DODDER: THE PROBLEM AND ITS CONTROL

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Dodder (Cuscuta spp.) is an orange threadlike parasitic annual weed that infests alfalfa hay and seed fields. Other common names for dodder include tangle gut, lovevine, strangleweed, devil's gut, witch's shoelaces, hairweed, and devil's hair. These aliases only begin to describe the troublesome nature of the weed.

ECOLOGY OF DODDER

Among the many species of dodder, the three most troublesome in alfalfa fields are largeseed dodder (Cuscuta indecora), field dodder (C. campestris), and smallseed dodder (C. planiflora). These three species are difficult to distinguish in the field. Smallseed dodder differs slightly from the other two in appearance, in that it is finer stemmed, has small flowers, and forms smaller denser patches (13).

The majority of dodder seeds are hard, meaning the seed coat is impermeable to oxygen and water. Consequently, only a small percentage of the total dodder seed present in an alfalfa field will germinate in any one year. Researchers (2,16) have reported less than 10 percent emergence the first year after planting dodder seed. As a result of these hard seeds, once an alfalfa field is infested with dodder, it can be expected to be a problem for several years. No consensus has been reached regarding the number of years dodder seed can remain viable in the soil, however many believe periods of 10 to 20 years or longer are possible.

Results from Allred and Tingey (1) and Dawson (2) showed that peak emergence of dodder occurs in the spring (April, May and June), but that largeseed and field dodder are capable of germinating throughout the summer as dormancy is broken. Researchers have also found that most of the dodder emerges from the surface 0.5 inch of soil (1,2,16). The temperature requirement for germination depends on the species of dodder. Cuscuta approximata, also known as small-seeded dodder, germinates at lower constant temperatures, 35-45, compared to largeseed and field dodder whose germination is best at 50°F and 60°F and above, respectively (1).

Dodder emerges as a rootless, leafless stem, dependent upon the food reserves stored in the seed for its immediate survival. The newly emerged seedling rotates in a counterclockwise direction in search of any elongated object within 3 inches of the point of emergence (a stem, a blade of grass, or even a toothpick) around which to coil (13). However, if a suitable host is not found within a few days, the dodder plant will die. If dodder has been successful in contacting and twining around a suitable host, it then sinks its haustoria (sucker-like structures) into the stem (Figure 1). Dodder's original contact to the soil is then severed, and it lives entirely at the expense of the host, thus depriving the host plant of water and nutrients. Growth of alfalfa plants parasitized by dodder is retarded and they often appear chlorotic and spindly.

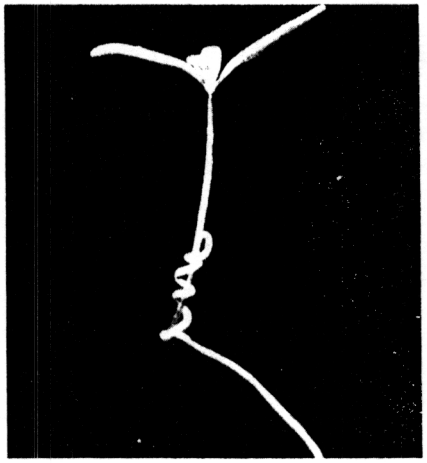
The problem continues as numerous stems of dodder originate and grow from the point where attached to the alfalfa stem. The dodder stems grow rapidly, 3 inches per day has been reported, and attach to other stems on the same plant or adjacent plants. When left unchecked, the dodder plant can form a dense mat greater than 10 to 15 feet in diameter which can coalesce, turning large areas of the field an orange color.

Dodder emergence is unaffected by shade (4), but hook opening and twining are light dependent (17,19). Dawson found that the shade of alfalfa reduced dodder attachment by over 90 percent and the vigor of the dodder was greatly reduced. Both largeseed and field dodder have been found to grow best in open sunlight. Therefore, some degree of control is offered by the shade of alfalfa, but this is seldom noticed by the grower.

