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A program to attack all susceptible life stages as well as the larval stages is desirable in integrated alfalfa weevil (*Hypera postica* De Geer) control. The egg and adult stages are also quite vulnerable if correct control measures are properly timed and applied.

Thermal treatments with liquid petroleum gas (LP) and combination treatments of gas flaming followed by appropriate insecticidal spraying were used in the experiments reported in this bulletin. These investigations were conducted to determine the comparative effectiveness for weevil control of flaming alone and flaming in combination with chemical spray treatments. The experimental plots were located in the north-central and Eastern Panhandle regions of West Virginia.

There has been an increased interest by workers during the past five years in experimenting with flaming or burning of fields to control forage crop insects (Bennett and Luttrell 1965; Miller and Thompson 1967; Bishop and Pienkowski 1967). However, the idea is not new. Webster (1912) reported that alfalfa weevil larvae and pupae were controlled by burning after cutting the alfalfa. Essig and Michelbacher (1933) observed promising results in the control of pea aphids after burning. Hughes (1943) found that plant bug populations were effectively reduced by correct burning procedures; Lilly and Hobbs (1962) made similar observations.

Methods and Materials

In 1964-65 an AFCO row burner modified to a boom-type burner (Figure 1) was used to flame experimental plots and fields. Tractor speeds varied from 1 to 4 mph in different experiments; the angle of flame impingement with the ground was approximately 60° and the gas pressure was about 40 psi. The individual pre-heat type of burners were spaced so that the flames overlapped slightly and the burner mouths were approximately 14 to 16 inches above the ground surface. The burner boom flamed a swath 10 feet wide. Flaming treatments were applied on October 20 and November 11, 1964, and on March 16 and 17, 1965.

The same AFCO burner (1964-65) and a Brunner burner (Figure 2) were used in the 1965-66 flaming experiments. The gas pressures varied from 40 to 60 psi in the different plots as indicated in Table 3; tractor speeds varied from 3 to 3.5 mph. The height of the burners above ground, angle of flame impingement with the ground, and other adjust-

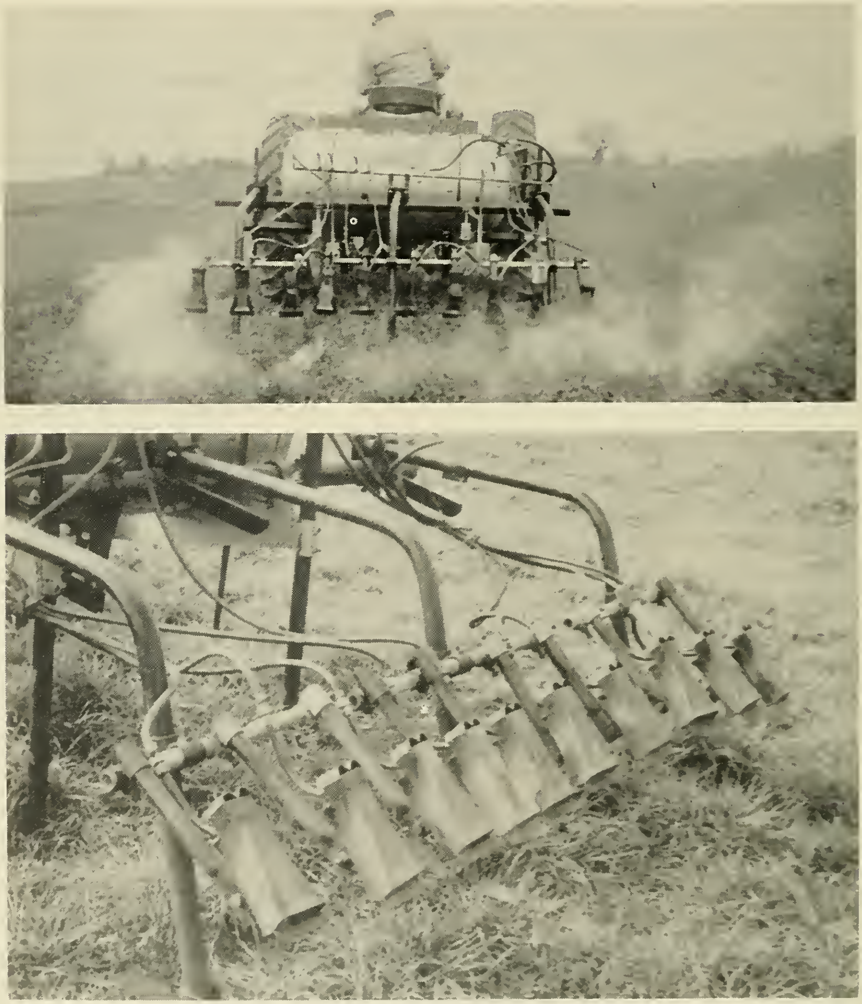

Figure 1. Modified AFCO burner used in flaming experiments to control the alfalfa weevil in 1964-65-66.

