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Cultural control of leafy spurge

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I. Introduction

The strictest definition of the term "cultural control" includes practices that can be used on cultivated land. This limits the control practices to preventive measures, intensive cultivation, competitive crops, or a combination of the three. A broader definition allows use of all nonchemical control practices including grazing livestock and mowing. However, the most practical control measures for use on large infestations on cultivated land include combinations of cultivation, competitive crops and chemicals.

II. Weed control

Most weed scientists list three types of weed control – prevention, control and eradication. But some use the term "elimination" as an intermediate between control and eradication. Prevention is the first and perhaps most important step in a weed control program. It is the process whereby a given species is kept from contaminating an area. No new weed seeds are carried onto the area, and existing weeds are not allowed to reproduce.

Control is the process of limiting weed infestations and, therefore, control practices are used after a weed infests a crop. The practices reduce weed competition so that a crop can be produced. Thus, the amount of control is usually balanced between the costs involved and the amount of possible injury to the crop. Control is the usual aim toward annual weeds competing with farm crops.

Eradication is complete elimination of all plants, plant parts and seeds from an area. All living plants are eliminated and the supply of seeds in the soil is exhausted. Usually it is far easier to eliminate the living plants than the seeds in the soil. For true eradication, both must be accomplished.

Elimination is the removal of living plants in a weed infestation. The term is most commonly used when discussing the control of perennial weeds.

III. Life history and growth habits

Control measures can be applied more effectively if the life history and growth habits of the weed are understood. The biology of leafy spurge has been discussed in Chapter 5 of this monograph, but some information will be restated as it relates to cultural control practices.

Leafy spurge develops earlier in the spring than any of the other noxious weeds in South Dakota except hoary cress (*Cardaria* spp.). Leafy spurge normally emerges early in April and is full grown (1 to 3 feet tall) (.3 to .9 in) and flowering by later May or early June. This early, rapid, rank growth gives the weed a competitive advantage over the spring-sown crops and all low-growing crops. When top growth is plowed or cut back, it will emerge and

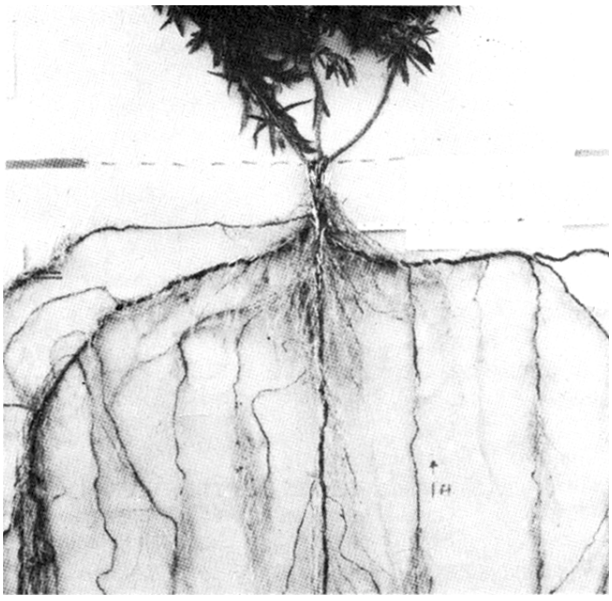

Figure 1. A 15½-month-old leafy spurge seedling showing shoot, primary vertical roots, lateral roots, secondary vertical roots and feeder roots. Adventitious buds formed on the crown at soil level and on all vertical and lateral roots.

flower any time during the summer.

The most formidable part of the plant is the well-developed root system (13). After the seed germinates, the plant develops rapidly and adventitious buds are visible on the root of a 1-week-old seedling; but the bud of a 4-day-old seedling grown under ideal conditions is capable of producing a new shoot if the old shoot is removed. Buds are found on lateral roots less than 90 days after the seedling emerges. Crowns of buds, at or just below the soil line, are formed on the stems produced from lateral roots and on the hypocotyl of the main axis of the plant. They produce new shoots if top growth is removed (20).

After 15.5 months of growth, one seedling produced a primary vertical root 5.5 feet (1.68 m) long with 276 buds (Figure 1), 32 feet (9.75 m) of lateral roots, and 70 feet (21.4 m) of branch roots with a total of 1,440 adventitious buds (20).

Buds produce shoots very readily, especially if the upper part of the plant has been injured or killed (13). Buds were found to a depth of 7 feet in Iowa (2). The concentration of buds on the root decreases with depth (6).

