INTEGRATING WEED AND WEEVIL CONTROL PROGRAMS

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INTRODUCTION

Winter weeds have been an ever present problem associated with alfalfa hay production. Weed infestations vary from virtually non-existent up to the point where competition is so great that the alfalfa can hardly grow. The severity of the problem is also dependent on the species present. Direct losses due to weeds occur because of reduced hay quality. Indirect losses such as reduced alfalfa vigor, increased disease incidence or reduced effectiveness of insecticides, contribute to reduced stand longevity. Herbicides such as weed oil fortified with dinoseb (frequently referred to as 'dinitro') or diuron (Karmex) have been used to control these weeds. New materials are being developed, as indicated in the earlier papers. Flaming has been used successfully to control weeds, but the benefits usually did not justify the costs.

Insect pests at first and second cuttings have traditionally not been a serious problem. This situation has changed drastically in the last few years, as outlined elsewhere in this symposium. The reason for this change has been the rapid spread of the Egyptian alfalfa weevil, with devastating results at first cutting, and even severely reduced second cuttings in many instances. Insecticides such as guthion, methoxychlor, methoxychlor plus diazinon, and imadan have been used with varying success to control this insect. Again, new materials are being developed and are described elsewhere.

Soon after the Egyptian alfalfa weevil started to build up in the late 1960s it was observed that certain weed control treatments were also offering a degree of weevil control. Similar results have been reported in other parts of the USA. Subsequent testing showed that flaming was particularly effective in providing both broadleaf weed control coupled with high levels of weevil suppression. Weed oil fortified with dinoseb also was found to at least partially control both weeds and weevils. These observations led to initiation of studies directed towards determining a) the influence of weed control treatments on Egyptian alfalfa weevil, b) the influence of weevil control treatments on weed and alfalfa growth, and c) the feasibility and economic practicality of integrating the control of weeds and weevils.

The results of integrated weed/weevil control studies during the last two years are reported herein. It must be emphasised that these results are from ongoing research, and thus conclusions must be viewed as tentative and may be modified by future testing.

MATERIALS AND METHODS

The test plot areas were all located in commercial fields which had been in production for at least one year. Applications of herbicides were made using either a hand-held boom, or by commercial field rig. Weed oil fortified with dinoseb (oil/dinitro) was applied by hand carried boom, or by commercial rig, at the rate of 40 gal/A oil plus 1.25 lb a.i./A dinoseb (1 quart) in 100 gal/A of total mix, unless otherwise noted. Hollow cone nozzles and a minimum of 80 p.s.i. were used for most applications. Flaming was by propane burner, with J-12 Manchester burners set up on a 12' boom. Pressure (45-90 p.s.i.) ground speed (1.8 to 3.0 m.p.h.) and boom height varied according to location. The temperature measurements in the speed of flaming trial were obtained using a chromel/alumel thermocouple attached to a calibrated millivolt strip chart recorder. The thermocouple was placed approximately 0.5" above the soil surface inside an alfalfa crown.

The data for economics were based on chemical cost, plus cost of application. The data for flaming included cost of propane (at 16¢/gallon) per acre, and allowed $2.25/hr for the driver, $1.50/hr for the tractor and 50¢/A for rental (or depreciation) of the flamer. The value of the hay was judged on a sliding scale as indicated with the appropriate table.

RESULTS AND DISCUSSION

Weed Control:
Diuron has provided very variable weed control (Table 1). This was due to variations in weed species present, rainfall pattern, and formulation of mix. The relatively low weed control at Williams 1970 and Davis 1971 was due to almost complete lack of control of

Table 1. Overall weed control ratings, at five locations, resulting from herbicide or flaming treatments. (All data means of 4 replications, rated on 0 = no control, 10 = complete control basis).