Figure 2. Brunner burner used in 1966-67 (top), and March flaming operations in alfalfa fields.

ments were similar to those described for 1964-65. The dates of application of the flaming treatments were again in late fall and in early spring (Table 3).

All of the experimental flaming conducted in 1966-67 was done with the same Brunner burner used in 1965-66. The adjustments and operations were also similar to those described for the 1965-66 program; the tractor speed was 4 mph.

Twenty-six different insecticides were used experimentally as treatments supplemental to LP gas flaming—those having common names are listed in Table 2-5. The proprietary materials used in these tests were: SD-8447, 2-chloro-1-(2,4,5-tri = chlorophenyl) vinyl dimethyl phosphate; SD-9129, dimethyl phosphate ester with *cis* 3-hydroxy-N-methyl = crotonamide; SD-4072, 2-chloro-1-(2, 4-dichloro = phenyl) vinyl diethyl phosphate; SD-7438, S,S′-benzylidene bis-(0,0-dimethyl phosphorodithioate; GS-13005, S-((2-methoxy-5-oxo-^{2}-1,3,4,-thiadiazolin-4-yl) = methyl)

0,0-dimethyl phosphorodithioate; Bayer 37289, 0-ethyl 0-2,4,5-trichlorophenyl ethylphosphonothioate and Bayer 25141, 0,0-diethyl 0-p-(methylsul = vinyl) phenyl phosphorothioate.

Hay yield data (total and alfalfa) were taken from three different fields which had received combination treatments of flaming plus insecticidal spray foliar treatments. In all of the treated plots the total alfalfa yield was greater than in the untreated plots (Table 4). Tippins (1964) and Bishop and Pienkowski (1967) also reported increased yields after flaming.

Results and Discussion

The tests listed in Table 1 were devoted entirely to LP gas flaming to determine the optimum tractor speeds for pulling the burner and times of application for alfalfa weevil population reduction. Because of the scarcity of adult weevils at sampling time (May 6, 1965) the results pertaining to the effect of flaming on adult weevils are not realistic. On the May 13, 1965, sampling date, five treatments gave economic control of the larvae, but not significantly greater reduction than two other treatments—No. 6 and No. 9 (flaming 4 mph, 11-4-64 and 2-16-65) with 68 and 60 per cent kills. In West Virginia, flaming to reduce alfalfa weevil populations is more effectively applied either in the fall from mid-November to mid-December, depending upon the prevailing weather, or in the spring from mid-February to late March. Fall flaming affects the egg and adult stages; spring flaming affects the newly hatched larvae from fall-laid eggs and some of the early emerging adults from winter hibernation. Normally by mid-March 90-95 per cent of the fall-laid eggs have hatched and the tiny larvae are in the alfalfa leaf buds. Spring flaming, when properly applied, is most effective in killing the young larvae and frequently reduces weevil populations to the extent that the alfalfa grower has to apply only one foliar treatment before the first cutting. Flaming in March also retards the growth of pepper weed (*Lepidium* spp.) and common chickweed (*Stellaria media* (L.) Cyrillo), two of the most prevalent weed pests in alfalfa fields in West Virginia, to the extent that alfalfa growth dominates these pests rather than being adversely affected by them (Figure 3). Yellow rocket (*Barbarea vulgaris* L.) and dandelion (*Taxacum officinale* Weber), two other serious weed pests of alfalfa, are also retarded in growth by flaming operations applied in March.

The 34 different kinds of treatments listed in Table 2 were applied in the fall of 1964 for the purpose of comparing the effectiveness of these fall applications against weevil populations the following spring (seven months later). These treatments were directed primarily against the ovi-

TABLE 1

COMPARATIVE EFFECTIVENESS OF GAS FLAMING APPLIED AT DIFFERENT RATES OF SPEED AND TIMES OF THE YEAR FOR ALFALFA WEEVIL CONTROL (1964-65).

