Comparative Residual Nature of Certain Insecticides Applied as Low Volume Concentrate and Water Emulsion Sprays

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Studies conducted over a 3-year-period yielded results which strongly indicate that applying insecticides in a highly concentrated form caused greater initial deposits and longer residual action than when the same materials were applied as water emulsion sprays. These investigations included malathion on grain sorghum and oats, and malathion, azinphosmethyl, and methyl parathion on alfalfa.

Messenger (1) first reported the successful use of applying insecticides as low volume concentrates. He stated that certain grasshoppers on the western rangeland were controlled with technical malathion at a rate as low as 6 fluid ounces per acre. Malathion applied in the same manner also has been used on a large scale program to reduce overwintering boll weevil population in the High Plains of Texas (2,3). Low volume formulations of malathion and other chemicals have given effective control of the boll weevil, bollworm, and tobacco budworm (4,5).

Based on previous studies, it is apparent that a prolonged residual toxicity existed when the toxicants were applied as low volume rather than as conventional sprays. Little

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information is available on the manner in which this greater toxicity is achieved. Nemec and co-workers (6) reported that chemical residue analysis showed the greater residual action was due primarily to more material being deposited on the plant by the low volume method. This and other causes for the increased residual toxicity of insecticides applied as low volume concentrates are considered in the present study. For simplicity of presentation, the various experiments will be discussed in relation to the crop on which the insecticides were applied.

Alfalfa

Low volume and conventional sprays of malathion, methyl parathion and azinphosmethyl were applied by airplane to alfalfa that was 10 to 12 inches in height. Low volume concentrates of the toxicants were applied at 60 feet swaths and the conventional water emulsion sprays were applied at swaths of 35 feet. Total volumes delivered per acre by the 2 methods of application were 1 quart and 2 gallons, respectively. The plots were 150 feet long.

Samples collected from the treated and control plots were analyzed for insecticide residues according to reported colorimetric procedures for malathion (7), methyl parathion (8), and azinphosmethyl (9). In addition, each of these materials except azinphosmethyl were quantitated using sodium thermionic gas chromatographic techniques (10, 11).

The comparative deposits and dissipation rates of the 3

insecticides applied to alfalfa are shown in Table 1.

TABLE 1

Deposit and Dissipation of Insecticides from Alfalfa Following Aerial Applications of Water Emulsion and Low Volume Formulations

Days After Treatment	PPM Insecticide					
	Malathion		Azinphosmethyl		Methyl Parathion	
	W.E.	L.V.	W.E.	L.V.	W.E.	L.V.
0	16.19	30.60	7.36	26.92	25.07	36.20
1	9.23	6.82	5.85	15.46	3.86	9.15
3	1.21	2.51	1.83	6.01	1.73	2.39
7	.56	.22	.77	3.83	.32	.51
14	0	0	0	.80	0	0
21	0	0	0	.34	0	0

Rates in lbs/a; Malathion 1.0, Azinphosmethyl 0.5, Methyl Parathion 1.0 Volumes of spray per acre for water emulsion and low volume treatments were 2 gallons and 1 quart, respectively. W.E. - Water emulsion sprays; L.V. - Low volume concentrates.

In each case the low volume concentrate formulation resulted in a higher residue deposited on the crop. The difference in the amount of insecticide on the alfalfa was only slight for methyl parathion; however, alfalfa sprayed with low volume azinphosmethyl had 3 times more toxicant on the plant than those sprayed with the water emulsion formulation.

Rates of dissipation of malathion, azinphosmethyl, and methyl parathion from the alfalfa plant did not differ greatly when

applied as low volume or water emulsion sprays. The percentages of the deposits remaining on the plants 3 days after application were almost identical with both methods of treatment. There was an indication that residues of azinphosmethyl persisting after 3 days were more stable following low volume applications.

Oats

Four different treatments were utilized in the investigation of the residual properties of malathion on oats. Treatments I and II (Table 2) were designed to compare the residues on oats

TABLE 2

Residual life of Malathion When Applied Aerially as Water Emulsion and Low Volume Concentrate Formulations to Oats

Days After Treatment	PPM Malathion Residues			
	Water Emulsion[a]	Low Volume[b]		
	0.5 lbs/a	0.5 lbs/a	0.8 lbs/a	1.6 lbs/a
	Treatment			
	I	II	III	IV
0	30.76	98.20	47.66	67.17
1	13.81	56.85	18.38	46.65
3	6.03	44.53	3.37[c]	17.32[c]
5	1.19	32.27	3.50	11.43
7	0	24.51	3.32	9.76
11	0	9.20	2.17	4.19
15	0	6.22	2.02	3.34
21	0	1.63	--[d]	---
28	0	0	---	---

[a] Total volume spray per acre was 2 gallons; [b] Total volumes of spray per acre were 8, 12 and 24 ounces, respectively, for the three treatment rates; [c] One and one-half inches of rain fell between the 1st and 3rd day; [d] No samples collected.

resulting from low volume and water emulsion sprays of malathion. These were side-by-side tests with the same pilot applying both formulations. The water emulsion and low volume malathion were applied at 40 feet swaths to oats that were 5 to 8 inches in height. The water emulsion spray was applied at a rate of 0.5 pounds per acre and delivered in a total volume of 2 gallons of water. Eight fluid ounces of the concentrated malathion was applied to give a treatment rate of 0.5 pounds per acre.