The abundance of buds is also influenced by soil texture, with more buds in a very fine sandy loam, followed by a silty clay loam, a silty clay, a fine sandy loam, and finally a loamy sand (6).

Perennial plants store energy in the form of readily available carbohydrates in roots and crowns. These root reserves are utilized in the rapid spring growth of vegetative shoots with a corresponding decline of the supply of these reserves in the roots. When plants reach a certain stage of growth, excess carbohydrates are produced, which are translocated to the storage areas within the root system.

In leafy spurge the supply of available carbohydrates (Figure 2) decreases from late April to late May (the period of active growth), gradually increases until mid-July, slowly decreases until early September and fluctuates to a high level in late October (1). The amount of organic nitrogen is high during late April and early May, followed by a sharp decline until late May, a more or less gradual decline until late August, a low plateau during September and a sharp incline during October and November (1).

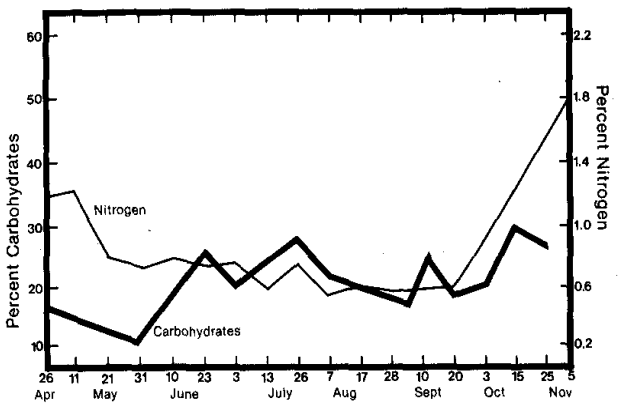

Figure 2. Seasonal variations in the percentages of total available carbohydrates and total available nitrogen in underground parts of leafy spurge.

IV. Prevention

The use of clean crop seed, proper seedbed preparation, good crop rotation, sound soil management practices, weed-free feed and forage and clean machinery prevents infestation by leafy spurge on cultivated land. Prevention is easier with leafy spurge than some species because its fruit does not possess any of the appendages (parachutes, plumes, awns, spines, barbs or air bladders) conducive to its spread by wind, water or animals. Seeds are dispersed a few feet by dehiscence of the seed capsule and for longer distances by birds; but man is probably the chief agent for seed dispersal.

The use of weed-free crop seed is an essential part of any weed control program. Although crop seed is cleaned, it may contain weed seed if the cleaning is not done properly. Even though leafy spurge seed is relatively easy to remove from seed of the major crops grown in the states and provinces where leafy spurge is a problem, it is safer to plant seed produced on weed-free areas.

It is also important to use weed-free feed and forage for livestock. Leafy spurge seed is found frequently in hay and occasionally in screenings and other feed fed to livestock. Some seeds may retain their viability after passing through the animals' digestive tracts, and viable spurge seeds could be distributed with manure.

The possibility of spreading weed seed with contaminated machinery and equipment should not be overlooked. If weedy grain as been planted with a grain drill or harvested with a combine, there is a possibility that weed seeds will be distributed with the machine the next time it is used. One leafy spurge infestation in South Dakota started at the spot where a grain threshing machine, obtained in Indiana, was unloaded in 1918. Thirty years later the infestation, covered over 600 acres.

Successful establishment of large numbers of leafy spurge seedlings in closed grasslands is unlikely; but when the habitat is disturbed or opened in some way, seedlings emerge and survive (4). Good stands of alfalfa and (or) perennial grasses that are managed properly also prevent the invasion of leafy spurge.

Numerous rangeland sites that have been maintained in good or excellent condition have not been invaded by leafy spurge, even though the weed infested adjacent cultivated land or grassland that was abused by over grazing. Frequently, the first areas of a native grassland to be invaded by leafy spurge are those that have been disturbed, such as the mounds around badger holes. This is especially true of earth mounds near rocks on which birds might perch.

In all instances, new spurge seedlings should be eliminated promptly because the longer they are ignored the more difficult the task of controlling the weed. Seedlings are easily controlled, but established plants and invading infestations are extremely difficult to control.