Adult Weevils			Weevil Larvae		
Treatments[a]	Comp. Effectiveness[b]	% Kill	Treatments[a]	Comp. Effectiveness[b]	% Kill
		BLUE FARM (Plots 2A x 2)			
		(Coll. 5-6-65)			
1	a	100.0	7	a	82.0
5	a	100.0	9	b	78.0
9	ab	91.0	2	bc	64.0
3	ab	53.0	6	bc	60.0
2	ab	53.0	10	bcd	58.0
7	ab	40.0	8	bcd	57.0
6	ab	27.0	5	bcd	50.0
11	ab	0.0	4	bcde	46.0
4	ab	0.0[c]	3	bcde	34.0
8	ab	0.0[c]	1	de	18.0
10	b	0.0[c]***	11	e	0.0**
		(Coll. 5-13-65)			
			2	a	90.0
			5	a	84.0
			1	a	84.0
			10	a	82.0
			4	a	82.0
			9	ab	68.0
			6	abc	60.0
			3	bcd	51.0
			8	cd	40.0
			7	cd	27.0
			11	d	0.0**

[a]Treatments: (LP gas flaming, 40 psi applied at speeds and on dates indicated)

1. 1 mph, 10-20-64
2. 2 mph, 10-20-64
3. 3 mph, 10-20-64
4. 2 mph, 11-4-64
5. 3 mph, 11-4-64
6. 4 mph, 11-4-64
7. 2 mph, 2-16-65
8. 3 mph, 2-16-65
9. 4 mph, 2-16-65
10. 3 mph, 3-17-65
11. Untreated (Geometric average adult count 3.0; larval count 1527.0)

[b]Duncan's Multiple Range Test at level indicated for Log (N + 1) of the data: antilog of data means —1 is presented as the geometric average count per 25 sweeps. Treatments sharing a letter in common do not differ in effectiveness.

[c]Negative control (more specimens in treated than in untreated plots) is acknowledged by 0.0% to indicate lack of control.

**5.0 per cent level of significance.

***10.0 per cent level of significance.

TABLE 2

Comparative Effectiveness of Insecticidal Treatments and Flaming Procedures in the Control of the Alfalfa Weevil (1964-65).

Adult Weevils			Weevil Larvae		
Treatments[a]	Comp. Effectiveness[b]	% Kill**	Treatments[a]	Comp. Effectiveness[b]	% Kill**
3	a	100.0	21	a	93.0
34	ab	94.0	15	ab	90.0
23	abc	90.0	22	abc	89.0
1	abcd	83.0	17	abcd	88.0
2	abcde	79.0	8	abcd	87.0
10	abcdef	75.0	30	abcd	87.0
4	abcdef	75.0	28	abcd	86.0
29	abcdef	72.0	13	abcd	84.0
14	abcdef	63.0	19	abcde	83.0
11	abcdef	56.0	3	abcde	82.0
24	abcdef	40.0	18	abcde	82.0
21	abcdef	31.0	32	abcde	80.0
20	abcdef	31.0	5	abcde	80.0
9	abcdef	26.0	11	abcde	77.0
15	abcdef	18.0	25	abcde	77.0
22	bcdef	13.0	12	abcde	77.0
7	bcdef	7.0	7	abcde	76.0
26	bcdef	0.0	6	abcde	76.0
19	bcdef	0.0[c]	23	abcde	75.0
6	cdef	0.0[c]	27	abcde	74.0
8	def	0.0[c]	29	abcde	73.0
32	def	0.0[c]	1	abcde	73.0
5	def	0.0[c]	34	abcde	72.0
28	def	0.0[c]	10	abcde	71.0
18	def	0.0[c]	24	abcde	71.0
17	def	0.0[c]	16	abcde	71.0
16	def	0.0[c]	9	bcde	69.0
25	def	0.0[c]	2	bcdef	69.0
13	def	0.0[c]	20	cdef	63.0
30	def	0.0[c]	4	def	61.0
33	ef	0.0[c]	33	def	60.0
31	ef	0.0[c]	14	def	58.0
12	f	0.0[c]	31	ef	43.0
27	f	0.0[c]	26	f	0.0

[a]Treatments: (Hydraulic sprayer, 30 psi, 15 G/A; granules applied with hand, cyclone-type spreader; flaming with modified AFCO row flamer, 40 psi; all treatments applied 10-20-64).

1. SD-7447, EC (1.0 lb/A) Spray S.
2. Flamed, 3 mph
3. Flamed, 2 mph
4. Imidan, EC (0.5) + Sun Oil 11E (2 G/A)
5. SD-9129, EC (1.0) S.
6. Thimet Granules (2.0) Gr.
7. Methyl Ethyl Azinphosmethyl, (2.0)
8. SD-4072, EC (1.0) S.
9. Sun Oil, 11E (2G) S.
10. Flame, 4 mph
11. UC-10854, Gr. (1.0)
12. GS-13005, EC (1.0) S.
13. SD-4072, EC (2.0) S.
14. Sun Oil, 7E (2G) S.
15. Bay 25141, Gr. (1.0)
16. Imidan, EC (1.0) S.
17. Imidan, EC (2.0) S.
18. Dimetilan, EC (1.0) S.
19. GS-13005, Gr. (1.0)
20. Imidan, EC (1.0) S.
21. SD-4072, Gr. (2.0)
22. SD-4072, Gr. (1.0)
23. SD-7447, EC (1.0) S.
24. Bay 25141, EC (2.0) S.
25. Bay 25141, Gr. (2.0)
26. Untreated (Geometric average adult count 4; larval count 960)
27. UC-10854, Gr. (1.0)
28. Bay 37289, Gr. (1.0)
29. Flame, 1 mph
30. Methyl Ethyl Azinphosmethyl. Gr. (1.0)
31. Azinphosmethyl, EC (0.5) + Sun Oil 11EL (2G) S.
32. SD-9129, EC (2.0) S.
33. Azinphosmethyl, EC (0.5) + Sun Oil 11EL (2G) S.
34. Flamed, 3 mph + Azinphosmethyl, EC (0.75) spray, 4-30-65