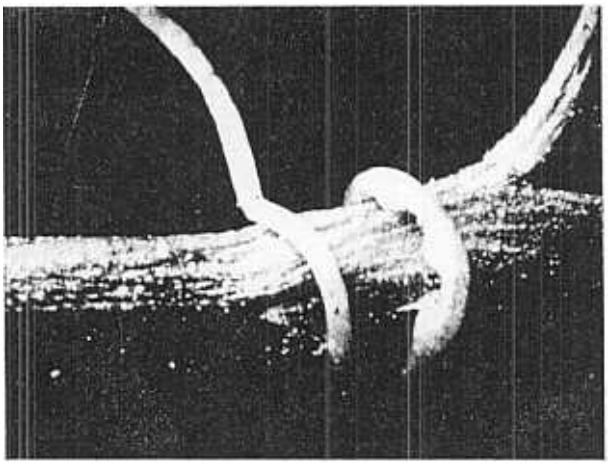
Dodder is a prolific seed producer. During late spring and throughout the summer, clusters of small white flowers are produced near the alfalfa stem (Figure 1). The potential amount of dodder seed is overwhelming when one observes the number of flowers on a dodder plant and realizes that each flower is capable of producing up to 4 seeds.

Figure 1. Physical characteristics of dodder: (a) Dodder twined counterclockwise around alfalfa plant. (b) Haustoria embedded in alfalfa stem. (c) Dense mat of dodder with numerous blossoms produced near alfalfa stem. (d) Dodder attached to alfalfa stem below cutting height.

(a)

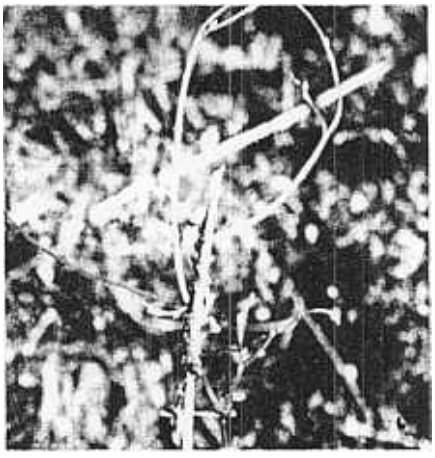


(b)



(c)

(d)



THE PROBLEM

The adverse effects of dodder in alfalfa hay are many-fold and a few are as follows:

1. Lower forage yields
2. Stand reduction
3. More time required to cure hay in windrows
4. Lower quality alfalfa
   a. uncured "slugs" in the alfalfa bales
   b. subsequent invasion of summer grassy weeds
5 Discounted hay prices

A vicious series of events takes place once a dodder infestation has occurred. Although a "parasite" is not generally believed to kill its host, dodder weakens the alfalfa plant to such a degree that eventually, if left uncontrolled, it will kill the alfalfa. Therefore, forage yields are reduced as a direct result of stand reduction and reduced alfalfa vigor. Grass species then invade where the alfalfa has been weakened or killed. Because of the succulent nature of dodder, heavily dodder infested alfalfa may require at least one extra day to cure. When the dodder has not cured sufficiently, discolored "slugs" appear in the bales. All these factors lead to discounted hay prices for the grower. On the average, the market reduction in price approaches ten dollars per ton or greater.

The extent of dodder infestation in the major alfalfa-producing counties of the state has been documented in a recent survey conducted by the University of California Cooperative Extension Service. The results are illustrated in Figure 2. A trend of greater infestations in the warmer counties of the state can be observed. However, the most striking observation is the high percentage of dodder infestation in the alfalfa fields of the high desert areas of Los Angeles and San Bernardino Counties. Dodder is present in approximately 90-95 percent of the alfalfa fields in the high desert and is a severe problem in approximately 30 percent of these fields. A number of factors may contribute to this high degree of infestation including:

1. A climate favorable to growth and reproduction of dodder
2. A stand life of 4-7 years or longer
3. Few alternative crops
4. Long established ranches with large soil reserves of dodder seed

In the high desert a stand of alfalfa is left in production for 4 to 7 years or longer. After this time a grain crop is usually produced in the winter, and the field is again planted to alfalfa the following fall. Because of this, whenever soil moisture and temperatures are adequate for dodder emergence, a suitable host plant is present, alfalfa. Additional work is needed to determine the extent of the soil reserves of dodder seed, but they are expected to be extremely large.

