performed much better under artificial greenhouse conditions. In experiments conducted on actual mudflats, P. lapathifolium competed very well; however, it is an annual, and not likely to be able to compete as well with mature L. salicaria plants. However, perhaps it has a potential role in the effort to control purple loosestrife.

Dobberteen, Ross A., Ethan Perry, Norton H. Nickerson (1989). Clear plastic retards purple loosestrife growth (Massachusetts). Restoration and Management Notes 7(2):100.

Location: A freshwater marsh in northern Massachusetts.

Objective: To test the efficacy of clear plastic cover in increasing water surface temperatures and thus controlling purple loosestrife.

Summary: Experimental plots in a freshwater marsh were covered with 4-mil clear plastic after purple loosestrife stems were counted and cut. After two weeks, covered plots had between 6% and 38% fewer stems than control plots.

Gabor, T. Shane and H.R. Murkin (1990). Effects of clipping purple loosestrife seedlings during a simulated wetland drawdown. Journal of Aquatic Plant Management 28:98-100.

Location: Greenhouse facilities at the Delta Waterfowl and Wetlands Research Station, on the Delta Marsh in south-central Manitoba.

Objective: To determine the effect on seedling establishment of clipping of purple loosestrife seedlings during a simulated drawdown.

Summary: Purple loosestrife seeds were germinated and maintained under saturated soil conditions, in order to simulate wetland drawdown conditions. Treated seedlings were then clipped at the soil surface at 21, 42, and 63 days after sowing. Clipping at 21 days prevented regrowth from the clipped stems, and subsequent plants arose from previously non-germinated seeds. Clipping at 42 and 63 days resulted in regrowth of 2 new shoots from each stem, indicating that clipping of purple loosestrife seedlings after the sixth week will only stimulate more dense growth of loosetrife, whereas clipping at the third week eliminates the clipped plant before its roots have developed enough to regenerate the shoot.

Haworth-Brockman, Margaret J. and Henry R. Murkin (1993). Effects of shallow flooding on newly established purple loosestrife seedlings. Wetlands 13(3):224-227.

Location: Shade-house in south-central Manitoba, Canada.

Objective: To determine the efficacy of shallow flooding of seedlings for the control of purple loosestrife.

Summary: In June 1987, purple loosestrife seeds were collected and sown in pots in an outdoor shelter. Seedlings in three different height categories were then subjected to four different flooding depths, up to 30 cm, throughout the growing season. Results indicated that flooding up to 30 cm has no significant impact on seedling density or survival, and thus is useless as a management tool.

Haworth-Brockman, Margaret J., H.R. Murkin, R.T. Clay, and E. Armson (1991). Effects of underwater clipping of purple loosestrife in a southern Ontario wetland. Journal of Aquatic Plant Management 29:117-118.

Location: Green Gables Marsh, near Kingston, Ontario.

Objective: To assess the effectiveness of underwater cutting in controlling mature purple loosestrife plants.

Summary: Experimental plots were established in a marsh with an established monospecific stand of purple loosestrife. During the summers of 1987 and 1988, plants were clipped at least 10 cm below the water surface, either in early, mid-, or late summer. There was no significant effect of the clipping treatments, indicating that mowing of loosestrife stands is not a feasible means of control.

Welling, Charles H. and Roger L. Becker (1990). Seed bank dynamics of Lythrum salicaria L.: implications for control of this species in North America. Aquatic Botany 38:303-309.

Location: Greenhouse and outdoors at the University of Minnesota Agricultural Experiment Station.

Objective: To determine whether promoting germination of seeds from wetland soil will exhaust the L. salicaria seed bank.

Summary: Samples of the top soil layers were taken at each of three Minnesota wetlands and combined. Greenhouse and outdoor experiments were conducted under conditions conducive to germination: absence of litter, competition, and standing water; high levels of light and temperature; seedling removal. Favorable greenhouse conditions resulted in a dense cover of L. salicaria seedlings, but removal of these seedlings with glyphosate did not result in a significant reduction in the seed bank. Also, although relatively shallow burial prevented germination of seeds, small soil disturbances led to further seed germination. Results suggest that encouraging recruitment of L. salicaria in wetlands is unlikely to exhaust the seed bank. Thus, eliminating new populations of L. salicaria should have priority over attempts to control older stands with well-established seed banks.

MECHANICAL CHEMICAL

Benedict, Jim (1990). Purple loosestrife control in Voyageurs National Park. Park Science 10(3):21-22.

Location: Voyageurs National Park in northeastern Minnesota.

Objective: To control purple loosestrife.

Summary: Since August 1988, park employees have been spraying dense stands of purple loosestrife twice during the summer with SEE-2,4-D. Any remaining flower stalks are cut and burned, and smaller plants around the edges of dense stands are removed by hand. Wetlands are monitored annually, showing that in three years, the plant densities have decreased by 95%, and the plants making up the stands are mostly one year old. This method, along with varying the herbicide to reduce resistance, should in time deplete the seed bank and mostly eliminate purple loosestrife.

Malecki, Richard A. and Thomas J. Rawinski (1985). New methods for controlling purple loosestrife. New York Fish and Game Journal 32(1):9-19.

Location: Howland Island Wildlife Management Area in Cayuga County in central New York.

Objective: To test the efficacy of several methods of management of purple loosestrife.

Summary: Plots were established in stands of purple loosestrife, and the plants were subjected to several treatments between 1978 and 1980. The treatments were: mid- and late-summer cutting, flooding at different depths, application of two rates of glyphosate to plants at three stages of development, and sowing of competing plants near stands of loosestrife. Late-summer cutting reduced shoots significantly, but should be used with another method of control. Flooding appears to be useful only if a consistently high level of water is able to be maintained during the growing season. Glyphosate provided good control, especially when applied during July and August, and seeds from treated plants were about 50% less viable than those from untreated plants. Japanese millet and reed canarygrass appear to be capable of competing successfully with loosestrife seedlings, and Japanese millet is unlikely to become an agricultural weed (in the Northeast).

ADDITIONAL REFERENCES:

BIOCONTROL

Linehan, D. (1982). Bugging the weeds: a look at integrated pest management. U.S. Fish and Wildlife Service News, April/May:8-9.

Schwegman, J.E. (1993). Purple loosestrife biocontrol. Illinoensis 10(1):2.

CHEMICAL

McKeon, W.H. (1959). A preliminary report on the use of chemical herbicides to control purple loosestrife (Lythrum salicaria) on a small marsh. Proceedings of the Northeastern Weed Control Conference 13:329-332.

MECHANICAL

Novak, L.C. (1968). Mechanical control of purple loosestrife. Progress Report 1, Division of Refuges, Region 5, U.S. Fish and Wildlife Service.

MISCELLANEOUS

Carroll, D. (1994). Subduing purple loosestrife. Conservationist 49:6-9.

Gagnon, L.P. (1953). The control of purple loosestrife in La Commune at Baie du Febvre--1952. Proceedings of the Eastern Section of the National Weed Commission of Canada 6:135-136.

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Quebec, Ministere de l'Agriculture. 46 pp.

Rawinski, T.J. (1982). The ecology and management of purple loosestrife (Lythrum salicaria) in central New York. Masters dissertation, Cornell University, Ithaca, NY.

Smith, L.S. (1959). Some experiences with control of purple loosestrife at the Montezuma National Wildlife Refuge. Proceedings of the Northeast Weed Control Conference 13:333-336.

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Scientific Name: Melilotus alba
Common Name: White sweetclover
Family: Fabaceae
Location: MN MO KS NE SD ND WI
Control: Burning Mechanical

Habitat: Sweetclover can tolerate a wide variety of conditions, but cannot tolerate dense shade or flooded areas. Sweetclover can be found in abandoned fields, pastures, open prairies, on roadsides and railroad ballasts.