[b]Duncan's Multiple Range Test at level indicated for Log (X + 1) of the data; antilog of data means −1 is presented as the geometric average count per 25 sweeps. Treatments sharing a letter in common do not differ in effectiveness.

[c]Negative control (more specimens in treated than in untreated plots) is acknowledged by 0.0% to indicate lack of control.

**5.0 per cent level of significance.

Figure 3. Top, flamed and unflamed part of plot in March; right, same flamed and unflamed part of plot in April. Note grayish foliage damaged by larval feeding and white pepper weed blossoms in unflamed part in photo at right.

positing weevils and the eggs already deposited in the alfalfa stems. Flaming at 2 mph gave the greatest reduction of adult weevils, but this treatment was not different from 14 other treatments (range 100-18 per cent reduction). The best larval reductions resulted from the use of SD-4072 and Bayer 25141 granular formulations; however, these treatments were not significantly different from 24 other kinds (range 93-71 per cent reduction). Thirteen treatments (Table 2) gave economic control (80 per cent or more population reduction) of weevil larvae. Subsequent observations revealed that treatment No. 34 (flaming 3 mph, 10-20-64 followed by one azinphosmethyl spray 4-20-65) gave the best protection up to harvest time (about May 15).

The spring flaming treatment applied (3-24-66) in the Demory field No. 1 in 1966 gave excellent larval reductions as late as May 19, 1966. Harvesting was unavoidably delayed in this field and one malathion foliar spray applied May 26, 1966, was necessary to prevent excessive larval damage (Table 3-A).

Field No. 8 on the Widmyer farm was divided into replicated plots (2X) for comparison of fall and spring flaming and various hydrocarbon-insecticide spray mixture applications directed against the egg stage (fall and spring) and the newly hatched larvae in the spring. None of the treatments gave economic control (Table 3-B) but spraying with a hydrocarbon-insecticide mixture (Trt. No. 4) in December and flaming only in November (Trt. No. 5) had the greatest effect on adult and larval population reduction.

Similar kinds of treatments were applied in field No. 9 on the Widmyer farm (Table 3-C). Flaming in late March followed by a combination spray SD-7438 plus methyl parathion applied April 19, 1966, (Trt. No. 1) gave excellent adult and larval control. At least four other treatments (Nos. 5, 4, 2, and 9) also produced excellent larval reductions.

Plots in another part of Widmyer field No. 8 flamed in mid-November and sprayed with malathion May 3, showed excellent adult and larval weevil control (Table 3-D).

Combination treatments (flaming—fall and spring) followed by insecticidal foliar spraying (SD-7438 plus methyl parathion) and spraying alone (SD-7438) April 20, 1966, produced excellent control of adults and larvae (Table 3-E).

Hay yield samples were taken from the first cutting in eight plots in two fields on the Widmyer farm and from six plots in one field on the Blue farm in 1966. All of the treated plots (flamed and sprayed) produced more total alfalfa than the untreated plots. Plots flamed in mid-November and sprayed late in April with SD-7438 plus methyl parathion produced the best hay yield (Table 4).

TABLE 3

COMPARATIVE EFFECTIVENESS OF GAS FLAMING AND FOLIAR SPRAY TREATMENTS TO CONTROL THE ALFALFA WEEVIL (1966).

