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Leafy spurge: A threat to crops and rangelands in Utah

J. O. EVANS and J. M. TORELL

J. O. Evans is an associate professor of Plant Science and is investigating new methods of weed control, including biological management, new tillage implements, and integrated pest management. He teaches undergraduate and graduate courses in weed science at Utah State University. Jim M. Torell, a graduate research assistant in the Plant Science Department, is identifying leafy spurge assessions. He is a specialist in integrated techniques of weed control.

Characteristics

Leafy spurge (*Euphorbia esula* L.) is a deep-rooted perennial plant that was introduced into North America during the 1800s from Eurasia. The first infestation on this continent is believed to be from contaminated grain seed brought here by Eastern European immigrants. Leafy spurge is an attractive species and may also have come here as an ornamental plant (Figure 1). The initial infestations increased rather rapidly because the plant produces abundant seed and is encouraged by the usual farming operations, and it spreads aggressively on rangeland and pastures. Contaminated grain seed was probably a major source of the weed as it spread throughout the northern tier of states in the United States and the prairie provinces of Canada. Some states and provinces presently report about one million acres of the weed in their area.

Leafy spurge is a prime example of many noxious weeds of farmland, noncropland and ranges in that initial small patches become established on low-value land and then spread throughout an ecologically suitable area. The initial infestations are not controlled due to the cost of control on infested sites. Community leaders and land managers fail to recog-

Figure 1. A leafy spurge plant that is several years old.

nize the tremendous economic burden the species will impose as it spreads from these obscure patches. Many other important noxious weeds have become widespread in the United States due to this attitude towards new and/or exotic plants. Generally, serious noxious weeds are recognized as significant threats to food and fiber production or an economic burden only when they have increased to near or beyond manageable proportions. In North Dakota, leafy spurge spread from 423,425 acres in 1979 to 861,823 in 1982. The infestations presently cost the state more than $12 million annually in control programs and loss of agricultural production.

Early attention to new weed infestation can be effective since simple pulling generally eliminates most new weed infestations. Once a weed has spread, however, it demands more drastic measures are required to realize any measure of success. In this respect, overcoming weed problems is a lot like fighting fires; a small fire can be doused by a small amount of water, but control is difficult once the fire has spread. Dyer's woad and musk thistle in Utah, yellow starthistle in Idaho and spotted knapweed in Montana are examples of how weeds have spread. Leafy spurge is unique in many respects to other noxious weeds as it is nearly impossible to kill existing plants once they have been allowed to establish an extensive reserve of carbohydrates in the roots. Even the most drastic control strategies usually do little more than stop the above-ground growth of the plants for a year or two followed by reestablishment of the plant. Leafy spurge has just started to infest Utah. Much effort has been focused on the existing small infestation in hopes of eliminating the weed from the state. Figure 2 reveals the present leafy spurge distribution in Utah. It is presently located in the northern counties of the state.

Economic effects

The economic effects of leafy spurge have been well documented by researchers in North Dakota and Montana. Leafy spurge limits beef cattle production since it reduces production and utilization of forage. It has poisonous properties but cattle losses are rare because they avoid this highly unpalatable species. Sheep will graze leafy spurge, especially in its early growth stages, and do not appear to be significantly harmed by any toxic properties. Leafy spurge can compete favorably with most farm and range crops. Since it is a deep rooted perennial, it survives dry conditions very well. Current farm and range crops do not crowd the weed out, even under favorable circumstances. Additional control strategies must be integrated with cropping in order to limit the spread of leafy spurge.

Biology

Leafy spurge is a tenacious deep-rooted perennial plant that is adapted to a wide variety of environments, but is particularly well-adapted to rangeland and pastureland throughout the northern United States and much of Canada. It is 2 to 3 feet tall, has linear leaves and an inflorescence of inconspicuous flowers (the cyathium) subtended by yellow bracts. Each cyathium superficially resembles a single flower. Laticifers permeate most of the plant body and produce copious amounts of latex, the milky juice throughout the plant.

