WINNING THE DODDER BATTLE

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Abstract: A comprehensive strategy has been developed to control dodder in alfalfa. The first step is to prohibit the introduction or spread of dodder through sound management practices, purchasing only dodder-free seed, equipment sanitation, and forbidding both the application of manure containing dodder and the entry of sheep that have recently grazed alfalfa contaminated with dodder. Dinitroaniline herbicides have been shown to control dodder, providing an average of over 90 percent control early in the season, then declining to approximately 85 percent control by mid-season, and 65 percent control by late-season. Control varies depending upon the herbicide and the rate, with prodiamine giving the longest residual control. No chemical replacement has been found for dinoseb, which was the standard for controlling dodder that has already become attached to the alfalfa. The most effective remaining methods are to burn the foliage of parasitized alfalfa plants below the point of dodder attachment, or to mow the infected plants down to the soil surface with a flail mower. Flail mowing was determined to be quicker and less injurious to the alfalfa, making this practice an attractive alternative to burning. However, burning at the end of the season was found to be highly effective for destroying dodder seed, thus reducing subsequent dodder emergence (a 96 percent or greater reduction in dodder emergence was observed with all burn treatments).

Keywords: Alfalfa, dodder control, weed control, herbicides, dinitroaniline flail mowing, burning.

INTRODUCTION

The orange thread-like weed dodder (Cuscuta spp.) is perhaps the most troublesome weed in alfalfa fields. Many other weeds compete with alfalfa for water, nutrients, and light, but dodder, being a parasite, reduces yield and kills alfalfa directly by stealing carbohydrates and water from the alfalfa plant. Not only does it reduce forage yields, but it reduces the quality of the alfalfa as well. Once dodder is present in a field it is likely to be a problem for several years since dodder seed may remain viable in the soil for 10 to 20 years. Because dodder has no root system and does not need to carry on photosynthesis to survive, most herbicides cannot control it. All of these factors combine to make dodder especially problematic. An integrated approach involving several cultural practices is required in order to win the battle against dodder. These methods include prevention, preemergence control, post-attachment control, and seed destruction.

PREVENTION

The importance of prevention cannot be overstated. If dodder is not present in a field, everything possible should be done to prevent its introduction. Subsequently, if dodder is present, all measures should be taken to avoid its spread.

Dodder seed is very similar in size and shape to alfalfa seed. Planting alfalfa seed contaminated with dodder is a very common means by which dodder is spread. It is advisable to buy only certified alfalfa seed or seed of known purity.

Farming equipment can also disseminate dodder seed. Swathers, balers, and other equipment should be cleaned thoroughly when moving from a dodder contaminated field into a clean field.

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Another method by which dodder can be spread is with livestock. Dodder seed can pass through the digestive tract of animals and still germinate. Therefore, manure from animals that have been fed alfalfa hay contaminated with dodder should not be applied to any alfalfa field. It is also a common practice in many areas of the state to graze alfalfa fields with sheep during the winter. Numerous alfalfa fields have become infested with dodder because of this practice. Sheep that have just grazed a dodder infested field should not be allowed on another field for at least six days, for this is the time required for a complete turn around in the rumen contents of the animal.

In cases of a severe dodder infestation, the best option may be to rotate to a non-host crop. The dodder seed reserves will diminish after a few years without alfalfa or another host plant, making the field more suitable for future alfalfa production.

These simple safeguards can prevent countless hours of work, worry, and expense that can occur if dodder is allowed to infest a field.

PREEMERGENCE DODDER CONTROL

The use of a preemergence herbicide is a logical strategy for fields that are known to be infested with dodder. The preemergence herbicide trifluralin (Treflan TR-10) has been found to control dodder and is becoming a popular practice. A Special Local Needs registration for the use of trifluralin for dodder control was granted during the summer of 1987. This registration permits the application of two 20-lb (two lbs active ingredient) treatments approximately 60 days apart.