Adult Weevils			Weevil Larvae		
Treatments[a]	Comp. Effectiveness[b]	% Kill	Treatments[a]	Comp. Effectiveness[b]	% Kill
A—DEMORY FARM (Plots 3.75A x 2)					
(Coll. 5-1-66)					
			1	a	82.0
			2	b	0.0*
(Coll. 5-12-66)					
			1	a	99.0
			2	b	0.0*
(Coll. 5-19-66)					
1	a	100.0	1	a	99.0
2	b	0.0*	2	b	0.0**

[a]Table 3-A Treatments: (LP gas, 100 psi)

1. 3.5 mph, 3-24-66
2. Untreated (Geometric average adult weevil count 4.0; larval count 1111.0)

Adult Weevils			Weevil Larvae		
Treatments[a]	Comp. Effectiveness[b]	% Kill	Treatments[a]	Comp. Effectiveness[b]	% Kill
B—WIDMYER FARM (No. 8, Plots 1A x 2)					
(Coll. 5-1-66)					
4	a	50.0	4	a	50.0
5	ab	31.0	5	ab	25.0
9	ab	0.0	9	ab	0.0
8	ab	0.0[c]	8	ab	0.0[c]
6	ab	0.0[c]	6	ab	0.0[c]
1	ab	0.0[c]	1	ab	0.0[c]
2	ab	0.0[c]	2	ab	0.0[c]
7	ab	0.0[c]	7	ab	0.0[c]
3	b	0.0[c]*	3	b	0.0[c]*

[a]Table 3-B Treatments: (LP gas flamed, 60 psi; some plots flamed and sprayed hydraulically, 30 psi, 15 G/A)

1. Flamed, 3 mph; 11-15-65
2. Sprayed only, 7N (Sun Oil) 4 G/A + Alfatox (2 qts/A), 11-12-65
3. Flamed, 2 mph, 11-15-65
4. Sprayed only, 9N (Sun Oil) 4 G/A + Alfatox (2 qts/A), 12-10-65
5. Flamed, 3 mph, 3-23-66
6. Sprayed only, 7N (4 G/A) + naled (1.0), 12-10-65
7. Sprayed only, 91EL (Sun Oil) 4 G/A + Alfatox (2 qts/A), 11-12-65
8. Sprayed only 7N (4 G/A) + naled (4.0), 11-2-65
9. Untreated (Geometric average adult weevil count 2.0; larval count 1.0)

(Continued)

TABLE 3 (Continued)

Adult Weevils			Weevil Larvae		
Treat-ments[a]	Comp. Effective-ness[b]	% Kill	Treat-ments[a]	Comp. Effective-ness[b]	% Kill
C—WIDMYER FARM (No. 9, Plots 1.5A x 2) (Coll. 5-1-66)					
1	a	100.0	1	a	98.0
5	a	71.0	5	ab	98.0
2	ab	15.0	4	abc	92.0
11	ab	0.0	2	abc	91.0
9	b	0.0[c]	9	abcd	87.0
8	b	0.0[c]	6	bcd	85.0
6	b	0.0[c]	8	cd	84.0
4	b	0.0[c]	7	cde	82.0
7	b	0.0[c]	10	cde	60.0
3	c	0.0[c]	3	de	38.0
10	c	0.0[c]**	11	e	0.0*

[a]Table 3-C Treatments: (LP gas flamed, 60 psi, 3 mph; some plots flamed and sprayed hydraulically, 30 psi, 15 G/A)

1. Flamed, 3-23-66; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.25), 4-29-66
2. Flamed, 11-15-65; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.25), 4-19-66
3. Flamed, 11-15-65
4. Flamed, 3-23-66; sprayed 91EL (4 G/A) + malathion, EC (1.25), 11-16-65
5. Flamed, 3-23-66; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.25), 4-19-66
6. Flamed, 3-23-66; sprayed 91N (4 G/A) + malathion, EC (1.25), 11-16-65
7. Sprayed only SD-7438, EC (0.5), 5-3-66
8. Flamed, 3-23-66; sprayed (4 G/A) + methyl parathion, EC (0.25), 5-3-66
9. Flamed, 3-23-66; sprayed 91EL (4 G/A) + malathion, EC (1.25), 11-17-65: methyl parathion, EC (0.5), 5-3-66
10. Flamed, 3-23-66; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.25), 5-3-66
11. Untreated (Geometric average adult weevil count 2.0; larval count 599.0)

D—WIDMYER FARM (No. 8; Plots 2.5A x 2) (Coll. 5-10-66)					
1	a	100.0	1	a	90.0
3	ab	0.0	2	ab	77.0
2	b	0.0[c]*	3	b	0.0**

[a]Table 3-D Treatments: (LP gas flamed, 60 psi, 3 mph; plots flamed and hydraulically sprayed 30 psi, 15 G/A)

1. Flamed, 11-15-65; sprayed malathion, EC (0.5) + methoxychlor, EC (0.5), 5-3-66
2. Flamed, 3-23-66; sprayed 7EL (4 G/A), 5-3-66
3. Untreated (Geometric average adult weevil count 2.0; larval count 600.0)

E—BLUE FARM (No. 5; Plots 1.6A x 2)
(Coll. 5-1-66)

			6	a	94.0
			4	a	92.0
			2	b	66.0
			1	b	65.0
			3	b	43.0
			5	b	0.0**

(Coll. 5-10-66)