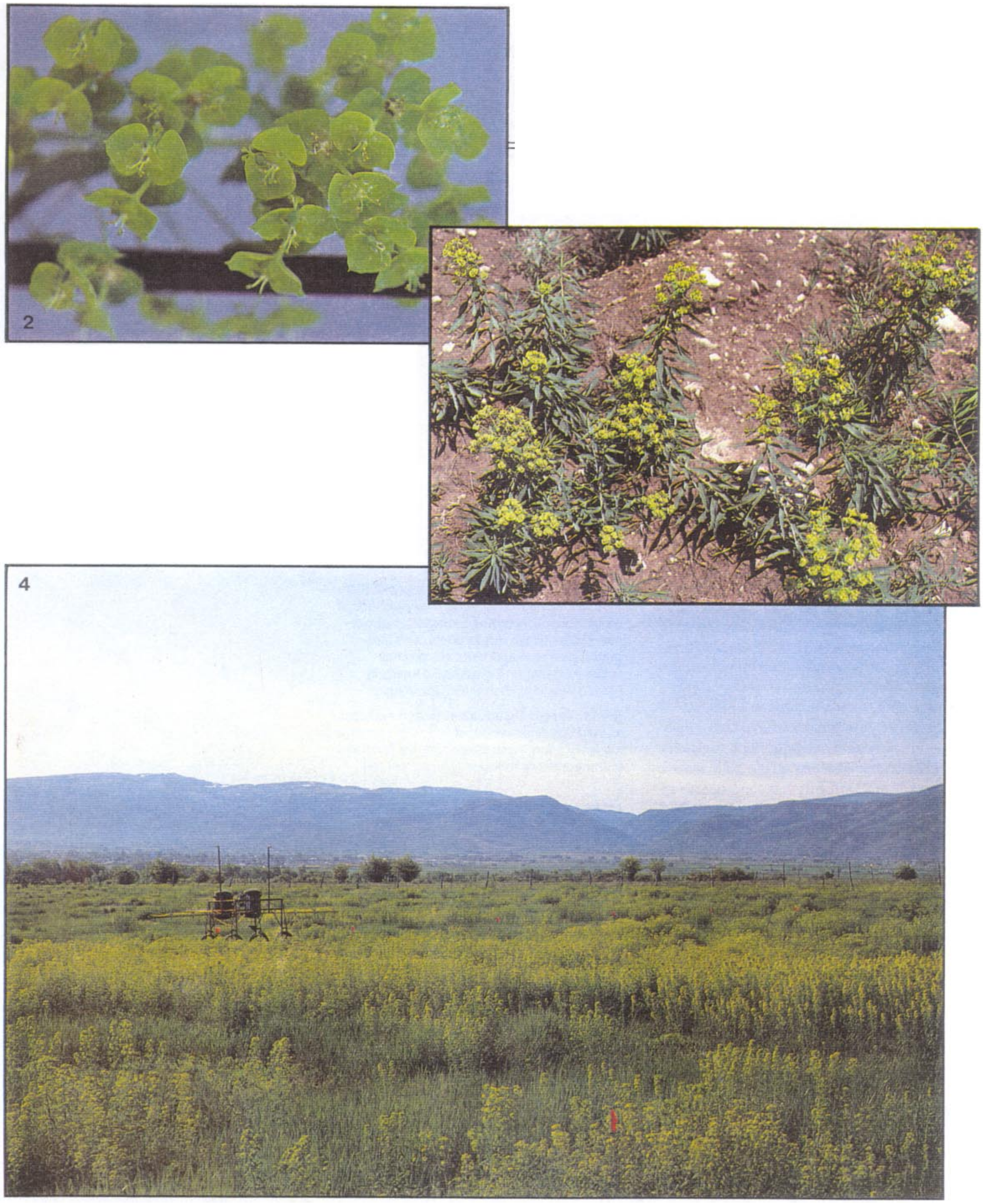

Figure 2. Although leafy spurge produces many seeds, it usually spreads via its roots.

Figure 3. Leafy spurge can infest a variety of sites, including desert areas.

Figure 4. Leafy spurge infestations become so dense that they can eventually crowd out most other vegetation. *Photos by the authors.*

Leafy spurge is a member of the spurge family (Euphorbiaceae) and is usually classified as a single species, *Euphorbia esula* L., but evidence now indicates that leafy spurge is a complex involving at least two species. Schaeffer *et al*. (1985) have proposed that leafy spurge is a segmental allohexaploid and with genome formula AABBCC. This indicates that leafy spurge may have been a hybrid of three diploid species carrying the A, B, and C genomes. This genetic diversity may help explain why different populations vary in their responses to control measures.