Location Rating date		Williams 2/19/70	Davis 2/27/71	U.C.D. 2/25/71	Woodland 2/28/71	Modesto 3/2/71
Treatment	Rate lbs a.i./A			Overall weed control		
Untreated check		0.0	0.0	0.0	0.0	0.0
Diuron	2.4	7.2	5.6	9.1*	2.8	10.0**
GS-14254	1.5	8.5			8.1	
			8.5			10.0
Oil/dinitro	40 gal+1.25	8.8	7.2	5.0	7.5	5.7
Flamed, once, early Feb.		9.6	4.6	6.4	5.6	8.9***

* - 0.5% X-77 used in spray mix.
** - Diuron rate was 2.0 lbs/A.
*** - Flamed twice, 3 days apart.

Table 2. Egyptian alfalfa weevil larvae control resulting from weed oil/dinitro or flaming treatments (All counts are means of 4 replications).

Location Date of assessment	Williams 3/12/70	Orland 3/20/70	Colusa-S 3/31/71	Colusa-Z 4/13/71	U.C.D. 4/9/71	Yolo 3/16/71	Modesto 4/1/71
Treatment			Weevil larvae per sweep				
Untreated check	55.4	96.1	26.3	41.9	48.3	28.0	24.4
20 gal/A weed oil*		30.4		48.9		36.0	
40 gal/A				28.8	33.1	23.2	32.1
60 gal/A "			-	19.6		21.2	
70 gal/A "			2.6				
Flamed, once, early Feb.	3.7	13.4	2.6	22.3	7.1	8.8	2.9**

* - All weed oil treatments included 1.25 lbs. a.i./A dinitro.
** - Flamed twice, 3 days apart.

groundsel (Senecio vulgaris L.). The low weed control for diuron at Woodland 1971 was attributed to lack of rainfall after application and hence no activation of the herbicide in the soil, coupled with a lack of foliar activity as no adjuvant was used. The UCD 1971 trial showed good weed control early, although only moderate rainfall occurred. This was attributed to the use of 0.5% X-77 in the spray mix, which should have increased foliar uptake. The increased weed growth, with time, in the diuron treatments (Fig. 1) was due to speedwell (Veronica buxbaumii Tenore) which was completely tolerant of the chemical and which thrived in the absence of other weed competition.

GS-14254 (Sumitol) is a relatively new herbicide (still experimental), and is described elsewhere in this symposium. At 1.5 to 2.0 lb a.i./A it has provided consistently high, broad spectrum, weed control (Table 1). This herbicide seems to have considerable foliar activity and hence is probably not so dependent on rainfall for activation, as demonstrated by good weed control at Woodland 1971 (Table 1).

Oil/dinitro has been used for weed control in alfalfa longer than any other herbicide. Performance in the trials summarized in table 1 showed that the weed control obtained was variable. Low weed control resulted when heavy stands of grassy weeds were present (UCD 1971), or very dense mats of chickweed (Stellaria media L.) were present and were too thick to penetrate completely (Modesto 1971). Oil/dinitro applications in mid December, in tests not reported herein, have given better weed control than treatments made in late January. Performance on weeds such as groundsel, fiddleneck (Amsinkia douglasiana D.C.), shepherds purse (Capsella bursa-pastoris L.), chickweed, and many other broadleaved weeds has been good provided adequate coverage was obtained. Many grasses, however, have not been or were only partially controlled, such as wild oats (Avena fatua L.), foxtail barley (Hordeum jubatum L.) and ripgut brome (Bromus rigidus Roth.).

Weed control obtained following flaming treatments has also been variable (Table 1). This variation, similar to oil/dinitro, has been due to lack of control of the variable stands of grass species. This was the reason for the low control ratings shown in Table 1, UCD 1971 and Woodland 1971, and was also reflected in the relatively poor control of the annual bluegrass (Poa pratensis L.) in the speed of flaming trial (Table 3a). Control of broad leaved species that have either a rosette growth habit, or thick fleshy stems, has proved difficult. Lack of control of sowthistle (Sonchus spp.) was reason for the low rating at Davis 1971 (Table 1). The rosette growth habit of shepherds purse was the reason it required more heat (250°F) to kill it than the more straggling plant chickweed (200°F) (Table 3a). The lack of complete control of annual bluegrass, even at the slowest flaming speed (Table 3a), was typical of the response of a grass species to flaming; complete control of grasses probably can never be obtained at reasonable economic levels of flaming.