V. Intensive cultivation for elimination

Intensive cultivation is the process whereby tillage equipment is used to sever the underground parts of perennial weeds at the proper depth and time interval. This causes a major reduction or depletion of underground food reserves, which are used to produce new top growth each time it is removed by cultivation. To obtain optimum results the proper depth and time interval must be determined.

Limited work with the use of intensive cultivation for eliminating leafy spurge has been reported (3, 9, 10). However, the principles developed with field bindweed (*Convolvulus arvensis* L.) in Kansas seems to apply to leafy spurge (11, 18).

Depth of cultivation. Studies with field bindweed demonstrated that increased depth of cultivation did not reduce the number of cultivations required for elimination and deep plowing. The first cultivation buried seeds so deeply that they did not germinate, left the soil loose and left a mass of undecayed roots on the surface that hampered subsequent operations with a duckfoot field cultivator (18). The duckfoot cultivator performed better when cutting against the hard surface left by shallow cultivation (18). Deep cultivation has little merit in a control program for leafy spurge because the plant can recover from the complete removal of the underground part to a depth of 3 feet (.9 in) (16).

Interval of cultivation. Studies with field bindweed indicate that root reserves are depleted faster by cultivating at 14-day intervals than at 7-day intervals (11). While cultivating field bindweed 8 days after plants emerge (every 2 or 3 weeks) until all plants are dead, the percent of carbohydrates declines rapidly from April 1 to mid-July, then remains fairly constant until the first of October; and the amount of roots in a cubic foot of soil gradually declines (Figure 3). This intensive cultivation causes a significant reduction of available carbohydrates and kills the roots in the 6- to 18-inch (15- to 46-cm) soil level (18). It has been recommended that leafy spurge not be permitted to develop beyond a height of about 2 inches (5 cm) (16).

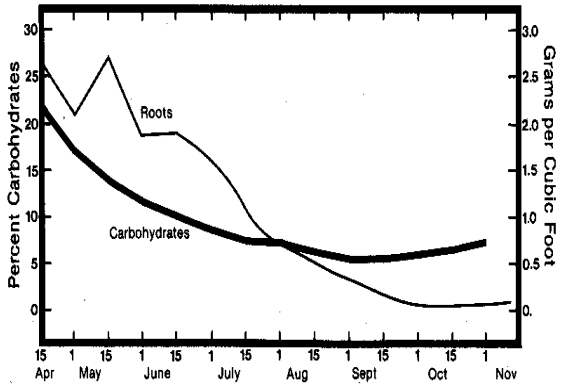

Figure 3. Seasonal variations in the weight of roots in a cubic foot of soil and the percent of available carbohydrates in the roots of field bindweed that was cultivated intensively.

Cultivation equipment. The basic requirement for equipment used for intensive cultivation is that it sever all the roots of the weed at a depth of 4 inches (10 cm) or more. A duckfoot cultivator is used most commonly for that purpose. It is a field cultivator equipped with shovels or sweeps that are 12 to 14 inches (30 to 36 cm) wide and mounted so that they overlap (Figure 4). Twelve-inch (30-cm) sweeps, for example, are mounted 9 to 10 inches (23 to 25 cm) apart so that they overlap 2 or 3 inches (5 or 7.5 cm). Some cultivators have sweeps mounted on two gangs and others on three (Figure 5). More crop residue will slip through the machine if sweeps are mounted on three gangs.

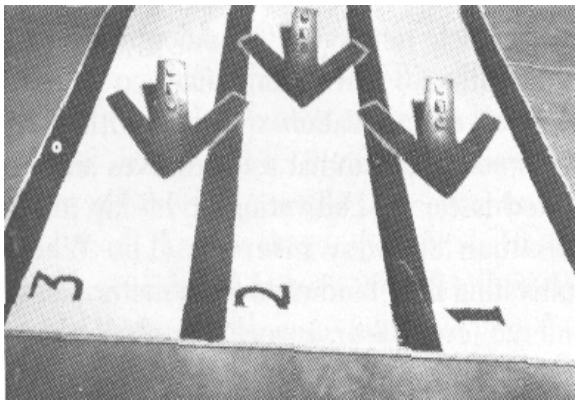

Figure 4. Twelve-inch (30.5 cm) duckfoot shovels showing how they should overlap when mounted on a cultivator.

Figure 5. Duckfoot cultivator with sweeps mounted on three gangs.