6	a	100.0	6	a	100.0
4	ab	100.0	4	a	100.0
2	ab	100.0	2	a	100.0
3	ab	0.0	3	ab	0.0
1	ab	0.0	1	ab	0.0
5	b	0.0***	5	b	0.0***

[a]Table 3-E Treatments: (LP gas flamed, 100 psi, 3.5 mph; some plots flamed and sprayed hydraulically, 30 psi, 15 G/A)

1. Flamed, 11-16-65
2. Sprayed, SD-7438, EC (0.5), 4-20-66
3. Flamed 11-16-65; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.5), 4-20-66
4. Flamed, 3-23-66; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.5), 4-20-66
5. Untreated (Geometric average adult weevil count 1.0; larval count 343.0)
6. Flamed, 11-16-65; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.5), 4-20-66

F—BLUE FARM (No. 8, 2nd Program; Plots 1.6A x 2)
(Coll. 5-19-66)

			2	a	81.0
			3	a	78.0
			4	a	77.0
			6	b	43.0
			1	b	34.0
			5	c	0.0*

(Coll. 5-25-66)

3	a	80.0	1	a	16.0
1	a	44.0	5	b	0.0
5	ab	0.0	2	b	0.0[c]
2	ab	0.0[c]	6	bc	0.0[c]
6	b	0.0[c]	3	bc	0.0[c]
4	b	0.0[c]**	4	c	0.0[c]***

[a]Table 3-F Treatments: (LP gas flamed, 100 psi, 3.5 mph; some plots flamed and sprayed hydraulically, 30 psi, 15 G/A)

1. Flamed, 11-16-65; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.5), 4-20-66
2. Flamed, 3-23-66; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.5), 4-20 and 5-4-66
3. Flamed, 11-16-65; sprayed malathion, EC (91.0), 4-20 and 5-4-66
4. Sprayed SD-7438, EC (0.5), 4-20 and 5-4-66
5. Untreated (Geometric average adult weevil count 4.0; larval count 2317.0)
6. Flamed, 3-23-66; sprayed SD-7438, EC (0.5) + methyl parathion, EC (0.5), 4-20-66

(Continued)

TABLE 3 (Continued)

Adult Weevils			Weevil Larvae		
Treatments[a]	Comp. Effectiveness[b]	% Kill	Treatments[a]	Comp. Effectiveness[b]	% Kill
G–REEDSVILLE FARM (Plots 4A x 2)					
(Coll. 5-11-66)					
			2	a	81.0
			1	b	6.0
			3	b	0.0**
(Coll. 5-28-66)					
4	a	88.0	4	a	100.0
3	a	16.0	1	b	61.0
2	b	0.0[c]	2	bc	55.0
1	b	0.0[c]***	3	c	0.0**

[a]Table 3-G Treatments: (Mowing and removing winter stubble 3-30-65; one plot hydraulically, 30 psi, 15 G/A sprayed after mowing)

1. Oscillating mower
2. Reel-type mower
3. Untreated (Geometric average adult weevil count 16.0; larval count 1299.0)
4. Oscillating mower; sprayed malathion, EC (1.0), 5-12-66

[b]Duncan's Multiple Range Test at level indicated for Log (N + 1) of the data; antilog of data means —1 is presented as the geometric average count per 25 sweeps. Treatments sharing a letter in common do not differ in effectiveness.

[c]Negative control (more specimens in treated than in untreated plots) is acknowledged by 0.0% to indicate lack of control.

*1.0 per cent level of significance.

**5.0 per cent level of significance.

***10.0 per cent level of significance.

Experimental flaming and insecticidal foliar spraying were continued in 1967 in several fields on the Reedsville farm. Some of the plots were flamed only and some were both flamed and sprayed. The results of these tests show that both kinds of treatment, flaming alone and flaming followed by foliar sprays with malathion applied in the spring, significantly reduced weevil populations. The combination flaming application in March, plus the spraying treatment in May, was the best treatment (Tables 5-A, 5-B, and 5-C).

Malathion and azinphosmethyl foliar sprays gave economic control of the alfalfa weevil in plots on the Davis farm (Table 5-D). The plots were flamed late in March 1967.

TABLE 4

Hay Yield Data from Fields Treated with Hydraulic Sprays and Flaming Procedures 1966.