DODDER CONTROL

Any researcher or grower who has attempted to control dodder has had his efforts wrought with frustration. Dodder is a particularly difficult weed to control because:

1 Unlike other weeds, a dense vigorous stand of alfalfa does not insure adequate dodder control.
2. Season-long control is required since the high percentage of hard seeds leads to dodder emergence throughout the season.
3 Seeds are viable for a number of years, making a one or two year crop rotation insufficient.
4 Many weeds are excellent hosts for dodder, examples being field bindweed, Russian thistle, purslane, lambsquarters and pigweed.
5 Dodder does not need to carry on photosynthesis to survive, therefore the long residual herbicides that effect photosynthesis, i.e. diuron, are rendered ineffective for dodder control.
6 Because of the vigor and seed production capability of dodder, a high degree of control is required.
Present control methods are costly, injurious to the alfalfa and largely ineffective.

Table 1 lists present dodder control strategies used in the counties with one percent dodder infestation or greater, and the percentage of alfalfa growers using each practice.

Table 1 Percent of Alfalfa Growers Using Various Dodder Control Methods[1/]

Method	%
Flaming	22.4
Chemical	
Contact Herbicides	35.5
Preemergence Herbicides	8.9
No Program	43.9

[1/]Information taken from University of California Cooperative Extension Service survey results and original documents are available at the Los Angeles County Office.

Both contact herbicides and flaming with propane or butane fueled weed burners are used for controlling attached dodder. When only scattered patches of dodder are present, common grower-practice is to "spot treat" infested areas once with dinoseb or by burning. In order for these controls to be effective, it is necessary to kill the alfalfa plant below the point of dodder attachment. If this is not accomplished, the exposed portions of dodder may be killed, but the haustoria are alive and embedded in living alfalfa tissue and dodder can regenerate from this point. Where widespread infestations make spot treatments impractical, growers are forced to solid burn or spray a field or use a combination of the two methods. An emulsion of 2.0 lbs ai/A of dinoseb plus 10 gallons of weed oil in 75 to 90 gallons of water per acre provides effective control as a single treatment during the hot summer on short alfalfa stubble (14). When burning, two treatments are ordinarily used: the first flaming for partial control and to dry the vegetation, and the following burn the next day or shortly after to completely destroy the above-ground vegetation. These methods of dodder control, whether used as a "spot" or solid treatment, are time consuming, costly, injurious to the alfalfa, and largely ineffective. Follow-up treatments will also be required after each subsequent cutting. The effects of solid burning on a one year old alfalfa stand is outlined in Table 2.

Table 2. The Effect of Solid Burning on First Year Alfalfa

Treatment	Yield/acre[1/]	Crowns/ft^2	Stems/crown
Non-Burned	1.18	6.2	7.5
Burned	.78	4.8	4.9
Percent reduction	34.0	22.0	35.0

[1/]Average of 6 burned and non-burned areas expressed as air-dried tons

Solid burning resulted in a yield loss of 0.4 tons per acre, a 34 percent reduction as compared to the non-burned treatment. The stand was reduced by 22 percent. At cutting time there was no visual difference in plant height between burned and non-burned areas. Therefore, the yield reduction caused by burning appears to be due to a stand reduction and stem numbers per crown rather than a reduction in plant height.

Sample costs of solid burning a first-year alfalfa stand are presented in Table 3.