Sweeps must be flat when in operation. The angle of the sweeps can be adjusted when the cultivator wheels of a pull-type implement or the tractor wheels for a tractor-mounted implement are put on 4-inch (10 cm) blocks. The sweeps are lowered to the ground and adjusted until all portions of each sweep are touching the ground.

The moldboard plow, of course, will cut all the roots. The spring-tooth harrow, on the other hand, is unsatisfactory on leafy spurge–30 cultivations a year for 2 years are required (3). The duckfoot cultivator is as effective for eliminating leafy spurge (9) as it is for field bindweed (8) and thistles, *Cirsium arvense* (L.) Scop. and *Sonchus arvensis* L. (7).

Intensive cultivation to eliminate leafy spurge. Cultivation from immediately after small grain harvest until freeze-up, followed with a season of intensive cultivation the next year, kills a high percentage of leafy spurge. Sometimes there are stragglers to clean up the next year. In other cases a single year of intensive cultivation kills 85 to 90 percent of weeds (10).

A duckfoot cultivator or blade-type implement is the best machine for cutting the heavy tough roots of leafy spurge. The wide sweeps or blades should overlap 3 to 4 inches (7.5 to 10 cm), be kept sharp, and adjusted so they are flat when in the soil and operating at a depth of 4 to 5 inches (10 to 13 cm). If there is considerable plant residue on the area, it may be necessary to use the moldboard plow for the first operation.

New shoots require 7 to 10 days to emerge after the roots have been cut. Another 7 to 10 days elapse before there are enough leaves to produce more food than is needed for growth. Therefore, little plant food is stored in the roots, and the root reserves are being used for plant growth for a period of 14 to 20 days after each cultivation. The most practical interval of cultivation is every 2 weeks during good growing conditions and every 3 weeks during dry, hot weather when plants are growing less rapidly. This generally means that cultivation should be done at 2-week intervals during late May, June, and July and at 3-week intervals during August, September, and October.

Plowing at a depth of 5 to 6 inches (13 to 15 cm) every 7 to 14 days effectively eliminates leafy spurge (12), but plowing requires two to three times as much power and time as a duckfoot cultivator for the same area and same results.

Combining intensive cultivation for part of the season with an application of a chemical is generally more practical for the production of a crop than an entire season of cultivation (9, 10). Income from the crop can be obtained and hazards from erosion resulting from a full season of cultivating are reduced. However, more time is required to eliminate the weed (9, 10).

VI. Competitive crops for control and elimination

Few, if any, crops are competitive enough to eliminate leafy spurge without the aid of intensive cultivation and (or) a herbicide, such as 2,4-D [(2,4-dichlorophenoxy) acetic acid]. Therefore, it is essential that a crop possess one or more of the following characteristics before it is used in the control or elimination of leafy spurge: a) early spring growth (winter annuals and some perennials qualify), b) late seeding date so that cultivation can be performed before seeding, c) dense foliage, and d) tolerance to 2,4-D or other broadleaf herbicides.

The competitive effects of different crops on field bindweed have been evaluated (8, 17), and the success was closely related to the crop's ability to shade the weed (17). It follows that the success of crops in suppressing leafy spurge is also related to shading ability.

Alfalfa is very effective in reducing light penetration through the crop canopy and was effective in reducing the size of field bindweed (17). Alfalfa commences spring growth about the same time as leafy spurge, which is approximately 10 to 15 days earlier than field bindweed. As a result, alfalfa does not compete as strongly with leafy spurge (9).

A dense stand of alfalfa prevents infestation by leafy spurge and reduces vigor of existing plants but does not eliminate many plants (3, 9). Six or seven cultivations performed prior to fall seeding of the crop, and the development of a heavier than normal stand of alfalfa, eliminate 80 percent of the weed in one year and maintain that level of control for as many as 3 years. However, leafy spurge spreads when stand density of the crop is decreased by disease or winter killing (9).

In a study with field bindweed, spring-sown cereals were not effective in reducing the weed, whereas winter rye and winter wheat reduced light intensity available for the weed and substantially reduced the vigor of field bindweed (17).

Spring-seeded small grain, alone, is of little value in a leafy spurge control program. The weed starts early in the spring and gets ahead of the crop. Application of 0.5 to 0.75 lb/A (0.56 to 0.84 kg/ha) of 2,4-D ester per acre prevents the weed from going to seed, slows its growth, and weakens some plants. These rates are the minimum that can be used to help keep the weed in check. Nevertheless some crop injury may be noted. After being sprayed, the small grain grows above the weed and holds leafy spurge in check until harvest. Four cultivations after harvest kill some of the weakened plants. Stands are reduced about 10 percent by plowing 2 weeks after harvest and cultivating three times during Sep-

tember and early October with a duckfoot cultivator. Spraying in the crop and cultivating after harvest holds the weeds in check and is a useful practice when included in a rotation that also includes systems that materially reduce the stand (9).