Detail: BURNING

Heitlinger, Mark E. (1975). Burning a protected tallgrass prairie to suppress sweetclover, Melilotus alba Desr. In: Prairie: A Multiple View, ed. Mohan K. Wali. University of North Dakota Press, Grand Forks. Pp. 123-132.

Location: Schaefer Prairie, a tallgrass prairie remnant in south central Minnesota.

Objective: To test hypotheses regarding the relationship between the densities of first- and second-year sweetclover and fire.

Summary: Three areas, A,B, and C, of sweetclover-infested prairie, were burned in spring of 1974, 1969, and 1973, respectively, and area C was burned again in early July of 1974. Densities of first- and second-year sweetclover individuals in the three areas were compared. Results indicate that early spring burning results in very high first-year sweetclover densities and very low second-year sweetclover densities in the same year. The latter is attributable to the fact that the second-year growth of the biennial sweetclover originates at the base of the stem, and thus is vulnerable to fire. Moreover, the burning in July eliminated both first- and second-year plants, with no sprouting or regrowth observed later in the season. Untested here, but supported in the literature, is the fact that an early fall burn between the first and second years of growth increases winterkill and decreases vitality of second-year plants.

BURNING MECHANICAL

Kline, Virginia M. (1986). Response of sweet clover (Melilotus alba Desr.) and associated prairie vegetation to seven experimental burning and mowing treatments. Proceedings of the Ninth North American Prairie Conference, July 29-August 1, 1984, pp. 149-152.

Location: Curtis Prairie, a 45-year-old restored tallgrass prairie in the University of Wisconsin Arboretum.

Objective: To test the efficacy of various burning and mowing schedules in controlling sweet clover in a restored prairie.

Summary: Plots were established in areas of tallgrass prairie infested with sweet clover, and quadrats were set up within the plots. The species present in the quadrats were recorded each year. The plots were subjected to various burning and mowing schedules over a number of years. The combination of an April burn followed the next year by a May burn was the most successful treatment. When this sequence was repeated after two years with no burning, the stands became almost completely free of sweet clover. Native prairie forbs displayed some loss of vigor and frequency in the same plots in which sweet clover was controlled, but were probably in no danger unless treatments were carried out over a long period of time.

Schwarzmeier, J.A. (1984). Sweet clover control in planted prairies: refined mow/burn prescription tested (Wisconsin). Restoration & Management Notes 2(1):35.

Location: Four sites on young planted prairie in southern Wisconsin.

Objective: To document the elimination of sweet clover (Melilotus alba) through shading out by competing vegetation combined with burning or mowing treatments.

Summary: Quadrats were staked out in a densely vegetated young prairie, in areas were second-year sweet clover was dominant. Plots were burned, mowed or left alone in May 1982, and cover was estimated in July of the same year. Resulting cover was 4.8%, 6.6% and 90.9%, respectively, suggesting the following tactics for controlling sweet clover reproduction: (1) note the earliest date that the stem bases receive full shade and burn 7-10 days after this date, or (2) Mow at 3-5 cm one to five weeks after the full-shade date.

MECHANICAL

Parker, Ingrid M., Shoshana K. Mertens, and Douglas W. Schemske (1993). Distribution of seven native and two exotic plants in a tallgrass prairie in southeastern Wisconsin: the importance of human disturbance. The American Midland Naturalist 130(1):43-55.

Location: Chiwaukee Prairie, a tallgrass prairie just north of the Wisconsin-Illinois border.

Objective: To determine correlations between densities of native and exotic prairie species and levels of disturbance in a tallgrass prairie.

Summary: Five transects were established in four separate regions of the prairie; three were established in areas considered undisturbed, and two in disturbed areas. The number of inividuals of seven native and two exotic species, including Melilotus alba, were recorded for each transect. The two exotic species were found almost exclusively in the disturbed sections of the prairie, and were the only species significantly and postively correlated with potassium, phosphorus, pH, and moisture. The densities of the two exotics were also strongly positively correlated, whereas the exotics were not positively correlated with the natives. Results suggest that altered drainage patterns and higher mineral content and pH of disturbed areas such as the roadbed in this study are more favorable to exotics such as M. alba than to native species. This further suggests that further disturbance of disturbed areas may be necessary to control exotic species and restore prairie to its original state.

ADDITIONAL REFERENCES:

BIOCONTROL

Craig, C.H. (1978). Damage potential of the sweetclover weevil Sitona cyulindricollis (Coleoptera:Curculionidae) in the Canadian

prairies. Canadian Entomology 110:883-889.

MECHANICAL

Smith, D. and L.F. Graber (1948). The influence of top growth removal on the root and vegetative development of biennial sweetclover. Journal of the American Society of Agronomy 40:818-831.

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Scientific Name: Poa pratensis
Common Name: Kentucky bluegrass
Family: Poaceae
Location: NE IA MN MO KS SD ND WI AB
Control: Burning Mechanical Chemical Grazing

Habitat:

Detail: BURNING

Curtis, John T. and Max L. Partch (1948). Effect of fire on the competition between blue grass and certain prairie plants. The American Midland Naturalist 39:437-443.

Location: Old cultivated field planted to prairie plants at the University of Wisconsin Arboretum in Madison.

Objective: To study the effects of fire on prairie plants and non-native sod.

Summary: Between 1941 and 1946, experimental plots were burned annually, either in March, May, or October. May burning of Kentucky bluegrass considerably reduced fruiting stems of the grass, but burning generally resulted in little change in number of fruiting stems. Total density of bluegrass sod, however, was reduced to less than one-fifth of the original after six years of burning.

Engle, D.M. and P.M. Bultsma (1984). Burning of northern Mixed Prairie during drought. Journal of Range Management 37(5):398-401.

Location: Samuel H. Ordway Memorial Prairie in north-central South Dakota.

Objective: To evaluate the response of prairie species on two soil types to two burning times during drought years.

Summary: In 1980, treatment plots were

established on two native range sites in which Kentucky bluegrass (Poa pratensis) was a major component. During the spring of 1980 and 1981, experimental plots were burned either before warm-season grasses had emerged or after they had reached a height of 5-10 cm. Burning at both dates reduced Kentucky bluegrass on both sites, but it also reduced a native cool-season grass and did not positively affect dominant warm-season species on the site with silty soil. Burning after emergence of warm-season grasses reduced the yield of these grasses.

Hensel, R.L. (1923). Recent studies on the effect of burning on grassland vegetation. Journal of Range Management 4(2):183-188.

Location: Kansas prairie.

Objective: To determine the effects of burning on various characteristics of a Kansas grassland.

Summary: A section of Kansas prairie was divided into two parts. One was burned in spring of each year from 1918 to 1921, the other was unburned. Data was collected to determine the effect on the principal forage plants. Kentucky bluegrass increased more than any other species on the unburned area, essentially taking over the unburned plot, and 250% on the burned area.

Towne, Gene and Clenton Owensby (1984). Long-term effects of annual burning at different dates in ungrazed Kansas tallgrass prairie. Journal of Range Management 37(5):392-397.

Location: Tallgrass prairie in the Kansas Flint Hills north of Manhattan, Kansas.

Objective: To determine the long-term effects of date of annual burning on Kansas tallgrass prairie.

Summary: For 56 years, experimental plots in ungrazed tallgrass prairie have been burned annually at four different dates. The burning dates were late-spring, winter, early-spring, and mid-spring; control plots were unburned. The cumulative data indicates that Kentucky bluegrass (Poa pratensis) was reduced by burning at all dates, and that this grass was eliminated in the unburned plots by the heavy accumulation of mulch.

Zedler, Joy and Orie L. Loucks (1969).