Weevil Control:

The term 'weevil' used throughout this report refers solely to the Egyptian alfalfa weevil, Hypera brunneipennis (Boh.). Control of this pest by insecticides is detailed elsewhere in this symposium. Guthion was used in several tests, with satisfactory results (e.g. Guthion treatments, Fig. 1).

Weevil larvae control by oil/dinitro or flaming treatments has been variable; flaming has however, generally be more effective than oil/dinitro (Table 2). The effect of these treatments has not been complete control, but rather a delay of from a week or two up to about six weeks in larvae build-up. This has resulted in either one less insecticide application, or elimination of the need for insecticide treatment.

The reduction of weevil damage following an oil/dinitro treatment has probably been due to the weed oil in the mixture. A trial in Yolo County in 1971 showed that omitting the dinitro from the mix did not alter the weevil control, but spraying dinitro alone (oil omitted) provided no weevil control. Weed oil increased as the gallons of weed oil sprayed per acre was increased (Table 2, Colusa-Z 1971 and Yolo 1971). The greater control in Colusa-Z reflected the lower weed infestation in comparison with Yolo 1971. The dense mat of weeds in the latter trial may have prevented the oil from reaching the insects.

The control of weevils by flaming results from heat killing the insects. The degree of control attained is therefore a function of the heat applied. Any factor that can influence the temperature attained can thus influence weevil control (weed control as well). Weevil control increased markedly as burner speed was decreased (Table 3b). Six mph raised the temperature only 60°F (Table 3a), caused only slight visible effects and killed no weeds, yet 50% weevil control was attained. On the basis of the measurements made under the conditions of this test a temperature of between 200° and 220°F was required for effective weevil control. Weevil control has generally been lower in weedy fields than in relatively weed free fields. The results in UCD 1971 (Table 2) versus those for the 1.5 mph speed of flaming (Table 3b) illustrate the influence of weeds. The two trials were flamed within 3 hours on the same day, UCD 1971 was very weedy, the speed of flaming moderately weedy.

Table 3a. Effect of flamer speed on temperature in alfalfa crown and on weed control. (Burner pressure 45 p.s.i., all data means of 3 replications; 0 = no weed control and 10 = complete control).

Flamer speed, mph.	Temp. °F	Weed Control Chickweed	Shepherds purse	Annual bluegrass
Untreated check	68(ambient)	0.0	0.0	0.0
6	127a*	0.0	0.0	0.0
3	179ab	7.0	2.0	1.3
1.5	230b	10.0	9.0	5.0
0.75	308c	10.0	10.0	8.7

* - Data within column followed by different letters are significantly different at p = 0.05 level.

Table 3b. Effect of flamer speed on weevil control, alfalfa yield and alfalfa quality. (All data are means of 3 replications).

Flamer speed, mph	Weevil larvae/sweep 3/19/71	Yield Tons/A	% protein	MCF*
Untreated check	85.8c**	0.88a	19.1	27.0c
6	42.7b	1.17b	21.1	24.8b
3	31.1b	1.25bc	22.8	22.7ab
1.5	12.4a	1.36c	23.8	23.0ab
0.75	4.4a	1.29bc	24.0	22.0a

* - Modified crude fiber.
** - Data within columns followed by different letters significantly different at p = 0.05 level.

Table 3c. Effect of flamer speed on economics of flaming for winter weed and weevil control in alfalfa.

Flamer speed, mph.	Alfalfa values $/ton*	$/A	Treatment Cost $/A**	Net profit $/A
Untreated check	27	23.80		
6	29	33.90	2.20	9.90
3	33	41.20	4.40	13.00
1.5	35	47.60	8.80	15.00
0.75	35	45.20	17.60	3.80

* - Value based on sliding scale of $27 per ton for severely damaged alfalfa (mainly stems) with 10 to 20% weeds to $35 per ton for top quality clean alfalfa hay.
** - See text for explanation.