Winter grain has some advantage over spring grain in that it keeps the soil covered over winter and starts growth earlier in the spring. However, early fall seeding prevents late cultivation.

Winter rye produces early growth offers early competition; however, it does not offer enough competition to control leafy spurge effectively. When three cultivations are performed between harvest and fall seeding of the next crop, the weed is controlled, but only half of it is eliminated in 3 years. When the same program is followed, except that the rye is sprayed with 0.5 lb/A (0.56 kg/ha) acid equivalent of 2,4-D ester during the spring, the percentage of elimination is increased (9).

Close-drilled soybeans, sudan grass, sorghum, millet, sunflower and hemp were planted after a field bindweed infestation in Minnesota had been duckfoot-cultivated twice to reduce weed vigor (17). The crops provide various amounts of shade. Soybeans was the most effective crop tested in this manner, and caused field bindweed to die back; only a few weak plants emerged after harvest. Sudan grass and sorghum were less effective in reducing field bindweed growth (17). The other crops tested, millet, sunflower and hemp, were not effective in reducing field bindweed growth (17).

Sudan grass and buckwheat are excellent competitive crops when three cultivations are performed before the crop is close-drilled during late June and the area is fall plowed after harvest. Either crop reduces leafy spurge density 50 percent in 1 year and 70 percent in 2 years (9). It is also speculated that forage sorghum would be effective on leafy spurge.

Table 1. Percentage of leafy spurge eliminated with several 4-year rotations involving various crops, cultivation and 2,4-D applications.

	First year		Second year		Third year		Fourth year	
Treat No.	Treatment*	% Kill	Treatment*	% Kill	Treatment*	% Kill	Treatment*	% Kill
1.	Cult-alfalfa	82	Alfalfa	81	Alfalfa	82	Corn 1/3 lb	81
2.	Cult-alfalfa	82	Alfalfa	81	Wheat ½ lb and cult	92	Corn 1/3 lb	92
3.	Cult-brome	82	Brome 1 lb and 1 lb	95	Brome 1 lb and 1 lb	98	Corn 1/3 lb	92
4.	Cult-brome	82	Brome 1 lb and 1 lb	95	Wheat ½ lb and 1 lb	96	Corn 1/3 lb	90
5.	Cult-brome	82	Brome 1 lb and 1 lb	95	Wheat ½ lb and cult	95	Corn 1/3 lb	98
6.	Oats-brome-1/3 lb	62	Brome 1 lb and 1 lb	24	Wheat ½ lb and cult	31	Corn 1/3 lb	39
7.	Oats 1/3 lb, cult	68	Cult-sudan	91	Wheat ½ lb and cult	94	Corn 1/3 lb	98
8.	Cult-sudan	79	Oats 1/3 lb, cult	96	Wheat ½ lb and cult	98	Corn 1/3 lb	97
9.	Cult-sudan-rye	90	Rye 1/2 lb, cult	94	Wheat ½ lb and cult	89	Corn 1/3 lb	94

* "lb" refers to pounds of 2,4-D ester applied per acre and "cult" to intensive cultivation Source: adapted from Derscheid *et al*. (10).

Smooth bromegrass, alone, is not effective in eliminating leafy spurge. When bromegrass is sprayed twice a year with 1 lb/A (1.12 kg/ha) acid equivalent of 2,4-D ester, 80 to 90 percent elimination is obtained in 3 years. However, complete elimination is seldom achieved even when spraying is continued for 5 or more years. When seven cultivations are performed before the bromegrass is fall-seeded and the crop is sprayed twice a year each of the next 2 years, 98 percent elimination can be achieved (10).

The above information on competitiveness of crops can be incorporated into crop rotations that are effective in reducing leafy spurge. Nine of 32 combinations of crops, cultivation, and 2,4-D spraying that were tested are given in Table 1 (10). Treatments 3, 5, 7, 8, and 9 are the best combinations because they keep pressure on the weed all year every year. Although 2,4-D was used several times in each 4-year treatment, intensive cultivation was used whenever possible. It is more effective, especially when trying to eliminate strains of the weed that are resistant to 2,4-D. Several methods that did not give satisfactory results illustrate the need for a year-around program each year (10).