Differential burning response of Poa pratensis fields and Andropogon scoparius prairies in central Wisconsin. The American Midland Naturalist 81(2):341-352.

Location: A marsh on the central Wisconsin sand plains, drained and converted to agricultural uses 50 years before the study.

Objective: To assess the responses to fire of native and non-native plant species on the site of a drained marsh, characterized by complexes of low ridges and depressions.

Summary: Plots were established in areas of bluegrass field and dry prairie, both on ridges and in depressions. Different plots were burned in April and in August of 1966. Plots were again burned in April of 1967. Data indicate that local site conditions are the most important variables for determining differences between stands. Production of Kentucky bluegrass growing in depressions was stimulated by burning, and all vegetation was harmed by burning on the ridges. A. scoparius seed production was stimulated by burning, however, suggesting that periodic burning would eventually allow native grasses to out-compete bluegrass at all topographic levels.

BURNING CHEMICAL

Masters, Robert A., Kenneth P. Vogel, and Robert B. Mitchell (1992). Response of Central Plains Tallgrass Prairies to fire, fertilizer, and atrazine. Journal of Range Management 45:291-295.

Location: Three tallgrass prairie sites in eastern Nebraska.

Objective: To determine the effect on the grassland community of burning and application of fertilizer and atrazine.

Summary: In three studies carried out from 1987 to 1989, experimental plots established in good to excellent grassland, were treated with various combinations of spring burning, fertilizer application and atrazine application. Non-native cool-season grasses, including Poa pratensis, were minor components of these grasslands. The combination of burning and fertilizer application had the greatest positive effect on the growth of native warm-season grasses, while the application of atrazine had a negative effect on the non-native cool-season grasses, mainly P. pratensis, while not affecting the native warm-season grasses.

BURNING GRAZING

Hartnet, D.C., K.R. Hickman and L.E.F. Walter (1996). Effects of Bison Grazing, Fire, and Topography on Floristic Diversity in Tallgrass Prairie. Journal of Range Management, 49(5): 413-420.

Location: Konza Prairie Research Natural Area in the Flint Hills region of northeast Kansas.

Objective: To assess the effects of bison grazing on the composition and biodiversity of tallgrass prairie plant communities in sites of contrasting prescribed fire regimes and topographical positions.

Summary: The study sites were located in both upland and lowland sites in an area that has been burned annually or every 4-years since the mid-1970's. There was an observed increase in plant diversity and mean plant species richness in sites grazed by bison. This effect was greater in annually burned sites compared to sites burned on 4-year intervals. The response to grazing, fire frequency, and topography varied per plant species. Sites grazed by bison were consistently higher in cool-season graminoids (including Poa pratensis, Agropyron smithii, and Carex spp.) than ungrazed exclosures.

BURNING MECHANICAL

Diboll, Neil (1986). Mowing as an alternative to spring burning for control of cool season exotic grasses in prairie grass plantings. Proceedings of the Ninth North American Prairie Conference, July 29-August 1, 1984, pp. 204-209.

Location: Prairie remnant in the University of Wisconsin-Green Bay Cofrin Memorial Arboretum.

Objective: To compare the effectiveness of mowing and burning for control of cool season grasses and promotion of native warm season grasses.

Summary: Five warm season grasses were planted in the study areas in 1974. In May of 1980, treated plots were either mowed and raked or burned. Burning reduced total cool season grass production 78%, and mowing averaged a 48% reduction. Kentucky bluegrass appeared to be reduced by both mowing and burning.

Hover, Edward I. and Thomas B. Bragg (1981). Effect of season of burning and mowing on an eastern Nebraska Stipa-Andropogon prairie. The American Midland Naturalist 105(1):13-18.

Location: Hover Prairie, a native prairie in eastern Sarpy County, Nebraska.

Objective: To evaluate the effects of the timing of burning or mowing on the health and species composition of native prairie.

Summary: Three plots were established at each of three locations at the study site. In April of 1978, one group of plots was mowed, and the vegetation removed, one group was burned, and one was left, to simulate a late summer mowing treatment. Two analyses were conducted, one in June and one in August, to determine canopy cover and individual plant development. Results indicate that spring mowing and burning are similar in their effects, and that they are superior to summer mowing in maintaining the native warm-season grasses over non-native cool-season grasses. Poa pratensis, one such cool-season grass, averaged lower cover in the plots burned in the spring, though apparently it was unaffected by mowing.

Richards, Mary S. and R.Q. Landers (1973). Responses of species in Kalsow Prairie, Iowa to an April fire. Proceedings of the Iowa Academy of Science 80:159-161.

Location: Tallgrass prairie and old pasture in northwest Iowa.

Objective: To assess the effect of timing of burning or mowing on cover values, dry weight and flowering response of prairie species.

Summary: One strip of prairie was burned and one strip was mowed in April of 1968. A total of thirty plots were established within the mowed burned and untreated areas of prairie. Samples and cover values were taken in June, July and August. Dry weight, cover, and number of inflorescences of Poa pratensis was reduced, whereas most other plants were unaffected or enhanced by the burn treatment. Mowing had an effect similar to burning on flowering of P. pratensis.

BURNING MECHANICAL GRAZING

Ehrenreich, John H. and John M. Aikman (1963). An ecological study of the effect of certain management practices on native prairie in Iowa. Ecological Monographs 33:113-130.

Location: Hayden Prairie in Howard County in northeastern Iowa; a prairie in which Poa pratensis was found in high freqencies.

Objective: To learn about the effects on the prairie of burning, mowing, grazing, and protection.

Summary: The study began in 1954, when the Hayden Prairie had been under protection for 9 years. In early spring of 1954, 1955, and 1956, experimental plots were burned, the result being that by 1956, some plots had been burned once, some twice and some three times. In 1955 and 1956, unburned sections of prairie were mowed. Additional plots were clipped repeatedly during or only once at the end of the growing season, to simulate grazing. The frequency and abundance of Poa pratensis decreased considerably with each burn. P. pratensis was not affected as much as native species by the frequent clipping treatments done to simulate heavy grazing. The results of this study indicate that annual early spring burning and mowing once at the end of the growing season are good methods for the control of Kentucky bluegrass in native Iowa prairie.

COMPETITION

Silvertown, J., C.E.M. Lines and M.P. Dale (1994). Spatial Competition Between Grasses, Rates of Mutual Invasion Between 4 Species and the Interaction With Grazing. Journal of Ecology, 82(1): 31-38.

Location: Little Wittenham Nature Reserve, Abingdon, Oxfordshire, England.

Objective: To test the invasion rates of 4 grasses (including Poa pratensis) and the effect grazing has on these rates.

Summary: The study site was split into plots and each plot was planted with one of four grasses (Festuca rubra, Festuca arundinaceae, Lolium perenne, and Poa pratensis). The plots were positioned adjacent to each other so that the invasibility (susceptibility to invasion as well as ability to invade neighbors) of each species could be assessed over this 2-year study. Tiller number was the criteria by which a plant's performance was judged. Some of the plots were grazed. Grazing was regulated every week by adjusting the grazing pressure to maintain a sward height of 3- or 9-cm. Three grazing periods were used: winter (1 November - 21 March), spring (21 March - 21 May), and summer (21 May - 1 November). Poa pratensis rate of invasion into plots of 3 other grasses appeared to be the same regardless of the identity of neighboring grass or treatment (timing and intensity of grazing).

CHEMICAL

Waller, S.S. and D.K. Schmidt (1983). Improvement of eastern Nebraska tallgrass range using atrazine or glyphosate. Journal of Range Management 36(1):87-90.

Location: Overgrazed rangeland in Gage County, southeastern Nebraska.

