Reprinted with permission from: Northern Prairie Wildlife Research Center. (est. 1991)

Published by: United States Governmental Survey. National Prairie Wildlife Research Center.

Species abstracts of highly disruptive exotic plants at Pipestone National Monument: *Euphorbia esula*

Park: Pipestone National Monument (PIPE)
Species: *Euphorbia esula* L. syn. *Galarrhoeus esula* (L.) Rydb.-Rydberg
Common Name: Leafy spurge
Urgency Ranking: High
Overall Ranking: 4-5 (tie)
Significance of Impact: 63

A. Current impact: 24

B. Ability to be a pest: 48

Feasibility of Control: 31

Taxonomic description

Leafy spurge is a perennial forb (30-90 cm tall). The entire plant contains a white, milky latex. It has an erect stem that is umbel-like branched above, simple below, glabrous, and may be somewhat woody. Stems originate just below the soil surface from a stout caudex. Leafy spurge has an extensive root system of branching rhizomes and deep roots. Due to the extensive root system, leafy spurge is usually found growing in extensive colonies arising from numerous root buds and seeds. Stem leaves are simple, alternate, entire to sinuate, linear-lanceolate to oblanceolate to oblong (2-10 cm long and 3-10 mm wide), one-nerved, green, and with an obtuse to acute tip. Leaves within the inflorescence are simple, whorled, entire, lanceolate to ovate (10-13 mm long) or cordate to reniform, and yellowish-green. The inflorescence is umbel-like and contains five to 17 primary umbel branches. Each of the primary umbel branches is one- to two-times dichotomous. Each branch bears a cyathium, an unusual hollowed-out cup-like structure. The cyathium includes 11 to 20 staminate flowers, each with a single stamen, and a single pistillate flower with a three-branched style. The ovary has three locules, and forms a three-parted capsule. Each part contains a single seed. Capsules are granulate on the keels 2.5-3.5 mm long). Seeds are smooth, grey or yellow to brown, mottled, ovoid to oblong (2.2-3.0 mm long). Each seed has a distinctive yellow caruncle on one end. This is a somewhat variable species that is known to hybridize with Euphorbia virgata Waldst. & Kit., another exotic of the northern Great Plains. Due to these hybridizations, various taxa are often placed into the so called “esula-aggregate” or the “virgata-group.” These two groups have a total of 78 entries, however, few have been reported in North America.

Biology/ecology

Leafy spurge and its related taxa are native to Eurasia. It is presently found in agriculture worldwide, except in Australia. Leafy spurge was first reported in North America in 1827 near Newbury, Massachusetts. However, the most likely point of significant introduction was in Minnesota in 1890 in a shipment of oats from Russia. Leafy spurge has spread into over 30 states and into every Canadian province, except Newfoundland. Leafy spurge is a major problem in Colorado, Idaho, Minnesota, Montana, Nebraska, North and South Dakota, Oregon, Wisconsin, and Wyoming.

Leafy spurge grows in a wide range of habitats. It is most aggressive in semi-arid areas, but it can be found in xeric to subhumid and subtropic to subarctic habitats. Leafy spurge will tolerate flooding for over 4 months. It is only slightly limited by shade. Leafy spurge occurs most commonly on untilled, non-crop areas such as pastureland, rangeland, woodland, prairies, roadsides, stream and ditch banks, and waste sites. It grows on all kinds of soils, but it is most abundant in coarse-textured soils and least abundant in clayey soils. Root growth and vegetative reproduction is highest on course textured soils. Sexual reproduction, germination, and seedling establishment is highest on clayey soils. Allelopathic compounds have been isolated from leafy spurge. Its allelopathic capacity is demonstrated in the field by the reduced number of forbs growing near leafy spurge. Also, allelopathy has been demonstrated in the greenhouse.

Leafy spurge is one of the earliest plants to emerge in the spring, usually in mid-March to late April. Once the stem emerges, elongation occurs rapidly. Initiation of the inflorescence occurs within 1 to 2 weeks of stem emergence. The terminal umbel then forms, and branches until eight to 16 branchlets are formed. Each branchlet usually forms a terminal greenish-yellow bract in May. These yellowish bracts make leafy spurge obvious from late May through June. Flowering in the terminal inflorescence generally ends in late June to mid-July. Pollination of leafy spurge is entirely by insects. Over 60 species of insects having been found on the flowers. The plants do not flower and growth is reduced during the hotter portion of the summer. If conditions are favorable, leafy spurge may produce a few lateral inflorescences throughout the summer and in the fall. Thus, it is possible for the plant to produce seed until frost.