Treatments III and IV were part of a large scale spray operation for the control of certain insects attacking oats. For both treatments, malathion was formulated as a low volume concentrate and applied at a swath width of approximately 100 feet.

In the 2 tests designed to evaluate the effect of formulation on residues of malathion on oats, it was found that the low volume concentrate gave greater deposits than the water diluted sprays (Table 2). In the side-by-side tests, deposits following low volume application (treatment II) were over 3 times greater than those on plants receiving conventional treatments (treatment I). In addition, the low volume applied residues tended to persist much longer. Malathion residues could still be detected 21 days after treatment. With the water emulsion residues, the quantity of toxicant on the plants after 7 days was undetectable.

The relative large deposits and increased persistance of malathion when applied as a low volume concentrate were further indicated by the results obtained in treatments III and IV

(Table 2). These experiments also project the extreme variation in insecticide deposits which are derived from aerially applying low volume concentrate materials. Though the calculated rate per acre of actual toxicant in treatment IV was approximately 3 times greater than in treatment II, much more malathion was deposited on the plants in the latter treatment.

Grain Sorghum

Grain sorghum was treated with malathion when approximately 75% of the head had completely emerged from the boot. Treatments were made by airplane. The water emulsion formulation of malathion was applied at a rate of 0.8 pounds per acre in a total volume of 2 gallons. An equivalent quantity of actual toxicant per acre, but with a total volume of 12 fluid ounces, was sprayed on adjoining plots. Initially, the samples collected for residue analyses were composed of the entire plant. After the grain was mature enough to remove from the heads, the stalk and heads were separated at harvest and the seeds removed before analysis.

The residual nature of malathion on grain sorghum forage following low volume and conventional spray applications is shown in Table 3. Only one application of water emulsion malathion was made (treatment I). Two separate experiments were conducted with the low volume formulation (treatments II and III). Different personnel and aircraft were used to apply the malathion in treatment III.

In evaluating the data from the low volume treatments

TABLE 3

Residues on Grain Sorghum Forage Resulting from Aerial Applications of Malathion as Water-Emulsion and Low Volume Concentrate Formulations.

Days After Treatment	PPM Malathion Residues Following Application of 0.8 lbs/a[a]		
	Water Emulsion	Low Volume	
	Treatment		
	I	II	III
0	14.82	35.89	15.09
1	1.21	28.70	5.66
3	.03	18.23	3.72
7	0	1.82	3.72
14	0	1.05	.91
21	0	.21	.60
28	0	.07	.03

[a] Volume of spray delivered per acre; water emulsion, 2 gallons; low volume concentrates, 12 fluid ounces.

(treatments II and III), which were designed to deliver identical quantities of spray per acre, it was found that treatment II plants contained over twice the insecticide residue than did plants in treatment III. Whether such variation can be expected with low volume application of insecticides is yet unknown. Although this difference was observed, the residues resulting from both low volume applications dissipated at a slower rate than

residues of the water emulsion spray. Traces of malathion were detectable 28 days after applying the low volume material, whereas the water emulsion residues were present for a maximum of 3 days.

Because of damage to the sorghum grain by insects and birds, no attempt was made to determine malathion residues on the seeds in treatment I and II. In treatment III, analyses were made on all grain beginning with the 14-day sample. Residues, 0.19 ppm, were found only on the grain sampled on the 14th day.

Discussion

Applying insecticides in very concentrated forms is now a common practice. This method reportedly affords more complete insect control and can be applied at a lower cost per acre. Like most drastic changes from the routine, first low volume applications of insecticides met with some skepticism and a concern that the practice could enhance pesticide residue hazards. Only those materials exhibiting a very low mammalian toxicity were considered for application in this manner. This attitude no longer exist among many insecticide users. Because of a noncommittal stand by the various regulatory agencies, many highly toxic and stable materials are now applied as low volume concentrates for insect control.

Results of the studies discussed in this report suggest that the increased residual toxicity attributed to the use of low volume insecticide sprays may be caused by two factors. First, it was found that in almost all comparative experiments that the low volume applied materials gave higher insecticide deposits on the

plant. Secondly, there were some indications that the low volume residues disappeared from the crops at a slower rate than residues of water emulsion formulations. The first factor seems to be the most important since often times rates of dissipation are the same regardless of the insecticide formulation. Both of these factors, and possibly others, do change the residual nature of an insecticide when applied as a low volume concentrate. For this reason, it appears necessary that each pesticide be thoroughly evaluated as to its residual life on the crop in question should there be a desire to apply the material in a concentrated form.

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