The results of trials conducted throughout California using trifluralin for dodder control are presented in table 1. Early-season dodder control was excellent, averaging over 91 percent. By mid-summer, approximately 3 to 4 months after treatment, dodder control had diminished noticeably. This is particularly true of the single treatment at the two pound rate, where control averaged 78 percent. Control declined to an even greater degree at the end of the season, but there is not normally as much dodder present at this late date. There is considerable variation in dodder control for the late season evaluations. This variation is a function of the dodder infestation level, alfalfa stand density, soil type, and other factors.

Some key points need to be understood for effective dodder control with trifluralin. It is essential that the first application be made prior to dodder emergence. Initial dodder emergence occurs in late February to March in most areas of the state. The date varies from year to year and field to field depending upon temperature and moisture status. Moist soil conditions must accompany temperatures exceeding approximately 60 degrees for dodder emergence to occur.

A dodder infestation is most apparent in mid-summer, but the majority of the dodder actually emerges and becomes attached to the alfalfa long before that time; two years of data indicate that attachment occurs during the entire growing season, but over 75 percent attaches by June (figure 1). This explains the research results illustrating the inefficacy of trifluralin applications made after first cutting.

Field experience and research plots have also shown that a split application of two plus two pounds extends the length of dodder control (table 1). This rate is only recommended for fields that have very severe dodder problems.

Occasionally, growers want to treat only some of their fields and have difficulty deciding which fields should be treated. The tendency is to treat the older fields where dodder is known to be a serious problem, having already killed some of the alfalfa plants. However, it is wiser to treat younger fields that still have a dense stand of alfalfa. In areas where the

stand is thin and the soil is exposed, trifluralin breaks down more rapidly by photodecomposition and is therefore less effective. Also, in a thin stand of alfalfa, dodder is exposed to sunlight and grows more vigorously and twines more readily.

Several trials have been conducted comparing other dinitroaniline herbicides with trifluralin (table 2). The other herbicides were pendimethalin (Prowl) and prodiamine (Endurance). Pendimethalin provided comparable dodder control with trifluralin. However, prodiamine was found to be superior, providing season-long dodder control. Four and a half to six months after application, prodiamine was still providing an average of 78, 87 and 94 percent control for the 2, 4, and 2 + 2 lb/A applications, respectively. When/if these herbicides become registered, the potential exists that they could be tank-mixed with winter herbicides so that winter weed control, summer grass control, and dodder control could be achieved in one application.

Dodder control with any of the preemergence dinitroaniline herbicides is not perfect, but the dodder population is reduced to such a degree that it is manageable with post-attachment control measures.

POST-ATTACHMENT CONTROL

Post-attachment dodder control measures must be employed to curtail the spread of dodder after it has become attached to the alfalfa. Dodder should be controlled after each cutting, and definitely before it has a chance to set seed. Dodder flowers develop into capsules that have the potential of producing up to four seeds per capsule. If dodder is not controlled before it sets seed, the grower is clearly fighting a losing battle.

The prospects for selective control (dodder control without injury to the alfalfa) are poor for dodder that has already become attached. The alfalfa must be destroyed below the point at which the dodder is attached with any of the present control methods. If the alfalfa stem is not killed below this point, the dodder can regenerate from the haustoria (sucker-like structures) that are embedded in the stem.

The most common treatment for attached dodder was the nonselective herbicide dinoseb (often referred to as dinitro). However, its use was banned in 1986 for possible birth defect risks. Several research trials were conducted in 1986 and 1987 aimed at finding a possible replacement for dinoseb. Twelve chemicals and combinations were studied at several rates (Table 3). None of the herbicides tested equaled the effectiveness of dinoseb. Many of the herbicides effectively desiccated the alfalfa leaves but did not kill the stems sufficiently. ENQUICK (urea sulfuric acid solution) and Ignite (glufosinate-ammonium) were the most successful alternatives.