Seeds mature about 30 days following pollination. As environmental conditions allow, the capsule dehisces often propelling the seeds up to 5 m from the parent plant. Although each capsule can produce three seeds, only about 15 to 20% will produce the full three seeds, 35% of the plants produce only two seeds, and the remaining capsules produce only one seed. Each plant produces from ten to 50 capsules with a seed yield range of 200 to 250 seeds per plant. Animals, birds, insects, equipment, seed, hay, grain, and the natural dehiscence of the capsule are all dispersal agents for leafy spurge. Sixty to 80% of the fresh seeds are viable. Seeds can remain viable in the soil for 5 to 8 years. However, annual viability in the soil deceases by about 13% each year. Ninety-nine percent of viable seeds will germinate in the first 2 years. Temperature is the most important requirement for germination. Temperatures between 20 and 30°C are optimal. Alternating freezing and thawing, wet and dry periods, and shortened photoperiod promote germination. Peak germination is from late-May to early-June. If adequate moisture is present, germination can occur throughout the growing season.

Although a successful seed producer, the primary way an established patch of leafy spurge spreads is through its extensive lateral root system. Vegetative reproduction occurs from both crown and root buds. The majority of the plants in the center of a patch are the result of crown buds, while the plants growing on the edge of a patch are primarily from lateral root buds. The crown buds are the first to form. Crown buds begin to develop 7 to 10 days after seedling emergence. Lateral roots and buds will begin to develop as the plants mature. Roots may either be long or short. Long roots have the capability to produce shoots and can reach nearly 5 m laterally and about 9 m in depth. Up to 300 buds have been counted on the long roots. Due to the large numbers of buds, any tillage technique may quickly spread the plant. For example, an experiment showed that rototilling increased the density of leafy spurge to 316 shoots/m^2 versus 134 shoots/m^2 in an untilled area. One experiment showed that root fragments only 1.5 cm in length could produce new shoots.

Distribution

Only one patch of leafy spurge covering less than 5 hectares occurs at Pipestone National Monument (PIPE). These plants are found on a site that was disturbed in the last 10 years. They have the potential to invade, quickly spread, and replace existing native plant communities and may endanger the areas secondary successional resources. The plants have little visual impact on PIPE.

Control

Biological, chemical, cultural, and mechanical control methods have all been used on leafy spurge with varying levels of success. An important consideration in controlling leafy spurge is that the seeds have the potential to remain viable in the seed bank for up to 10 years, and its ability to sprout from both the crown and the roots means that removal of living plants may not totally eliminate the plant. A further consideration is that many sources of new propagules surround PIPE. Most control methods will have a detrimental effect on other plant species, and they all constitute a disturbance that will favor reinvasion by leafy spurge or by other exotic species.

Mechanical cultivation is not generally recommended for leafy spurge control, because of its ability to sprout from buds. Few, if any, smother crops can eliminate this plant. However, good management of existing cover can often reduce the likelihood of a new invasion. Mowing can reduce aboveground stands, but it only serves to stimulate underground shoot development. Prescribed burning is not effective in controlling leafy spurge. Heavy grazing by sheep and goats has been shown to be a successful control method.

A number of chemical control options exist for leafy spurge. Many herbicides are not specific to leafy spurge or may not be specifically licensed for this particular use. It is important to read and follow all label directions. Due to the deep, vigorous root system of leafy spurge, chemical application will require follow up treatments.

Annual spring or fall applications of 2,4-D have yielded between 40 and 60% control of leafy spurge. Biennial treatments did not appear to enhance control, and no difference

was evident between amine and ester formulations of 2,4-D. Banvel (dicamba) gave good control the first year, but control rapidly decreased in the second year. Two applications per year at low rates did not appear to increase control over a single, annual, high application . A combination of annual, spring applied Banvel plus 2,4-D gave good control. Tordon (picloram) in a one time application, independent of season has yielded as high as an 80% control for 2 years. Two treatments per year at one-half the rate and an annual treatments at the normal rate of Tordon have given similar results. A combination of Tordon and 2,4-D was shown to furnish the best control of leafy spurge for any spring application. Roundup (glyphosate) applied in the fall has furnished good control the first year, but retreatment the following spring Roundup or 2,4-D was necessary.