Treatments (Spray Applications as Indicated)	Total Hay Average Yield Tons/A	Total Alfalfa Average Yield Tons/A
Widmyer Farm, Field 8 (5A)		
1 Flamed November 15, 1965, 3 mph; Sprayed April 15, 1966, SD-7438, EC (0.25) + Methyl Parathion, EC (0.25) (2A)	1.54[a]	1.51
2 Flamed March, 1966, 3 mph; Sprayed April 15, 1966, SD-7438, EC (0.25) + Methyl Parathion, EC (0.25) (2A)	1.04[a]	1.01
3 Untreated (1A)	1.37[a]	0.99
Field 9 (20A)		
1 Flamed October, 1965, 3 mph; Sprayed April 30, 1966, Malathion, EC (1.0) + Methoxychlor, EC (0.5) (4A)	1.57[b]	1.57
2 Flamed November, 1965, 3 mph; Sprayed April 30, 1966, Insecticide SD-7438, EC (0.5) + Methyl Parathion, EC (0.25) (4A)	1.61[b]	1.61
3 Flamed March, 1966, 3 mph; Sprayed April 30, 1966, Insecticide, 7EL, Sun Oil (4G) (4A)	1.19[b]	1.19
4 Flamed March, 1966, 3 mph; Sprayed April 30, 1966, SD-7438, EC (0.75) + Methyl Parathion, EC (0.25) (4A)	1.33[b]	1.33
5 Sprayed October 15, 1965, Malathion, EC (1.0) + Sun Oil, 91EL (4G) and again November 2, 1965 with Alfatox (1 qt.) + Sun Oil, 9N (4G); Flamed March 3, 1966, 3 mph (3A)	1.28[b]	1.28
6 Untreated (1A)	1.37[a]	0.99

(Continued)

TABLE 4 (Continued)

Treatments (Spray Applications As Indicated)	Total Hay Average Yield Tons/A	Total Alfalfa Average Yield Tons/A
Blue Farm, Field 5 (10A)		
1 Flamed November 16, 1965, 3 mph; Sprayed May 4, 1966, Malathion, EC (1.25) (2A)	1.14[a]	1.14
2 Flamed November 16, 1965, 3 mph; Sprayed April 20, 1966, SD-7438, EC (0.5) + Methyl Parathion, EC (0.5) (Tank mix) (2A)	1.37[a]	1.37
4 Flamed March 23, 1966, 3 mph; Sprayed May 4, 1966, SD-7438, EC (0.5) + Methyl Parathion, EC (0.5) (2A)	1.04[a]	1.04
5 Flamed March 23, 1966, 3 mph; Sprayed April 20, 1966, SD-7438, EC (0.5) + Methyl Parathion, EC (0.5) (Premix) (2A)	1.26[a]	1.26
6 Untreated (2A)	0.69[a]	0.69

[a]Average of 4 samples
[b]Average of 3 samples

TABLE 5

Comparative Effectiveness of Gas Flaming and Foliar Spray Treatments to Control the Alfalfa Weevil (1967).

Adult Weevils			Weevil Larvae		
Treatments[a]	Comp. Effectiveness[b]	% Kill	Treatments[a]	Comp. Effectiveness[b]	% Kill
A–REEDSVILLE FARM (A4, S1, 2, 3 and 4; Plots 5A x 2) (Coll. 5-5-67)					
2	a	75.0	2	a	88.0
1	a	0.0	1	b	0.0**
(Coll. 5-12-67)					
2	a	85.0	2	a	97.0
1	b	0.0**	1	b	0.0*

[a]Table 5-A Treatments: (LP gas flamed 100 psi, 3.5 mph; hydraulically sprayed 30 psi, 15 G/A)

1. Untreated (Geometric average adult weevil count 37.0; larval count 1147.0)
2. Flamed, 4-12-67; sprayed malathion, EC (1.0), 5-2-67

B—REEDSVILLE FARM (A6, S1; Plots 6.5A x 2)

(Coll. 5-5-67)

2	a	80.0	2	a	89.0**
1	a	. . .	1	b	
		(Coll. 5-12-67)			
2	a	92.0**	2	a	86.0***
1	b	. . .	1	b	. . .

[a]Table 5-B Treatments: (LP gas flamed 60 psi, 3.5 mph; hydraulically sprayed 30 psi, 15 G/A)

1. Flamed, 3-20-67
2. Flamed, 3-20-67; sprayed malathion, EC (1.0), 5-2-67

(No untreated plots, the per cent represents per cent fewer specimens in one treated as compared with the other; geometric average adult weevil count 28.0; larval count 374.0)

C—REEDSVILLE FARM (A5, S1; Plots 6.5A x 2)

(Coll. 5-5-67)

2	a	0.0[c]	2	a	62.0
3	a	0.0	3	a	0.0
1	a	0.0[c]	1	a	0.0[c]**
		(Coll. 5-12-67)			
2	a	100.0	2	a	83.0
1	ab	80.0	1	b	7.0
3	b	0.0***	3	b	0.0**

[a]Table 5-C Treatments: (LP gas flamed 60 psi, 3.5 mph; hydraulically sprayed 30 psi, 15 G/A)

1. Flamed, 3-20-67
2. Flamed, 3-20-67; sprayed malathion, EC (1.0), 5-2-67
3. Untreated (Geometric average adult weevil count 4.0; larval count 428.0)

(Continued)

Conclusions

Thermal treatments (flaming) and combined thermal and insecticidal treatments are effective in reducing alfalfa weevil populations when properly applied.