Table 3. Sample Costs of Solid Burning First-Year Alfalfa

Operation		Cost $/acre
Direct Costs		
Initial Flaming		
Propane...21 gallons/acre @ $.85/gallon		17.85
Labor.....2 workers, 10 min./acre @ $4.50/hr.		1.50
Burning		
Propane...10.5 gallons/acre @ $.85/gallon	=	8.92
Labor.....2 workers, 5 min./acre @ $4.50/hr.	=	.75
Total	=	29.02
Indirect Costs		
Yield reduction...0.4 tons @ $100/ton		40.00
Total Cost		69.02

It is evident that solid burning for dodder control is costly, both in terms of immediate costs and long-term yield reduction due to a decreased stand.

Chlorpropham (Furloe) is the only preemergence material registered by the Environmental Protection Agency (EPA) and the California Department of Food and Agriculture (CDFA) for selective control of dodder in alfalfa hay. Chlorpropham is most effective when applied just prior to dodder emergence on moist soil when the alfalfa is at least 6 inches tall. Chlorpropham has not gained wide acceptance because of its short soil persistence, 3 to 6 weeks (3,12). As full season control of dodder is preferred, multiple applications of chlorpropham are necessary. It has been found (9,12) that the soil persistence of chlorpropham can be extended by combining it with the insecticide carbaryl (Sevin) or PCMC (p-chlorphmyl N-methycarbamate). At the present time, carbaryl is registered as a chlorpropham extender.

Other herbicides which have been reported to provide dodder control include DCPA, dichlobenil, dinoseb, pronamide, and glyphosate (5,6,7,8,10,11,18). Unfortunately, these herbicides are either short-lived or provide only erratic control and/or are not currently registered for dodder control in alfalfa.

Trifluralin (Treflan) was first reported by Dawson (5,6) to control dodder. The weed control properties of trifluralin are generally believed to be in limiting root growth through its effect as a mitotic inhibitor (inhibits cell division). Dodder, however, has no roots. It is therefore suspected that trifluralin curtails the growth of dodder by inhibiting cell division of its growing shoots. The recent use of trifluralin on a commercial basis in alfalfa fields inspired further studies to determine the effect of trifluralin on dodder.

MATERIALS AND METHODS

Preliminary demonstration-type field trials were conducted during the 1985 growing season to determine the efficacy of trifluralin 10 percent granular formulation for dodder control in California alfalfa fields.

A severe dodder infestation occurred in two replications of a trial originally intended to be a summer grass control study. Dodder was noted to be absent or nearly absent in all of the trifluralin-treated plots (Table 4). Trifluralin was applied with a shaker jar on March 22 and was incorporated with flood irrigation within 3 days after application. The plots were evaluated on June 18, between the second and third cuttings. Later ratings were not possible due to a heavy dodder infestation which invaded the treated plots.

In another field trial trifluralin was applied at 2.0 and 4.0 pounds active ingredient per acre (lb ai/A) on February 25. The application was made by air with a Swathmaster Model 54076 spreader. The 4 lb ai/A rate was achieved by making two passes with the 2 pound rate. The field was flood irrigated to incorporate the herbicide. The number of dodder colonies were counted at third cutting on June 26 (4 months after trifluralin was applied), and then again on August 21 (6 months after application). The results are presented in Table 5.

Another study was undertaken in Lucerne Valley, California in an alfalfa field with a history of severe dodder. Trifluralin was applied after the first cutting. A single application of 2 and 3 lbs ai/A and a split application of 3 + 3 lbs ai/A were applied in this trial on May 15 and June 18 using the fertilizer hopper attached to the grain drill. After third and forth cuttings, the dodder infestation was so severe that the field had to be treated twice with dinoseb. The untreated beds had to be solid sprayed, whereas spot treatment was sufficient in the trifluralin-treated beds. Evaluations of dodder control were made throughout the season (Table 6). Evaluations made after July 18 reflected control of late emerging dodder since previous escapes had been controlled with dinoseb.