Control of leafy spurge by insects is often limited by the thick milky latex which tends to clog the mouth or sucking parts of most insects. However, some insects have potential as a biological control agents. The most widely studied insect for controlling leafy spurge is the spurge hawkmoth [*Hyles euphorbiae* L. (Lepidoptera:Sphingidae)]. It is a native to southern and central Europe, northern India, and central Asia. It was introduced into North America in 1963. The adult lays eggs on the plants and the larvae emerge and feed for 2 or 3 weeks. Disadvantages of this species are that it does not over winter well in the northern portions of North America, and large populations are quite susceptible to a virus. Beetles showing promise for control are *Aphthona cyparissias* Koch, *Aphthona flava* Guillebeau, and *Aphthona nigriscutis* Foudras (Coleoptera:Chrysomelidae). They have become established in some areas and are causing stress to some leafy spurge plants. The gall midge [*Bayeria capitigena* Bremi (Diptera:Cecidomyiidae)] prevents flowering of leafy spurge and is currently being evaluated. A root-boring beetle [*Oberea erythrocephala* Schrank (Coleoptera:Cerambycidae)] has shown some potential, but it is not easily established at most release sites. A rust fungus [*Uromyces scutellatus* Pers. (Fungus:Uredinales)] and some other rusts have received some attention, but little information is available. A large number of European rusts are being evaluated. Combinations of biological control methods and their use in conjunction with herbicides have furnished variable levels of success.

A potential biological control element for leafy spurge is the annual legume sunn hemp (*Crotalaria juncea* L.). Researchers have found that some naturally occurring compounds in sunn hemp act as a natural inhibitor to leafy spurge. Only a small amount of the compound has been isolated. In field tests, the presence of two sunn hemp seeds in a pot with a single leafy spurge plant reduced leafy spurge growth by almost two-thirds. Potential exists for using this compound in conjunction with other biological control agents.

References

Best, K.F., G.G. Bowes, A.G. Thomas, and M.G. Maw. 1980. The biology of Canadian weeds. 39. *Euphorbia esula* L. Canadian Journal of Plant Science 60:651-663.

Blockstein, D.E., B.D. Maxwell, and P.K. Fay. 1987. Dispersal of leafy spurge seeds (*Euphorbia esula*) by morning doves (*Zenadia macroura*). Weed Science 35:160-162.

Biesboer, D.D. 1987. Element stewardship abstract for leafy spurge (*Euphorbia esula*). The Nature Conservancy, Minneapolis. 17 p.

Bowes, G.G. and A.G. Thomas. 1978. Longevity of leafy spurge seeds in the soil following various control programs. Journal of Range Management 31:137-140.

Cole, M.A.R. 1991. Vegetation management guideline: Leafy spurge. Natural Areas Journal 11:171-172.

Coupland, R.T., G.W. Selleck, and J.F. Alex. 1955. The reproductive capacity of vegetative buds on the underground parts of leafy spurge (*Euphorbia esula* L.). Canadian Journal of Agricultural Sciences 35:477-484.

Cyr, D.R., and J.D. Bewley. 1989. Carbon and nitrogen reserves of leafy spurge (*Euphorbia esula*) roots as related to overwintering strategy. Physiologia Plantarum 77:67-72.

Cyr, D.R., and J.D. Bewley. 1990. Seasonal variation in nitrogen storage reserves in the roots of leafy spurge (*Euphorbia esula*) and response to decapitation and defoliation. Physiologia Plantarum 78:1-6.

Dunn, P.H. 1979. The distribution of leafy spurge (*Euphorbia esula*) and other weedy *Euphorbia* spp. in the United States. Weed Science 27:509-516.

Ferrell, M.A., T.D. Whitson, and H.P. Alley. 1989. Control of leafy spurge (*Euphorbia esula*) with growth regulator-herbicide combinations. Weed Technology 3:479-484.

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

Great Plains Flora Association. 1986. Flora of the Great Plains. University of Kansas Press, Lawrence, 1392 p.

Gylling, S.R., and W.E. Arnold. 1985. Efficacy and economics of leafy spurge (*Euphorbia esula*) control in pasture. Weed Science 33:381-385.

Hickman, M.V., C.G. Messersmith, and R.G. Lym. 1989. Picloram release from leafy spurge (*Euphorbia esula*) roots in the field. Weed Science 37:167-174.

Hickman, M.V., C.G. Messersmith, and R.G. Lym. 1990. Picloram release from leafy spurge roots. Journal of Range Management 43:442-445.