VII. Nonselective herbicides in a cropping system

Although the use of 2,3,6-TBA (2,3,6-tricblorobenzoic acid) and amitrole (3-amino-*s*-triazole) has not been approved for use on cultivated land, these herbicides, used in conjunction with plowing, reduced leafy spurge stands 60 to 95 percent in one year on experimental plots while growing crops of either oats or corn (10). Neither a single operation with a moldboard plow nor an application of amitrole is effective for reducing the density of a leafy spurge stand, but when used together they eliminate as much as 70 percent of the stand when applied in the fall and 80 percent when applied in the spring. Likewise, a combination of 2,3,6-TBA and plowing required only about half as much chemical to obtain the amount of elimination obtained when the plowing was not performed (9, 10).

In an oats-corn rotation, the first year oats were sprayed with 0.33 lb/A (0.37 kg/ha) of 2,4-D ester to hold the weeds in check until harvest. In mid-August several rates of 2,3,6-TBA and amitrole were applied in the stubble. The 2,3,6-TBA-treated plots were plowed 10 days later and the amitrole-treated plots 15 days after spraying. Percentage of elimination was 71 percent for 6 lb/A (6.72 kg/ha) of amitrole and 79, 80, and 95 percent, respectively, for 2, 4 and 6 lb/A (2.24, 4.48 and 6.72 kg/ha) rates of 2,3,6-TBA. Residual effect of 4 or 6 lb/A (4.48 or 6.72 kg/ha) of 2,3,6-TBA sometimes caused damage to oats planted the following spring but did not harm corn planted one month later (10).

During the second year lower rates of 2,3,6-TBA and amitrole were applied when the leafy spurge was 6 to 10 inches (15 to 25 cm) tall. Ten days later all plots were duckfoot-cultivated and an early maturing corn hybrid was planted immediately. Three row-crop cultivations were performed and 0.33 lb/A (0.37 kg/ha) of 2,4-D ester was applied between the first and second cultivations. Despite these treatments, the stand of leafy spurge became more dense on all plots, and the damage to corn occurred when a 4 lb/A (4.48 kg/ha) rate of 2,3,6-TBA in the spring was followed by a 6 lb/A (6.72 kg/ha) rate in the fall (10). Reversing the sequence to corn followed by oats with similar treatments caused an increase in leafy spurge density (10).

Chlorinated benzoic acid (PBA) and simazine [2-chloro-4,6-bis(ethylamino)-*s*-triazine], used in the same manner as 2,3,6-TBA and amitrole, were also ineffective in reducing the stand of the weed (10).

VIII. Preventing reinfestation

When established leafy spurge plants have been killed, the seeds in the soil will produce new plants for several years. Reinfestation can be prevented in cultivated land while using common crop rotations. The annual application of 2,4-D required to control annual broadleaf weeds kills leafy spurge seedlings (10).

Several 4-year rotations and the number of plants per square yard are given in Table 2. Treatments 2 and 4 were effective because 2,4-D was applied each year. Treatments 6 and 8 were not effective because 2,4-D damaged the alfalfa and sweetclover the first year. Subsequent treatments did not kill all plants that became established the first year. It is probable that treatments 6 and 8 would have been much more effective if the legume had not been damaged the first year. Treatments 1, 3, 5 and 7 were not effective because no 2,4-D was used (10).

Table 2. Number of leafy spurge plants that reinfested an area after several different 4-year rotations involving different crops and 2,4-D.

First year		Second year		Third year		Fourth year	
Treatment*	Plants per sq yd	Treatment*	Plants per sq yd	Treatment*	Plants per sq yd	Treatment*	Plants per sq yd
1. Oats	0.6	Oats	0.6	Wheat	1.8	Corn	3.8
2. Oats ¼ lb	0.7	Oats $^1/_3$ lb	0	Wheat ½ lb	0.3	Corn $^1/_3$ lb	0
3. Oats	0.6	Corn	0.3	Wheat	0	Corn	1.4
4. Oats $^1/_3$ lb	0.7	Corn $^1/_3$ lb	0	Wheat ½ lb	0.3	Corn $^1/_3$ lb	0.1
5. Oats-alfalfa	0.6	Alfalfa	0.4	Wheat	2.0	Corn	4.3
6. Oats-alfalfa ¼ lb	1.9	Alfalfa	1.0	Wheat ½ lb	0.6	Corn $^1/_3$ lb	1.9
7. Oats-sweetclover	0.6	Sweetclover	1.5	Wheat	1.5	Corn	4.7
8. Oats-sweetclover ¼ 1b	1.9	Sweetclover	1.0	Wheat ½ lb	1.4	Corn $^1/_3$ lb	1.6