PRELIMINARY RESULTS

These results demonstrate that trifluralin is an effective preemergent herbicide for the control of dodder. Herbicide rates of 2 lbs ai/A or greater provided consistent early-season control of dodder. The 1985 field trial results showed that all rates of trifluralin provided at least 75 percent control of dodder in early to mid-June. Evaluations made at this time indicate that plots treated with 3 and 4 lbs ai/A trifluralin had approximately one-half or less the number of dodder plants counted in the 2 lb ai/A trifluralin-treated plots. These results are in agreement with the findings of Fischer (15).

Although dodder control from a single application of trifluralin diminishes significantly after 3 to 4 months, it must also be noted that the dodder population declines as well. From mid-June to mid-August, the number of dodder colonies in a 26 x 100 foot area declined from 169.5 to 33.7 (Table 5). In the trial conducted in Lucerne Valley, initial dodder counts were made on the number of plants per 400 square feet, but by September the dodder population had diminished to the point that percent control was calculated based on the number of dodder plants per entire bed rather than per 400 square feet. Hence, even though the 2 and 4 pound rates did not give season-long control, they were most effective when the dodder population was greatest.

Trifluralin at 2 to 4 lbs ai/A has provided up to 3 or 4 months of residual dodder control. Results of studies conducted in Prosser, Washington by Dawson[1/] support these findings. Trifluralin applied at 6 lbs ai/A in late March 1984 and 1985 was found to provide good control up to mid-July. Dawson also found comparable rates of pendimethalin (Prowl) and prodiamine (Endurance) provided longer residual dodder control than trifluralin.

Dodder control resulting from the split application of trifluralin in May and June provided 89 percent control (Table 6). This treatment provided acceptable dodder control for the entire season. Only a few dodder plants were found in the border strips receiving this treatment.

Table 4. Early Season Dodder Control With Trifluralin

Location: Lancaster, CA
Soil: Sandy Loam
Irrigation Method: Border-Strip Flood
Plot Size: 8 x 30 ft.
Treatment Date: 3/22/85

Treatment	Rate lbs ai/A	Dodder Control[1/] 6/18
Trifluralin	1.0	8
Trifluralin	2.0	9.5
Trifluralin	3.0	9.5
Control	0	0

[1/]Rating: 0 = No Control and 10 = 100% dodder control

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Table 5. Evaluation of Dodder Control With Trifluralin

Location: Tracy, CA
Soil: Clay Loam
Irrigation Method: Border-Strip Flood
Plot Size: 26 x 100 ft.
Treatment Date: 2/25/85

Treatment	Rate lbs ai/A	Dodder Control 4 MAA[1/] No. of [2/] Colonies	4 MAA[1/] Percent Control	6 MAA[1/] No. of [2/] Colonies	6 MAA[1/] Percent Control
Trifluralin	2.0	42.5	75	23.5	30
Trifluralin	4.0	21.5	87	15.3	55
Control	0	169.5	0	33.7	0

[1/]Months after application (MAA)
[2/]Average number of dodder colonies in 6 areas 26 x 100 ft.

Floyd Colbert, Lilly Research Laboratories, Fresno, CA

1/personal communication (unpublished data). 1985. Irrigated Ag. Center, Prosser, WA

Table 6. Evaluation of Single and Split Applications of Trifluralin for Dodder Control

Location: Lucerne Valley, CA
Soil: Loam
Irrigation Method: Border-Strip Flood
Plot Size: 100 x 1000 ft.
Treatment dates:
1st application 5/15/85
2nd application 6/18/85