The most common way to control attached dodder is still spot treatment with a propane-fueled weed burner. While effective, this method is time consuming, costly, injurious to the alfalfa, and not much fun for the operator. Because of this, a major drawback of burning results from the grower's failure to burn the entire dodder-infested area. This leaves the perimeters of the burned area vulnerable to the mistakenly overlooked dodder. Recently, flail mowers have been used to control attached dodder. The equipment can be adjusted so that the alfalfa is cut off at the soil surface thereby killing the dodder.

A trial was conducted to compare the efficacy of flail mowing and burning for dodder control. Alfalfa injury resulting from these practices was also studied. Treatments were made four days after the fourth cutting in August. Plots were either mowed using a flail mower, burned with a weed burner, or received no treatment at all. Each treatment was replicated five times in areas where dodder was and was not present. Flail mowing required

less than a third the time of burning. The time savings was even greater when the dodder-infested area could be mowed in one pass. The plots were evaluated one week after treatment. The mowed plots had slightly less regrowth than the untreated plots. The burned plots, however, were just starting to show signs of recovery. Surviving dodder was found only on three stems in the mowed plots, and no dodder was observed at the next cutting. No dodder was found in the burned areas yet despite our conscientious efforts, there was a significant amount of dodder on the perimeter of two of the five burned plots.

The dodder control methods had a significant effect on alfalfa yield and stand, which was measured at the subsequent cutting (table 4). Where no dodder was present, flail mowing reduced alfalfa yield by 14 percent, while burning reduced yield by 27 percent. Dodder had an even more pronounced effect on yield. Uncontrolled dodder reduced alfalfa yield by 37 percent. A 31 percent yield reduction occurred where flail mowing was used to control dodder in an infested area. Burning a dodder-infested area had an even greater adverse effect on alfalfa yield (yield was reduced by 59 percent). While the two control methods were somewhat injurious to the alfalfa, yield was not reduced nearly as much as when the dodder was left untreated (table 4).

A similar trend was observed with alfalfa stand data. Both control measures reduced stand slightly, with burning having more of a detrimental effect. The presence of dodder reduced alfalfa stand to an even greater degree, with flail mowing having the least negative impact.

The main limitation of flail mowing occurs when some areas in the field are not level. The alfalfa cannot be mowed low enough, and therefore the dodder can survive. This can often be overcome by mowing unlevel areas from several angles. Occasionally, dodder can be seen below the point where the alfalfa is cut, but usually the stem dries back and regrowth is initiated below that point, thus destroying the dodder as a result. Flood irrigated fields are more difficult to mow, for the borders partially hinder the operation of the flail mower. However, overall, flail mowing has proven to be an attractive alternative to burning.

SEED DESTRUCTION

It has been speculated that burning may influence subsequent dodder emergence. Research trials were conducted in 1986, 1987, and are currently underway to test this hypothesis. The burn treatments were applied in October of each year with a propane-fueled weed burner. The treatments were a single "light" burn (to simulate a broad-scale field treatment), a "heavy" burn (to simulate a concentrated spot treatment), and a double burn (a light burn followed by another light burn two days later). A temperature of 700° F was reached with the light burn and 1200°F in the heavy burn treatment. Each treatment was replicated at least six times each year. The center two square feet of each treated area was sampled to a depth of one inch and the soil and other debris collected. The soil and plant material was then placed on the top of flats containing a planting mix. The flats were kept moist in a greenhouse at UC Riverside and emerged dodder seedlings were counted for a period of four weeks. The soil was then mixed and dodder seedling emergence was monitored for another 10 days. The single, heavy, and double burn treatments resulted in a 96, 99, and 98 percent reduction in dodder seedling emergence, respectively.

Most growers are not concerned with spot treating dodder at the end of the growing season because dodder is less vigorous due to cooler temperatures. However, these results indicate that it would be advisable to spot treat dodder infested areas at the end of the season, particularly if dodder seed is observed. This would reduce dodder emergence the following spring.