Objective: To evaluate atrazine and glyphosate for suppression of exotic grasses and promotion of native plant species.

Summary: Research plots were treated in April of 1979. Subsequent sampling indicated that both atrazine and glyphosate treatments reduced Kentucky bluegrass populations dramatically, and the reduction was maintained throughout the second growing season after treatment. Native species populations increased correspondingly.

MECHANICAL CHEMICAL

Vanden Born, W.H. (1965). The effect of dicamba and picloram on quackgrass, bromegrass and Kentucky bluegrass. Weeds 13:309-312.

Location: Greenhouse and field plots at the University of Alberta, Edmonton, Alberta.

Objective: To evaluate the responses of bromegrass, quackgrass and Kentucky bluegrass to picloram and dicamba applied at various rates and under various conditions and to assess the importance of rhizome depth in relation to herbicide effectiveness.

Summary: Several experiments were carried out in the course of this study. Young stands of Kentucky bluegrass were grown in the greenhouse and clipped to a height of 4 cm. Five lb/A dicamba had little effect on dry weight, but 10 lb/A dicamba reduced dry weight almost by half. Clipping to less than 1 cm before application of 1, 5 and 10 lb/A resulted in dry weight reductions of 18, 80 and 93%.

ADDITIONAL REFERENCES:

BURNING

Hadley, Elmer B. and Barbara J. Kieckhefer (1963). Productivity of two prairie grasses in relation to fire frequency. Ecology 44(2):389-395.

Graber, L.F. (1926). Injury from burning off old grass on extablished bluegrass pastures. Journal of the American Society of Agronomy 18:815-819.

CHEMICAL

Bingham, S.W., J. Segura, and C.L. Foy (1980). Susceptibility of several grasses to glyphosate. Weed Science 28:579-585.

MECHANICAL

Youngner, V.B., F. Nudge, and R. Ackerson (1976). Growth of Kentucky bluegrass leaves and tillers with and without defoliations. Crop Science 16:110-113.

MECHANICAL CHEMICAL

Ackerson, R.C. and D.O. Chilcote (1978). Effects of defoliation and TIBA (triiodobenzoic acid) on tillering, dry matter production, and carbohydrate reserves of two cultivars of Kentucky bluegrass. Crop Science 18:705-708.

MISCELANEOUS

Reader, R.J., Bonser, S.P. 1993. Control of Plant Frequency on an Environmental Gradient of Abiotic Variables, Neighbors, and Predators on Poa pratensis and Poa compressa. Canadian Journal of Botany, 71:4, 592-597.

Location: Abandoned pasture near Guelph, Ontario, Canada. Rolling hills ungrazed since 1969.

Objective: To measure the effects of 3 factors on the performance of seeds or plants across an environmental gradient. The three factors were:
1. Abiotic variables
2. Neighbors

3. Predators.

Summary: Poa pratensis and Poa compressa were grown on hills and hollows and exposed to abiotic variables with or without the presence of neighbors and or predators. Neighbors and abiotic variables were found to be more influential on seedling development than predators. In hollows the removal of neighbors increased seedling establishment of both species, but little difference was noted on ridgetops where litter and vegetation, as well as soil moisture and nutrients content, are lower. Predation on Poa spp. was insignificant; a fact that the author, and others, attribute to the small size of the seed. Abiotic factors proved to be an important control of P. pratensis tillers. Where neighbors were removed and predators excluded, P. pratensis tiller production increased in hollows, but was lower on ridgetops. This again was attributed to the difference in soil moisture and soil fertility.

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Scientific Name: Phalaris arundinacea
Common Name: Reed canary grass
Family: Poaceae
Location: WA
Control: Mechanical Chemical

Habitat: Reed canary grass occurs in wet habitats, such as wetlands, wet prairies, fens, and stream banks. It has been widely planted for forage and erosion control.

Detail: BURNING MECHANICAL CHEMICAL

Henderson, Richard A. (1990). Controlling reed canary grass in a degraded oak savanna (Wisconsin). Restoration and Management Notes 8(2):123-124.

Location: Degraded oak savanna in south-central Wisconsin.

Objective: To study ways to control reed canary grass.

Summary: A number of methods were used in an attempt to control or eliminate reed canary grass. The methods used were: early and late spring burning, hand-pulling, applications of glyphosate, and application of black plastic. Late spring burning is quite effective in weakening reed canary grass, although early spring burning seems to accelerate its spread. Hand-pulling is effective if carried out several times a year over a five-year period. Killing of monospecific stands with glyphosate or black plastic is effective if continued for at least three years, followed by seeding to native plants.

Preuninger, Jill S. and Charles E. Umbanhowar, Jr. (1994). Effects of burning, cutting, and spraying on reed canary grass studies (Minnesota). Restoration and Management Notes 12(2):207.

Location: Reed canary grass-infested wetland on the St. Olaf College campus.

Objective: To evaluate various control measures for control of reed canary grass.

Summary: Experimental plots were established in a previously cultivated wetland overgrown with reed canary grass. Treatments, which were burning, cutting, burning and spraying, and cutting and spraying, were begun in June of 1993. Cutting was to a height of 5 cm, continued every two weeks until mid-August, and was followed by removal of the clippings. The herbicide used was a formulation of glyphosate for aquatic applications. Results indicate that periodic herbicide application is the most effective control method, and that the other treatments serve mostly to increase germination of reed canary grass seedlings.

CHEMICAL

Comes, Richard D., Louis Y. Marquis, and Allen D. Kelley (1981). Response of seedlings of three perennial grasses to dalapon, amitrole, and glyphosate. Weed Science 29:619-621.

Location: Research plots at the Irrigated Agriculture Research and Extension Center, Prosser, Washington.

Objective: To evaluate three postemergence herbicides for control of reed canarygrass, redtop, and creeping red fescue.

Summary: The herbicides dalapon, amitrole + ammonium thiocyanate, and glyphosate were applied to new grass plantings four times throughout the growing seasons of 1975 and 1977. Reed canarygrass was most susceptible to herbicides three weeks after seedling emergence, and became less susceptible thereafter, except for glyphosate at the highest rate. Results indicate that a high rate of glyphosate applied five to ten weeks after seedling emergence, or higher rates of amitrole + ammonium thiocyanate applied three weeks after seedling emergence would be effective for reduction of reed canarygrass stands.

MECHANICAL CHEMICAL

Lyford, Mark (1993). Reed canary grass controls tested (Minnesota). Restoration and Management Notes 11(2):169.

Location: A small wetland on the campus of St. Olaf College in Northfield, Minnesota.

Objective: To test methods of control of reed canary grass.

Summary: In May of 1992, five treatments were applied to homogeneous plots of reed canary grass. The treatments were (1) cutting to 8 cm every two weeks and leaving clippings on plots, (2) cutting and removing clippings, (3) spraying with glyphosate once, (4) spraying with glyphosate once and cutting two weeks after spraying, and (5) no treatment. All stem counts decreased in treated plots. Stems in clipping treatments decreased to similar levels, and stems in spraying treatments were eliminated. Glyphosate is effective for eliminating reed canary grass, but treated areas would have to be monitored for new growth.

ADDITIONAL REFERENCES:

CHEMICAL

Bruns, V.F., R.R. Yeo, and W.D. Boyle (1963). Reed canary grass control with amitrol, dalapon, and MH formulations. Western Weed Control Conference Research Progress Report. 62 pp.

Comes, R.D. (1974). Control of reed canarygrass on ditchbanks with glyphosate. Abstracts, Weed Science Society of America, p. 116.

Fisher, R. and J.S. Faulkner (1975). The tolerance of twelve grass species to a range of foliar-absorbed and root-absorbed grass-killing herbicides. Proceedings of the the European Weed Research Society Symposium, pp. 204-215.