		Dodder Control					
		6/17		7/18	8/12		9/25
Treatment	lbs ai/A	No. of [1] Dodder Colonies	Percent Control	Visual [2] Estimated % Control	No. of [1] Dodder Colonies	Visual [2] Estimated % Control	Percent Control
Trifluralin	2	1.6	90	75	11.8	50	0
Trifluralin	3	.6	96	85	3.3	80	37
Trifluralin	3+3	---	--	97	0.2	96	89
Control		15.5	0	0	---[3]	0	0

[1] Average number of dodder colonies counted per 400 ft^2
[2] Dodder plants had coalesced and counts of individual colonies were not possible
[3] Counts of individual colonies were not possible as 50% of the area was covered with dodder

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FUTURE RESEARCH

It must be emphasized that the results from California tests are only preliminary results, but they do provide a promising direction for future research. Additional studies are suggested as follows:

1. Field Biology
   a. When does dodder emergence begin in different areas of the state?
   b. What is the pattern of dodder emergence for the season?
   c. What is the time requirement for the dodder plant to produce viable seed?

2. Control
   a. How effective are dinitroanalines?
   b. Based on plant emergence, when should preemergence herbicides be applied?
   c. Will the length of desired control require single or multiple applications?

As we gain answers to these questions through future research and field trials, the development of a more effective dodder control method is probable.

Literature Cited

Allred, K.R. and D.C. Tingey. 1964. Germination and spring emergence of dodder as influenced by temperature. Weeds 12:45-48.

2 Dawson, J.H. 1965. Prolonged emergence of field dodder. Weeds 14:373-374

3 _____. 1966. Factors affecting dodder control with granular CIPC. Weeds 14:255-259.

4. 1966. Response of field dodder to shade. Weeds 14:4-5

5. _____. 1967. Soil-applied herbicides for dodder control: initial greenhouse evaluation. Wash. Agr. Exp. Station Bull. 691.

6. _____. 1969. Longevity of dodder control by soil-applied herbicides in the greenhouse. Weed Sci. 17:295-298.

7. 1970. Dodder control in alfalfa with dichlobenil. Weed Sci. 18:225-230

8. _____. 1971. Dodder control in alfalfa with dinoseb D (-) (3-chlorophenylcarbamoylory)-2N-isopropylpropionamide. Weed Sci. 19:551-554.

9. _____. 1972. Inhibition of microbial enzyme prolongs dodder control with chlorpropham. Weed Sci. 20:465-467.

10. _____. 1978. Control of dodder (Cusucuta spp. with pronamide. Weed Sci. 26:660-664.

11. _____and A.R. Saghir. 1983. Herbicides applied to dodder (Cuscuta spp.) after attachment to alfalfa (Medicago sativa). Weed Sci. 17:295-298.

12. _____. 1984. Effect of carbaryl and PCMC on dodder (Cuscuta spp.) control with chlorpropham. Weed Science 32:290-292.

13. _____, F.M. Ashton, W.V. Welker, J.R. Frank and G.A. Buchanan. 1984. Dodder and its control. U.S.D.A. Farmers' Bulletin Number 2276.

14. Fischer, B.B. 1975. Control of dodder in alfalfa hay production. Proceedings, Fifth California Alfalfa Symposium, December 10-11, 1975. Pages 113-119.

15. _____. 1985. Weed Control Studies in Alfalfa. Runcina Vol 31.

16. Hutchison, J.M. and F. M. Ashton. 1980. Germination of field dodder (Cuscuta campestris). Weed Science 28:330-333.

17. Lane, H.C. and M.J. Kasperbauer. 1965. Photomorphogenic responses of dodder seedlings. Plant Physiol. 40:109-116.

18. McNeely, G.H., E.C. Hoffman, D.E. Bayer and C.L. Foy. 1966. Control of dodder with DCPA. California Agriculture, March, 1966.

19. Setty, P.N. and P.S. Krishnan. 1970. Influence of shading on the gross competition of Cuscuta species on Medicago sativa. Physiol. Plant. 23:1017-1023.

Figure 2. Distribution of Dodder in the Alfalfa-Producing Counties of California