* 2,4-D amine applied at ¼-pound rate, but 2,4-D ester applied at $^1/_3$- and ½-pound rates Source: adapted from Derscheid *et al*. (10).

IX. Grazing for control and elimination

Leafy spurge is not grazed by horses and cattle (14). During the early 1930's it was though that sheep avoided the weed growing in association with perennial grasses until almost all the other vegetation had been consumed (3). However, later it was learned that sheep readily graze small plants of leafy spurge (15). Although sheep are reluctant to graze mature plants, they will do so by first eating all the blossoms and later stripping the leaves from the stems (14, 15).

In some situations it takes 2 or 3 weeks for sheep to get accustomed to the weed. They seem to alternate between the weed and grass, eating the spurge rather greedily for a time and then shifting to grass (B. Landgraf, personal communication).

Weight grains of sheep grazing leafy spurge are comparable to those of sheep that graze on grass (14) and there are seldom any adverse effects to the sheep from grazing leafy spurge (3, 15). Lambs however, have had a tendency to scour (14), and death may occur when relatively large plants are being grazed (15).

Grazing sheep continuously on leafy spurge prevents the weed from spreading (5, 14, 15) and prevents seed production (5). However, leafy spurge must be grazed rather intensively for several years to reduce density. In one case in South Dakota, over 90 percent of the spurge was eliminated by 3 years of heavy overgrazing. With a more moderate grazing intensity, the stand is not significantly reduced until the fourth year (5, 15) when 85 to 90 percent is eliminated. Such a grazing intensity has eliminated 98 percent of the plants in 8 years (5). It is important that grazing be started early in the spring before the weed makes much growth. A more mature stand of leafy spurge should be mowed before grazing is permitted. Sheep in numbers sufficient to keep the weed closely cropped should be used (15). Although 3 or 4 years of intensive and continuous grazing, are required to eliminate 85 to 90 percent of the weed and 7 or 8 years for 98 percent elimination (5), grazing with sheep is a practical method of eliminating leafy spurge in many grasslands. Sheep are as effective as many of the herbicides they produce an income and herbicides are costly. In fact, the cost of herbicides may be greater than the land is worth.

X. Mowing for control

Perennials are generally mowed to prevent seed production. Mowing can also be used to starve underground parts. To prevent seed production, mowing should be done before viable seeds are formed. Leafy spurge seeds are not viable when they are yellow, orange-brown or reddish-brown, but they are viable when turning from brown to gray and should be mowed before this stage. This may be less than 2 weeks after inversion of the capsule (19).

To deplete root reserves of tall perennial weeds, repeated frequent cutting may be needed for 1 to 3 years. At no time must the plant be permitted to replenish its underground food supply. The best time to start mowing is usually when the underground root reserves are at a low ebb. This is between full leaf development and the time that flowers appear during late spring. The fluctuation of root reserves of an unmowed perennial plant and one that was mowed four times is illustrated in Figure 6.

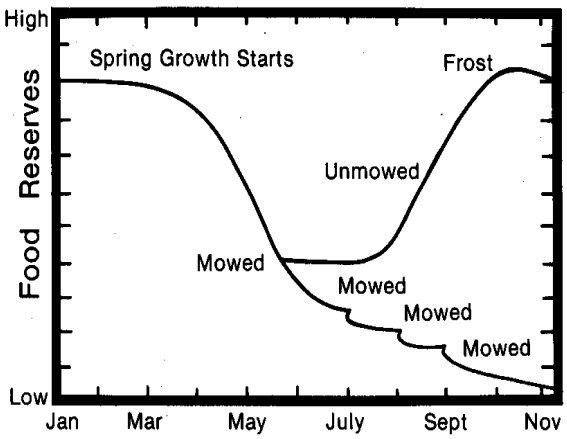

Figure 6. Seasonal variations of root reserves of a perennial weed when not mowed and when mowed four times.

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