Julian, M.H. (ed.). 1987. Biological control of weeds. CAB International. Wallingford, Oxon, United Kingdom. 150 p.

Knake, E.L., L. Wrage, D. Childs, B. Majek, C. Bryson, and J. Hull (eds.). 1991. Weed control manual. Meister Publishing Company, Willoughby, Ohio. 410 p.

Lacey, C.A., R.W. Kott, and P.K. Fay. 1984. Ranchers control leafy spurge. Rangelands 6:202-204.

Landgraf, B.K., P.K. Fay, and K.M. Havstad. 1984. Utilization of leafy spurge (*Euphorbia esula*) by sheep. Weed Science 32:348-352.

Le Tourneau, D., and H.G. Heggeness. 1957. Germination and growth inhibitors in leafy spurge and quackgrass rhizomes. Paper Number 3520. Minnesota Agricultural Experiment Station, St. Paul.

Lorenzi, H.J., and L.S. Jeffery. 1987. Weeds of the United States and their control. Van Nostrand Reinhold Company, Incorporated, New York. 355 p.

Lym, R.G., and D.R. Kirby. 1987. Cattle foraging behavior in leafy spurge (*Euphorbia esula*)-infested rangeland. Weed Technology 1:314-318.

Lym, R.G., and C.G. Messersmith. 1985. Leafy spurge control and improved forage production with herbicides. Journal of Range Management 38:386-391.

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

Lym, R.G., and C.G. Messersmith. 1987. Leafy spurge control and herbicide residue from annual picloram and 2,4-D application. Journal of Range Management 40:194-198.

Lym, R.G., and C.G. Messersmith. 1990. Cost-effective long-term leafy spurge (*Euphorbia esula*) control with herbicides. Weed Technology 4:635-641.

Lym, R.G., and C.G. Messersmith. 1990. Effect of temperature on picloram absorption and translocation in leafy spurge (*Euphorbia esula*). Weed Science 38:471-474.

Maxwell, B.D., M.E. Foley, and P.K. Fay. 1987. The influence of glyphosate on bud dormancy in leafy spurge (*Euphorbia esula*). Weed Science 35:6-10.

Messersmith, C.G., and R.G. Lym. 1985. Roller application of picloram for leafy spurge control in pastures. Weed Science 33:258-262.

Moomaw, R.S., and A.R. Martin. 1990. Ropewick application of picloram for leafy spurge (*Euphorbia esula*) control. Weed Technology 4:235-238.

Moomaw, R.S., A.R. Martin, and R.N. Stougaard. 1989. Leafy spurge. Neb. Guide G87-834. Cooperative Extension Service, University of Nebraska, Lincoln. 4 p.

Nebraska Cooperative Extension Service. 1991. A 1991 guide for herbicide use in Nebraska. EC 91-130. University of Nebraska. Lincoln. 51 p.

Nissen, S.J., and M.E. Foley. 1986. No latex starch utilization in *Euphorbia esula* L. Plant Physiology 81:696-698.

Radosevich, S.R., and J.S. Holt. 1984. Weed ecology implications for vegetation management. John Wiley & Sons, New York. 265 p.

Raju, M.V.S. 1975. Experimental studies on leafy spurge (*Euphorbia esula*). I. Ontogeny and distribution of buds and shoots on the hypocotyl. Botanical Gazette 136:254-261.

Rees, N.E., and P.K. Fay. 1989. Survival of leafy spurge hawk moths (Hyles *euphorbiae*) when larvae are exposed to 2,4-D or picloram. Weed Technology 3:429-431.

Rees, N.E., R.W. Pemberton, A. Rizza, and P.E. Pecora. 1986. First recovery of *Oberea erythrocephala* on the leafy spurge complex in the United States. Weed Science 34:395-397.

Steenhagen, D.A., and R.L. Zimdahl. 1979. Allelopathy of leafy spurge (*Euphorbia esula*). Weed Science 27:1-3.

USDA, Office of Public Affairs. 1989. Sunn hemp seeds: Sundown for range weed? Press Release 1647-89.

Watson, A.K. (ed.). 1985. Leafy spurge. Monograph Series Number 3. Weed Science Society. 104 p.

Whitson, T.D. (ed.) 1987. Weeds and poisonous plants of Wyoming and Utah. Cooperative Extension Service, University of Wyoming, Laramie and Cooperative Extension Service and Agricultural Experiment Station, Utah State University, Logan. 281 p.