Hodgson, J.M. (1968). Chemical control of reed canarygrass on irrigation canals. Weeds 16:465-468.

Marquis, L.Y., R.D. Comes, and C.P. Yang (1979). Selectivity of glyphosate in creeping red fescue and reed canarygrass. Weed Research 19:335-342.

Marquis, L.Y, R.D. Comes, and C. Yang (1984). Relative tolerance of desert saltgrass (Distichlis stricta) and reed canary grass (Phalaris arundinacea) to boron. Weed Science 32:534-538.

Newbold, C. (1975). Herbicides in aquatic systems. Biological Conservation 7:97-118.

MISCELLANEOUS

Bruns, V.F. (1973). Studies on the control of reed canarygrass along irrigation systems. Agriculture Research Service, U.S. Department of Agriculture publication ARS-W-3, 17 pp.

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Scientific Name: Rhamnus cathartica
Common Name: Common buckthorn
Family: Rhamnaceae
Location: IA MN ND
Control: Burning Mechanical Chemical

Habitat: Common buckthorn inhabits pastures, fencerows, slopes of ravines, and also invades open woodlands, prairie thickets, and disturbed forest edges. It prefers good sunlight and tolerates many soils.

Detail: BURNING MECHANICAL CHEMICAL

Archibold, O.W., D. Brooks and L. Delanoy (1997). An Investigation of the Invasive Shrub European Buckthorn, Rhamnus cathartica Location: Saskatoon area, Saskatchewan, Canada.
L., Near Saskatoon, Saskatchewan. Canadian Field Naturalist, 111(4): 617-621.

Objective: To report on the biology, ecology, and control of European Buckthorn.

Summary: This paper describes the habitat and distribution of Rhamnus cathartica in the Saskatoon area. The authors conducted a number of experiments and reported on the following six aspects of buckthorn:

1. Age class distribution: Their study in age class distribution showed that once a few pioneering individuals are established, ensuing seedling growth is vigorous and abundant. In a survey conducted by the authors the oldest buckthorn was 56 years old.

2. Fruit fall: traps were placed at 1, 2, 3, and 4 meters along each of three transects radiation from the base of each tree used in the study. Approximately 90% of the buckthorn seeds collected in seed traps fell directly beneath the canopy of the parent tree.
3. Factors affecting germination: Seeds do not germinate until extracted from the berry. Seedlings emerged at a mean of 42 days. Prolonged immersion of seeds in water prior to sowing has some impact on germination. Seeds immersed 2 weeks showed a slight drop in germination rate, and seeds immersed 2 months did not germinate at all.
4. Seedling numbers and seedbank: In their survey the average number of seedlings was 110.8 ± 16.0 m-2 in the spring and 123.7 ± 19.0 m-2 late in the growing season. Viable seedlings counted in the top 10-cm of soil under mature buckthorn trees was 620 m-2 and had a mean emergence of 28 days. Buckthorn seedlings dominated the understory at these research sites.
5. Allelopathic effects: The approach was to treat seeds with soil leachate from soils that supported buckthorn. In germination experiments conducted on tomato, lettuce, and radish all species exhibited a high germination rate after imbibition with the leachate. No interference with germination was detected. These experiments were limited. They did not consider the effects from leaf canopy or the germination and emergence of native plants.
6. Management: cutting and treating stumps with round-up proved to be the most effective method of buckthorn control in their study. They compared round-up to "Killex" but the latter did not perform well. Fire treatment was performed once with a torch held to the cambium for 2 to 3 minutes at an approximate temperature of 1000°C (much hotter and longer than the average controlled fire). Fire treated stems showed vigorous re-growth the following year. Treatment with garlon-4 was promising: Stems were sprayed on one side at about 30-cm above ground level. The application can be made during stem dormancy. The result was curtailed growth in 70% of treated stems, and retarded growth in the remaining 30%.

Boudreau, Denise (1992). Buckthorn research and control at Pipestone National Monument (Minnesota). Restoration and Management Notes 10(1):94.

Location: Riparian woods and oak savannas at Pipestone National Monument in southwestern Minnesota.

Objective: To test various methods for control of buckthorn.

Summary: In 1984 buckthorn was cut at ground level and treated with ammonium sulfate, which only prevented 25% of the plants from suckering. Diluted Garlon 3A was sprayed on a plot of buckthorn foliage, killing only part of the plant, while undiluted Garlon 3A used as a cut stump treatment killed 95% of the plants. Spring burning was found to kill the top part of the plant, but resprouting did occur.

MECHANICAL

Gourley, Linda Coenen (1985). A Study of the Ecology And Spread of Buckthorn (Rhamnus cathartica L.) with Particular Reference to the University of Wisconsin Arboretum. Thesis, University of Wisconsin-Madison, pp. 139-146.

Location: The wetland area of Balden-Capitol Avenue Marsh in Wisconsin.

Objective: To test double-cutting as a method of control of common buckthorn.

Summary: In June of 1982, randomly selected buckthorn plants were single-cut at a height of 36", and an additional number were single-cut and then cut at the base of the stem four hours later. In the summer of 1984, live resprouts from the treated plants were counted. Single-cutting was 27% effective in killing buckthorn plants, whereas double-cutting was 47% effective. The increased cutting time would have to be taken into account in applying this method.

MECHANICAL CHEMICAL

Apfelbaum, Steven I. (1984). Buckthorn control with herbicide tested (Illinois). Restoration and Management Notes 2(1):36.

Location: Oak-hickory forest of the Grove Nature Preserve, Glenview, Illinois.

Objective: To test the effectiveness of various concentrations of herbicide in controlling buckthorn.

Summary: Aqueous solutions of the herbicide Ortho A, ranging from concentrations of 10 to 100 percent, were applied to freshly cut stumps of buckthorn. The lowest effective concentration of 40% killed 87.5 percent of the test plants. Surrounding native plants suffered no conspicuous injury.

Chapman, Kim Alan (1983). Glyphosate tested for control of several woody species in railroad strip prairies (Michigan). Restoration and Management Notes 1(3):27-28.

Location: Bakertown and Lawton Amtrak Preserves, prairie preserves in southwest Michigan.

Objective: To test cutting, girdling and Roundup application for control of invading woody species in the prairie preserves.

Summary: Buckthorn shrubs were cut in midsummer; some leafy stems were left. A 10% solution of Roundup was sprayed on the cut stump and on the leaves. Two months later, all buckthorn stems had sprouted.

Glass, Steve (1994). Experiment finds less herbicide needed to control buckthorn (Wisconsin). Restoration and Management Notes 12(1):93.

Location: The Leopold Pines, a forest re-creation at the University of Wisconsin-Madison Arboretum.

Ojective: To test the efficacy of lower-than-recommended rates of herbicide application in controlling common buckthorn.

Summary: Plots were established for two experimental treatments using 6% Garlon 4 herbicide, less than the recommended 20-30%. In one treatment, the basal bark of 36 common buckthorn plants was sprayed with the herbicide. In the other, 41 plants were cut, and the herbicide was dribbled onto the cut surface to cover. The basal bark treatments were 97% effective, whereas the cut stump treatments were considerably less effective at the lower herbicide rate.

Hefty, Russell (1984). Buckthorn control with 2,4-D/2,4-DP (Wisconsin). Restoration and Management Notes 2(1):36.

Location: Sandburg Woods, a 8-ha oak-hickory woodlot in Wisconsin.

Objective: To test the effectiveness of the herbicide Weedone 170 in controlling buckthorn.

Summary: In September 1981, 40g of the herbicide Weedone 170 per liter of diesel fuel was applied to all exposed bark of cut buckthorn bushes. One year later, the kill rate was found to be 96 percent, and no damage was found to nontarget species.