Leafy spurge reproduces sexually via seeds and vegetatively via rootstocks containing numerous buds. The seed pod dehisces violently and disperses seed up to 20 feet from the parent plant. Animals may also carry seeds in their fur or on their feet. Rootstocks spread laterally and produce vertical shoots that are clones of the parent plant. Root buds are largely responsible for the ability of leafy spurge to resist control measures. When the topgrowth is killed, new shoots emerge from underground buds on the roots. A primary objective of research has been to find agents that will attack the root system.

Mahlberg (1985) reports that the laticifer contains a diverse array of natural products, including several triterperiods. Phytochemical studies help explain the response of leafy spurge "biotypes" to biocontrol agents and help define phylogenetic and taxonomic characteristics of this complex of plants.

Control

Cultural, herbicidal, and biological control methods are being utilized with varying degrees of success against leafy spurge. Tillage on cropland effectively kills seedlings, but such tillage is not practiced on much of the rangeland and pastureland where leafy spurge is best adapted.

Herbicides such as dicamba and picloram can provide moderately effective control of leafy spurge, but they are expensive and may affect desirable broadleaf plants. Small recently established patches can be controlled with heavy rates of herbicide to kill the plants before they develop an extensive root system, while extensive well-established infestations require annual yearly applications of low rates of herbicide.

Sheep will consume leafy spurge early in the growing season, and sheep grazing may help control large infestations where other methods are not practical. This method prevents leafy spurge from spreading and allows the landowner to realize an economic return from spurge-infested rangeland. However, researchers at Montana State University have not found that leafy spurge stands have been reduced as a result of sheep grazing.

Current research

Research on basic and applied aspects of the leafy spurge problem is underway at the Utah Agricultural Experiment Station. Field trials to determine more effective control strategies and laboratory studies to elucidate biochemical and taxonomic affinities within the leafy spurge complex appear promising.

Leafy spurge accessions from different populations have exhibited differential responses to herbicides. Various control programs for leafy spurge infestations must be evaluated before they can be recommended. Trials in Wasatch County are evaluating the effectiveness of herbicides for leafy spurge control under local conditions.

Leafy spurge is a member of a plant complex composed of several morphologically similar taxa with a variety of intergrading forms. Since taxonomic groups in the *E. esula* complex are not easily discerned on the basis of morphological characteristics, biochemical characters may provide additional information of the relationship among and within leafy spurge infestations. The chemical patterns may also be correlated with feeding preferences of potential biological control agents, information which may help predict the potential success of biocontrol programs before conducting expensive field trials.

Electrophoresis, a method of separating proteins in an electric field, also provides information about genetic variation within the complex. Isozymes, variant forms of individual enzymes, are being profiled in starch and polyarylamide gels. After the genetic basis for these isozyme patterns have been determined, indices of genetic similarity and distance can be calculated.

Mass spectrometry has long been recognized as a powerful tool for determining the identity of organic structures. Pyrolysis mass spectrometry (PyMS) has recently been developed to rapidly analyze complex biological materials and determine overall patterns of chemical variation. The sample is coated on a wire, which is placed in the pyrolysis unit, a device which rapidly heats the sample to a high temperature to fragment biological polymers. These fragments are fed into the mass spectrometer, where they are ionized and focused by a quadropole onto a detector, which records the intensity of each peak. The mass spectra undergo factor analysis, discriminant analysis and graphical rotation, statistical methods that detect patterns in tremendous chemical complexity of unfractionated biological mixtures. Factor analysis determines the linear combinations of data that best account for variation in the data set, discriminant analysis finds the factors that best discriminate between groups of replicated spectra, and graphical rotation tentatively identifies chemical components that may be responsible for observed differences. Windig *et al*. (1983) used PyMS to study the relationship between resistance to the black grass bug in forage grass lines to biochemical factors. Analysis of PyMS data identified factors closely related to insect damage, and also identified genetic differences characteristic of different grass lines.

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