CONCLUSION

Dodder is particularly destructive and difficult to control. The best strategy is to prevent its introduction into an alfalfa field. Once a dodder infestation has occurred, complete dodder control normally requires the integration of several control measures. Preemergence dinitroaniline herbicides effectively control dodder when applied prior to initial dodder emergence. However, they do not provide 100 percent control. Post-attachment control measures are needed to prevent the dodder from producing seed. Flail mowing was found to be an effective means of controlling attached dodder. Compared to burning, it appears to be less injurious to the alfalfa, as well as easier for the operator. Burning patches of dodder at the end of the season, particularly where clusters of dodder seed are present, is advisable to reduce dodder seed reserves and emergence the following year. With a conscientious effort and perseverance, a grower can win the battle against dodder by using a combination of these dodder control practices.

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Table 1. Summary of dodder control results with trifluralin from 1985, 1986 and 1987.

Treatment	Rate lbs/A	Days After Treatment (90-109)	(120-150)	(169-197)
Trifluralin (Range)	2	91.2 (81-99)	78.1 (58-99)	58.5 (30-99)
	4	98.2 (94-100)	90.6 (80-99)	66.7 (30-100)
	2 + 2	96.0 (96-100)	88.3 (77-100)	72.2 (22-99)

Average of 6 to 9 Trials.
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Table 2. Summary of dodder control with preemergence dinitroaniline herbicides from 1986 and 1987.

Treatment	Rate lbs/A	Days After Treatment (45-75)	(95-105)	(140-180)
Trifluralin (Range)	2	93 (90-95)	85 (76-98)	46 (30-72)
	4	99 (99)	97 (94-99)	58 (30-80)
	2 + 2	94 (90-96)	95 (86-100)	56 (45-77)
Pendimethalin (Range)	2	94 (85-100)	85 70-100)	49 (22-77)
	4	99 (97-100)	90 (73-100)	72 (55-93)
	2 + 2	95 (90-100)	98 (96-100)	76 (65-86)
Prodiamine (Range)	2	97 (99-100)	91 (92-100)	78 (79-94)
	4	99 (99-100)	97 (92-100)	87 (79-94)
	2 + 2	94 (87-100)	99 (98-100)	94 (94-95)

Average of 3 to 4 Trials.
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Table 3. Herbicides tested for the control of attached dodder

Trade Name	Common Name	Rate(s) Tested (lbs ai or gallons/A)
Bisulfate of Soda	bisulfate of soda	200, 400 lbs
Des-i-cate	endothall	1.1, 2.2 lbs
diesel	diesel	100 gallons
Diquat	diquat	0.5, 1.0 lbs
Enquick	urea sulfuric acid	20, 30, 40, 60 gal
Goal	oxyfluorfen	0.25, 0.50, 1.0 lbs
Ignite	glufosinate-ammonium	1.0, 2.0 lbs
Paraquat Plus	paraquat	0.5, 0.75, 1.0, 1.5 lbs
Thio-sul	ammonium thiosulfate	20, 30, 40, 60 gal
Weed oil	weed oil	30, 60 gallons
Diesel + Paraquat Plus	diesel + paraquat	100 gallons + 0.5 lbs
Paraquat + Karmex	paraquat + diuron	0.5 + 0.5, 0.5 + 1.0 lbs

Table 4. The effect of flailmowing and burning on alfalfa yield and stand where dodder is present and absent.

Treatment	Yield (tons/A) No Dodder	Yield (tons/A) Dodder Present	Stand (plants/ft^2) No Dodder	Stand (plants/ft^2) Dodder Present
Untreated	1.23	0.77	5.7	2.5
Flail Mowing	1.08	0.85	5.1	4.4
Burning	0.90	0.50	4.0	2.7
LSD .05		0.20		1.0

Figure 1. The seasonal distribution of dodder attachment, 1986 and 1987