Kline, Virginia (1984). Control of honeysuckle and buckthorn in oak forests (Wisconsin). Restoration & Management Notes 1(1):18.

Location: Oak woods at the University of Wisconsin Arboretum.

Objective: To test the effectiveness of different herbicide rates combined with cutting in controlling buckthorn.

Summary: In late summer and fall, when most native species were entering dormancy, Roundup was applied in 1:1 and 1:5 concentrations to freshly cut stumps of 144 large buckthorn bushes. Mortality rates for 144 large buckthorn individuals were 94.6 percent and 100.0 percent for the 1:1 and 1:5 concentrations, respectively. Data indicate that ground layer plants were not adversely affected by the treatment.

ADDITIONAL REFERENCES:

BIOCONTROL

Malicky, H., R. Soghian, and H. Zwolfer (1970). Investigations on the possibilities of a biological control of Rhamnus cathartica in Canada. Zeitschrift fuer Angewandte Entomologie 65:77-97.

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Scientific Name: Rosa multiflora
Common Name: Multiflora rose
Family: Rosaceae
Location: IA MO OH
Control: Chemical

Habitat: Multiflora rose inhabits roadsides, pastures, prairies, old fields, and open forests. It has a wide tolerance for soil, moisture and light conditions, avoiding standing water and preferring more moderate temperatures.

Detail: CHEMICAL

Creswell, John L. and Richard S. Fawcett (1981). Multiflora rose control in eastern Iowa. Proceedings of the North Central Weed Control Conference 36:43-45.

Location: Multiflora rose-infested pasture in four counties in eastern Iowa.

Objective: To test and demonstrate the efficacy of various herbicide treatments for control of multiflora rose.

Summary: Several herbicide treatments were applied to blocks of multiflora rose shrubs in May of 1981; an additional experiment was conducted in July of 1981. 2,4,5-T + 2,4-D and triclopyr, applied as foliar sprays, gave complete control at most sites. Picloram 10G applied to the soil also provided complete control at all locations.

Stroube, Edward W. and John F. Underwood (1981). Multiflora rose control in Ohio. Proceedings of the North Central Weed Control Conference 36:74-76.

Location: Multiflora rose-infested areas in southeastern Ohio.

Objective: To evaluate herbicide treatments for control of multiflora rose.

Summary: Several herbicide trials were conducted between 1971 and 1980, involving treatment of multiflora rose growing in hedgerow situations. Several different herbicides were applied, either in spray or pellet form, individually or in combination. Picloram (22K), glyphosate, picloram (101), and triclopyr (3A) + picloram (22K) all gave excellent topkill and regrowth prevention, as well as having little effect on surrounding vegetation.

ADDITIONAL REFERENCES:

BIOCONTROL

Hindal, D.F. and S.M. Wong (1988). Potential biocontrol of multiflora rose, Rosa multiflora. Weed Technology 2:122-131.

CHEMICAL

Albaugh, G.P., W.H. Mitchell, J.C. Graham (1977). Evaluation of glyphosate for multiflora rose control. Proceedings of the Northeast Weed Science Society 31:283-291.

Coartney, J.S. (1977). Foliar and soil-applied herbicides for the control of multiflora rose. Proceedings of the Southern Weed Science Society 30:323-325.

Derr, J.F. (1989). Multiflora rose (Rosa multiflora) control with metsulfuron. Weed Technology 3:381-384.

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MISCELLANEOUS

Barbour, B.M. and J.A. Meade (1980). Control of multiflora rose in pastures. Proceedings of the Northeast Weed Science Society 40:241.

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Lloyd, C.H. and G.W. Eley (1955). Multiflora rose eradication. Journal of Soil and Water Conservation 10(2):78-80, 99.

Underwood, J.F. and E.W. Stroube (1986). Multiflora rose control. Cooperative Extension Service, Leaflet #303. Ohio State University, Columbus, OH. 8 pp.

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Scientific Name: Rumex crispus
Common Name: Curly dock
Family: Polygonaceae
Location: NE IA MN MO KS SD ND UK CT SW
Control: Biocontrol

Habitat:

Detail: BIOCONTROL

Bentley, S. and J.B. Whittaker (1979). Effects of grazing by a Chrysomelid beetle, Gastrophysa viridula, on competition between Rumex obtusifolius and Rumex crispus. Journal of Ecology 67:79-90.

Location: Greenhouse at Lancaster University, Lancaster, England.

Objective: To study competition between Rumex obtusifolius and R. crispus, especially as affected by grazing by G. viridula.

Summary: Various experiments were conducted to examine species preference of G. viridula; effect of simulated grazing on each plant species and the competition between them; effect of grazing on each species individually; effect of grazing on each species' root:shoot ratio; and interspecific interactions and the effect of grazing thereupon. One important result is that this study suggests that R. crispus is apparently more vulnerable to grazing by the beetle, especially in the presence of R. obtusifolius, and that G. viridula apparently prefers R. obtusifolius to R. crispus.

DeGregorio, R.E., R.A. Ashley, R.G. Adams, Jr., F.A. Streams, and C.W. Schaefer (1991). Biocontrol potential of Hypera rumicis (L.) (Coleoptera:Curculionidae) on curly dock (Rumex crispus L.). Journal of Sustainable Agriculture 2(1):7-24.

Location: Greenhouses at the University of Connecticut, Storrs, CT.

Objective: To study effects of Hypera rumicis on curly dock and related crop plants under various conditions.

Summary: Four greenhouse experiments were performed, which brought the weevil H. rumicis together with curly dock plants under various conditions. Two experiments tested the weevil on the related crop plants rhubarb and buckwheat. The results of the experiment showed that curly dock was readily colonized by H. rumicis, which reproduced naturally on this plant. Infested plants were severely damaged and seed yield and biomass were greatly reduced. Rhubarb and buckwheat were only lightly fed upon, and the weevil failed to complete its life cycle on rhubarb.

Hatcher, P.E., N.D. Paul, P.G. Ayres and J.B. Whittaker (1994). Interactions between Rumex spp., herbivores and a rust fungus: Gastrophysa viridula grazing reduces subsequent infection by Uromyces rumicis. Functional Ecology 8(2):265-272.

Location: Laboratory and growth chambers in Lancaster, UK.

Objective: To study the interactions between and the effects on the plant of two parasites of curly dock, a rust fungus and a beetle.

Summary: Rumex crispus seeds were germinated and grown in growth chambers. Four studies examined: (1) interactions between the beetle (Gastrophysa viridula) and the rust (Uromyces rumicis) on curly dock by fungal inoculation of dock leaves and subsequent grazing by beetle larvae, or vice versa; (2) the effect of beetle damage on rust infection more specifically, by inoculation of grazed areas of dock leaves with rust spores; (3) the effect of artificial "beetle" damage on rust infection, by punching holes in the leaves and inoculating them with rust spores; and (4) the effect of artificial damage on rust infection in the field. Previous inoculation with rust spores had no significant effect on grazing by the beetle. Previous grazing had a large effect on rust infection, apparently preventing infection near the beetle-damaged areas and elswhere on the same and different leaves, to lesser extents. Artificial damage produced the same effects, to a lesser extent than actual beetle damage, in the laboratory and in the field. These results are important to keep in mind when designing biocontrol programs for Rumex crispus.

Schubiger, F.X., G. Defago, H. Kern, and L. Sedlar (1986). Damage to Rumex crispus L. and Rumex obtusifolius L. caused by the rust fungus Uromyces rumicis (Schum.) Wint. Weed Research 26(5):347-350.

Location: Greenhouse in Switzerland.

Objective: To study the influence of the rust fungus Uromyces rumicis on the development of Rumex crispus and R. obtusifolius under greenhouse conditions.