Integrating weed and weevil control:
The foregoing discussions have basically considered weed control and weevil control separately. Observations at first cutting in several trials in 1969 and 1970 indicated that only where weeds and weevils were controlled, by oil/dinitro or flaming, was the alfalfa quality and vigor approaching optimum. Alfalfa growth and economics of various treatments involving weed control only, weevil control only or combinations of both were therefore investigated in 1971.

Analysis of alfalfa and weed growth from early February until April 22, 1971 showed that maximum net profit was only obtained when both weeds and weevils were controlled (Table 4a). The treatments were diuron at 2.4 lbs a.i./A with 0.5% X-77 in 50 gal/A of water on Jan. 5, 1971; flamed at 45 p.s.i. and 2.0 mph on Feb. 4, 1971; oil/dinitro on Feb. 5, 1971 and guthion at 12 oz/A on April 2, 1971. The alfalfa (var. Eldorado) stand in this field was relatively weak, with a high infestation of foxtail barley, annual bluegrass, chickweed and speedwell. Two square meter (as 4 x 0.5 sq. meter) samples were taken from each plot at two weekly intervals starting Feb. 6, 1971; these were cut at ground level. The alfalfa and the weeds were separated, dried, and weighed. The data so derived were used to calculate tons of dry matter per acre. Weevil counts were made in the untreated plots throughout, and in all plots at the time when the larvae counts were high.

The total yield from this experiment was a very poor indicator of the effects of the various treatments. The untreated check plot (Fig. 1) yield comprised 50% alfalfa and 50% weeds, except for a brief period when alfalfa growth was rapid and weevil attack had not become severe. Weevil damage caused a severe loss in alfalfa yield from April 8 to April 22, this correlated well with the recorded larval peak.

Treatment with guthion (Fig. 1) reduced the weevil population, which saved the alfalfa from loss. The competition from the weeds, however, stopped the alfalfa from making any significant further growth. Overall yield did go up slightly, but the hay quality was still very low. A net profit of approximately $5.50 per acre was realized from this treatment (Table 4a). Diuron used without any insect control (Fig. 1) provided good early weed control. The weevil attack was very high, the number of larvae being greater than in the untreated check. This high weevil attack caused severe alfalfa yield reduction. The weed growth during the period April 8 to April 22 was very rapid, presumably because of the reduced competition from the alfalfa. The diuron treatment, although increasing yield slightly and decreasing the percentage of weeds in the hay, lost money due to the realively high initial cost (Table 4a).

The combination treatment of diuron for weed control and guthion for weevil control resulted in excellent first cutting hay (Fig. 1). The weed control was good and hence competition to the alfalfa was low. Weevil control was excellent and the combination of few weeds and essentially no weevils permitted the alfalfa to grow very rapidly between April 8 and April 22. This growth pattern should be compared with that for diuron to see the effect of weevils, and guthion only for the effect of weeds. This combination treatment cost a rather high $16.75 per acre, yet still provided the largest net profit (Table 4a). This was a very striking demonstration of the need to control weeds and weevils if optimum performance was to be realized.

Weed oil/dinitro provided good early weed control, but only moderate weevil suppression (Fig. 1). The weevil attack was still high enough to cause serious reduction in alfalfa yield. The grassy weeds in this field were not killed, this coupled with late rains in March and decreased alfalfa competition led to late weed growth. The end result was very weedy, damaged alfalfa by April 22, with a net loss of $3.00 (Table 4a). Flaming provided much better weevil control although the attack was still high enough to cause late alfalfa injury (Fig. 1). Weed control equaled that of oil/dinitro; but late growth was not as large. This resulted in increased yield of hay of better quality than the check. A net profit of $7.00 per acre was realized (Table 4a).

Cutting twice also provided a net profit (Table 4a). Plots cut on March 11, 1971 regrew rapidly with essentially no weevil attack. The same plots were cut again on April 22, 1971 and the yield of the two cuttings combined. Weeds and weevils were removed at the early cutting, this was presumed to account for the rapid regrowth of weevil free hay after cutting. A practice such as this is probably not sound in terms of weakening the alfalfa and so possibly reducing stand longevity.