Thermal treatments can be applied at times of the year when the farmer is not too busy with other farming activities. Flaming procedures usually assure the farmer protection against alfalfa weevil in the spring until he can apply required foliar treatments which are a necessary part of an integrated control program. Frequently the weather, during critical weevil damage periods in the spring, prevents foliar treatments from being applied at the proper time, in the correct manner, and commonly when this occurs extensive damage is inflicted on the first cutting by improperly controlled larval feeding.

TABLE 5 (Continued)

Adult Weevils			Weevil Larvae		
Treat-ments[a]	Comp. Effective-ness[b]	% Kill	Treat-ments[a]	Comp. Effective-ness[b]	% Kill
		D—PRESTON DAVIS FARM (Plots 2A x 2) *(Coll. 5-13-67)*			
3	a	98.0	1	a	96.0
1	ab	92.0	2	a	96.0
2	bc	85.0	4	ab	89.0
6	bc	65.0	3	ab	71.0
4	bc	58.0	5	ab	0.0
5	c	0.0**	6	b	0.0[c]***
		(Coll. 5-23-67)			
2	a	97.0	3	a	87.0
3	b	76.0	2	ab	80.0
1	bc	18.0	4	ab	79.0
5	c	0.0	1	ab	72.0
6	c	0.0[c]	5	ab	0.0
4	c	0.0[c]**	6	b	0.0[c]***

[a]Table 5-D Treatments: (All plots LP gas flamed, 60 psi, 3.5 mph 3-31-67; plots hydraulically sprayed 30 psi, 30 G/A, 5-3-67)

1. Malathion, EC (1.0)
2. Azinphosmethyl, EC (0.75)
3. Malathion, EC (0.75)
4. Carbaryl, 80W, (1.0)
5. Untreated (Geometric average adult weevil count 20.0; larval count 50.0)
6. Naled, EC (1.0)

[b]Duncan's Multiple Range Test at level indicated for Log (N + 1) of the data; antilog of data means —1 is presented as the geometric average count per 25 sweeps. Treatments sharing a letter in common do not differ in effectiveness.

[c]Negative control (more specimens in treated than in untreated plots) is acknowledged by 0.0% to indicate lack of control.

*1.0 per cent level of significance.

**5.0 per cent level of significance.

***10.0 per cent level of significance.

In addition to reducing weevil populations, the growth of certain weed pests (pepper grass and chickweed) is effectively retarded in flamed plots.

Flaming operations to reduce weevil populations can be effectively applied in West Virginia either in the fall (mid-November to mid-December) or in the spring (mid-February to late March). The prevailing weather and careful field observations will dictate the timing of the flaming in either season. Follow-up insecticidal treatment(s) on the foliage is usually necessary to achieve economic control of the alfalfa weevil until harvest time of the first cutting.

Tractor speeds less than 3 mph are not practical and more than 4 mph are not feasible under West Virginia conditions of terrain. The better flaming results were achieved with gas pressures of about 60 psi and a flame impingement angle with the soil surface of 60° with the tip of the burner approximately 16 inches above the ground.

Literature Cited

Bennett, S. E. and H. Luttrell. 1965. Alfalfa weevil control by flaming. Tenn. Farm and Home Sci. Prog. Rep. 55:6-8.

Bishop, J. L. and R. L. Pienkowski. 1967. Early season control of the alfalfa weevil. J. Econ. Entomol. 60(4):1171-73.

Essig, E. O. and A. E. Michelbacher. 1933. The alfalfa weevil. Calif. Agr. Exp. Sta. Bull. 567.

Hughes, J. H. 1943. The alfalfa plant bug, (*Adelphocoris lineolatus*) (Goeze) and other Miridae (Hemiptera) in relation to alfalfa seed production in Minnesota. Minn. Agr. Exp. Sta. Bull. 161.

Lilly, C. E. and G. A. Hobbs. 1962. Effects of spring burning and insecticides on the superb plant bug *Adelphocoris superbus* (Uhli) and associated fauna in alfalfa seed fields. Can. J. Plant Sci. 42:53-61.

Miller, R. L. and V. J. Thompson. 1967. Winter flaming with LP gas to control alfalfa weevil. Ky. Univ. Ext. Misc. 345.

Webster, F. M. 1912. Preliminary report on the alfalfa weevil. U.S.D.A. Bur. Entomol. Bull. 112.