Summary: Rumex spp. seeds were sown in pots in the greenhouse. One group was inoculated five times with a spore suspension over 50 or 74 days, at which times half of the total number of plants were harvested. All treated plants sustained heavy damage. Seed yield was greatly reduced, and seeds produced weaker plants. Only 43% of treated plants with severe damage showed any new growth the following spring. Rumex crispus suffered more damage than R. obtusifolius, making this rust a likely candidate for a biocontrol agent for curly dock.

Whittaker, J.B. (1982). The effect of grazing by a chrysomelid beetle, Gastrophysa viridula, on growth and survival of Rumex crispus on a shingle bank. Journal of Ecology 70:291-296.

Location: A shingle bank of the River Lune, near Lancaster, England.

Objective: To test the possibility that grazing by G. viridula was the reason for the low density of R. crispus on a river bank.

Summary: Rumex crispus plants were raised from seed and transplanted to the shingle bank in May of 1978. Two female beetles were transferred to each R. crispus plant, except for those in the control group, which were kept free of the beetle. Dry weights of the plants were determined in June and September, at the end of the first and third generations of the beetle, respectively. This experiment was repeated in 1980, in which generations 1 and 2 were assessed. The missing generations were eliminated by flooding. Shoot and root dry weights of R. crispus were significantly reduced by G. viridula. The beetle damage, combined with natural flooding of the shingle bank, led to only 37% survival of the grazed plants, whereas 74% of control plants survived. R. crispus is apparently quite susceptible to the weakening effects of grazing by G. viridula.

ADDITIONAL REFERENCES:

BIOCONTROL

Julien, M.H., R.C. Kassulke, and K.L.S. Harley (1982). Lixus cribricollis (Coleoptera:Curculionidae) for biological control of the weeds Emex spp. and Rumex crispus in Australia. Entomophaga 27(4):439-446.

MISCELLANEOUS

Weaver, S.E. and P.B. Cavers (1979). Dynamics of seed populations of Rumex crispus and Rumex obtusifolius (Polygonaceae) in disturbed and undisturbed soil. Journal of Applied Ecology 16:909-917.

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Scientific Name: Salsola iberica
Common Name: Russian thistle
Family: Chenopodiaceae
Location: NE MN KS SD ND AB WA CA
Control: Chemical

Habitat: Russian thistle is found in cultivated fields, roadsides, waste places, fencerows, and along railroad tracks. It is more common on drier soils.

Detail: CHEMICAL

Adams, E.B. and D.G. Swan (1988). Broadleaf weed control in conservation reserve program (CRP) grass plantings. Research Progress Report of the Western Society of Weed Science, 1988, p. 367.

Location: A fall dormant seeding of crested wheatgrass and sheep fescue at Ritzville, WA.

Objective: To compare the efficacy of eleven herbicide treatments for control of broadleaf weeds in grassland.

Summary: Herbicides were applied in May of 1987 to experimental plots in CRP plantings. Visual evaluations were conducted at the end of June, 1987. Dicamba at 0.28 kg ai/ha provided 70% control of Russian thistle, but overall control of this weed was poor.

Blackshaw, R.E. (1990). Russian thistle (Salsola iberica) and kochia (Kochia scoparia) control in dryland corn (Zea mays). Weed Technology 4(3):631-634.

Location: Corn cropland at the Lethbridge Research Station, Lethbridge, Alberta, Canada.

Objective: To test the efficacy of various herbicides in controlling Russian thistle and kochia in corn.

Summary: Russian thistle seed was sown with corn in non-irrigated experimental plots. Dicamba, 2,4-D, bromoxynil, MCPA, or a combination were applied either preplant or postemergence, in June of three separate years. Results indicate that environmental conditions (i.e., moisture) of the growing season determines the most suitable treatment, as several different treatments offered good control. Atrazine and dicamba plus 2,4-D provided the most consistent postemergence control of Russian thistle.

Cudney, David W. and Steve B. Orloff (1988). Russian thistle, Salsola iberica, control in onion, Allium cepa. Weed Technology 2(3):375-378.

Location: Commercial onion fields in the high desert of southern California.

Objective: To test the efficacy of combinations of bromoxynil and oxyfluorfen in controlling Russian thistle in onion.

Summary: Experimental plots established in onion fields were treated with bromoxynil, oxyfluorfen, or both combined, once or twice in each of the 1985 and 1986 growing seasons. Results indicated that two applications, 14 days apart, were most effective when the second application was a combination of the two herbicides, with a higher ratio of bromoxynil. Applying the herbicides with a petroleum oil additive also increased effectiveness.

Young, Frank L. and Ralph E. Whitesides (1987). Efficacy of postharvest herbicides on Russian thistle (Salsola iberica) control and seed germination. Weed Science 35(4):554-559.

Location: Barley fields near Washtucna, Washington.

Objective: To determine the effect of various herbicides on Russian thistle, postharvest, and on germination of Russian thistle seed.

Summary: Dicamba, glyphosate, chlorsulfuron, paraquat, 2,4-D amine, metribuzin, bromoxynil, or a combination was applied on September 5 of 1983 and 1984. Control was evaluated later in the fall and the following spring. During the same time, seeds from treated plants were subjected to germination tests. Chlorsulfuron, glyphosate plus chlorsulfuron, paraquat and bromoxynil plus metribuzin each provided acceptable control, in the field trials. All applications reduced germination of seed except dicamba, dicamba plus glyphosate, and 2,4-D; chlorsulfuron had the greatest effect.

ADDITIONAL REFERENCES:

CHEMICAL

Young, F.L. and D.R. Gealy (1986). Control of Russian thistle (Salsola iberica) with chlorsulfuron in a wheat (Triticum aestivum) summer-fallow rotation. Weed Science 34:318-324.

MECHANICAL

Blackshaw, Robert E., Francis O. Larney, C. Wayne Lindwall, and Gerald C. Kozub (1994). Crop rotation and tillage effects on weed populations on the semi-arid Canadian prairies. Weed Technology 8(2):231-237.

MISCELLANEOUS

Wallace, A., W.A. Rhodes, and E.F. Frolich (1968). Germination behavior of Salsola as influenced by temperature, moisture, depth of planting, and gamma irradiation. Agronomy Journal 60:76-78.

Young, J.A. and R.A. Evans (1972). Germination and establishment of Salsola in relation to seedbed environment: I and II. Agronomy Journal 64:214-224.

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Scientific Name: Setaria viridis
Common Name: Green foxtail
Family: Poaceae
Location: NE IA MN MO KS SD ND NY AR UT MB
Control: Mechanical Chemical

Habitat: Green foxtail is widespread in cultivated soils and waste places. It is more common in cooler areas of the United States.

Detail: CHEMICAL

Beckie, Hugh J. and Ian N. Morrison (1993). Effective kill of trifluralin-susceptible and -resistant green foxtail (Setaria viridis). Weed Technology 7(1):15-22.

Location: University of Manitoba Research Station at Portage la Prairie, Manitoba.

Objective: To determine the responses of different green foxtail biotypes to various dosages and times of application of trifluralin herbicide.

Summary: Experimental plots were established in 1989 and 1990, in fields sown to spring wheat in 1988. In the first treatment, trifluralin was incorporated into the soil one week before the field was sown to rapeseed, and resistant (R) and susceptible (S) green foxtail seeds were broadcast over the field. In the second, trifluralin was incorporated immediately after sowing of wheat, and green foxtail seed was sown as above. The S biotypes sown with rapeseed were drastically reduced in all respects with the recommended level of trifluralin incorporated pre-planting, whereas the R biotypes were increasingly reduced only as the level of trifluralin increased. These differences were even more pronounced in the second treatment, with trifluralin incorporated post-planting. Results suggest that resistance and susceptibility should be taken into account in any program to control green foxtail.

Boydston, Rick A. (1992). Drought stress reduces fluazifop-P activity on green foxtail (Setaria viridis). Weed Science 40:20-24.

Location: Greenhouse studies.

Objective: To determine the efficacy of

fluazifop-P in controlling drought-stressed green foxtail, as compared to nonstressed plants.

Summary: Green foxtail plants were raised in growth chambers and either maintained at 20% soil water content, or allowed to dry out to 6% SWC and maintained in this stressed condition. Plants were sprayed with fluazifop-P, and the drought-stressed plants were either watered immediately thereafter, or watered to the 20% level at some number of days after treatment with the herbicide. Results indicated that drought stress before and up to 1 day after spraying did not reduce the effects of the herbicide on green foxtail, but plants kept in drought conditions 2 to 4 days after treatment did not suffer as much injury from the herbicide. These results suggest moisture availability after herbicide treatment is an important factor in green foxtail control.

Evans, J.O. and B.M. Jenks (1989). Broadleaf and green foxtail control with DPX-M6316 and primisulfuron in corn. Research Progress Report of the Western Society of Weed Science, Honolulu, HI, 1989, pp. 280-281.

Location: Young cornfields in Logan, UT.

Objective: To evaluate postemergence herbicides for control of broadleaf and green foxtail control in corn.

Summary: Eight herbicide treatments were applied in June, 1988, and visual evaluations were made on July 12. Primisulfuron + atrazine at 1.0 lb ai/A provided the best control of green foxtail (93%).

Jordan, David L., M. Cade Smith, Marilyn R. McClelland, and Robert E. Frans (1993). Weed control with bromoxynil applied alone and with graminicides. Weed Technology 7(4):835-839.

Location: Main Experiment Station at Fayetteville, Arkansas.

Objective: To evaluate weed control, including Setaria viridis, using various herbicide combinations.

Summary: Seeds of several weeds, including green foxtail, were sown in experimental plots in the spring of 1991 and 1992. The broadleaf herbicide bromoxynil was applied alone and with several graminicides at various rates, when weeds were at the 3- to 6-leaf stage. Effectiveness of the graminicides alone for controlling green foxtail varied from 59% to 89%; addition of bromoxynil reduced control considerably. Clethodim, at 0.14 kg ai/ha, gave the best control. Results indicate care should be taken not to mix bromoxynil, for broadleaf control, with graminicides.

Khan, Mohammad and William W. Donald (1992). Sulfonylurea herbicides reduce survival and seed production of green and yellow foxtails (Setaria spp.). Weed Technology 6(2):284-290.

Location: Greenhouse at Fargo, North Dakota.

Objective: 1) To determine the effect of various herbicides on green and yellow foxtail seedling mortality and seed production; 2) to determine the effect of herbicide on yellow foxtail applied at various growth stages; 3) to determine the effect of foliar vs. soil herbicide applications on yellow foxtail.

Summary: (1) Green and yellow foxtail were sown in the greenhouse and sprayed with four different sulfonylurea herbicides 25 days later. Green foxtail survival and seed production were not greatly affected by the treatments.

Linscott, Dean L. and Richard H. Vaughan (1990). Fenoxaprop for annual foxtail (Setaria sp.) control in seedling perennial forages. Weed Technology 4(3):560-564.

Location: Field plots at the Cornell University Department of Agronomy Research Farm, Aurora, NY.

Objective: To test the efficacy of fenoxaprop herbicide for foxtail control in grass crops.

Summary: Experimental plots were established in new timothy and orchardgrass plantings at various developmental stages, alone or in combination with alfalfa. The herbicide fenoxaprop was applied at various rates in late spring of 1985 and 1986 to test for control of annual foxtail and crop injury. Fenoxaprop applied at 0.13 and 0.18 kg/ha controlled foxtail species over 90% in both years.

MECHANICAL

Bubar, Carol J. and Ian N. Morrison (1984). Growth responses of green and yellow foxtail (Setaria viridis and S. lutescens) to shade. Weed Science 32:774-780.

Location: University of Manitoba research sites at Graysville, Manitoba and Portage La Prairie, Manitoba.

Objective: To study the response of two Setaria spp. to shade.

Summary: Foxtail seed was sown in each June of 1979, 1980, and 1981. Plots artificially provided three different levels of sunlight, and an additional plot provided shade through coplanting with wheat. No significant difference in shade-tolerance was found between the two species. Shade reduced height, number of tillers, and dry weight in green foxtail, suggesting the benefits of tall, competitive grasses for controlling green foxtail.

MECHANICAL CHEMICAL

Manthey, Diane R. and John D. Nalewaja (1981). Wild oat and green foxtail control as influenced by herbicide placement and seed depth. Proceedings of the North Central Weed Control Conference 36:22-23.

Location: Greenhouse at North Dakota State University, Fargo, ND.

Objective: To study the role of depth of seed sowing and soil incorporation of herbicide in control of two weed species.

Summary: Green foxtail seeds were sown at four depths, and chloramben herbicide was incorporated

into the soil at four depths. Green foxtail control increased for all seed depths as cloramben incorporation depth increased, indicating the importance of root uptake of herbicide.

Peterson, Dallas E. and John D. Nalewaja (1992). Environment influences green foxtail (Setaria viridis) competition with wheat (Triticum aestivum). Weed Technology 6(3:607-610.

Location: Greenhouse experiments.

Objective: To determine the effects of environmental factors on the competitive ability of green foxtail.

Summary: (1) Green foxtail and wheat were grown under various conditions of density, sowing date, soil moisture, and temperature. Green foxtail reacted most positively to 30C and field capacity, and negatively to increased competition from the wheat, because of earlier wheat sowing date. (2) Wheat and green foxtail were grown, alone and together, with various levels of nutrients. Foxtail and wheat did not exhibit competition at higher levels of nutrients. Results indicate green foxtail is most competitive at high temperature, high soil moisture and high soil fertility, especially if given an edge in seedling establishment.

ADDITIONAL REFERENCES:

CHEMICAL

Boydston, R.A. (1990). Soil water content affects the activity of four herbicides on green foxtail (Setaria viridis). Weed Science 38(6):578-582.

Eberlein, C.V. and R. Behrens (1984). Propanil selectivity for green foxtail (Setaria viridis) in wheat (Triticum aestivum). Weed Science 32(1):13-16.

Fontana, S.A. (1979). Control of foxtail grass and broadleaf weeds in barley with propanil. Proceedings of the North Central Weed Control Conference 34:36.

Grafstrom, L.D., Jr. and J.D. Nalewaja (1981). Propanil + MCPA ester for foxtail control in wheat. Proceedings of the North Central Weed Control Conference 36:49.

O'Sullivan, P.A. (1981). Control of wild oats, green foxtail and Tartary buckwheat with mixtures of propanil or propanil/MCPA and postemergence wild oat herbicides. Canadian Journal of Plant Science 61(2):383-390.

Rahman, A. and R. Ashford (1972). Control of green foxtail in wheat with trifluralin. Weed Science 20:23-27.

MECHANICAL

Nadeau, Leonie B. and Ian N. Morrison (1986). Influence of soil moisture on shoot and root growth of green and yellow foxtail (Setaria viridis and S. lutescens). Weed Science 34:225-232.

Nadeau, L.B. and I.N. Morrison (1983). Root development of two Setaria species under different soil moisture regimes. Aspects of Applied Biology 4:125-134.

MISCELLANEOUS

O'Donovan, J.T. (1994). Green foxtail (Setaria viridis) and pale smartweed (Polygonum lapathifolium) interference in field crops. Weed Technology 8(2):311-316.
