A Laboratory Evaluation of Test Apparatus and Techniques for Investigating Spray Deposit and Drift in Crack and Crevice Treatments[1,2]

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There is very little data available on the movement of insecticides from point of application to non-target areas in crack and crevice treatments. Methods utilized at present are not as accurate as is desired. Research is constantly being done to improve techniques and equipment that are available. Until recently the area of crack and crevice treatment has been largely neglected. SHORE (1974) used mathmetics to estimate the amount of residue in cracks and crevices based on the amount of insecticide that is used in application. WRIGHT and JACKSON (1975) studied deposit of insecticide residue in non-target areas after crack and crevice treatment using aerosol and compressed air sprayers.

This paper gives the results of a study using a test apparatus that shows potential in investigating deposit and drift in crack and crevice treatment in addition to evaluating and comparing available application equipment.

METHODS

For this study application equipment used by pest control operators was modified to fit the test apparatus. A Multi-Teeject[R] nozzle[3] and a B & G sprayer[4] was used for application of insecticide. The chemical used for testing the apparatus was analytical standard grade Chlordane[5].

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[1]Contribution from the Oklahoma State University Agricultural Experiment Station. Published with the approval of the . . . .

[2]Use of trade names in this publication does not imply endorsement of the products named or criticism of similar one not mentioned.

[3]B and G (3.785 liter) compressed air sprayer, manufactured by B and G Equipment Company, Plumsteadville, Pennsylvania.

[4]Ibid.

[5]Velsicol Chemical Corp., 341 East Ohio Street, Chicago, Ill.

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Modifications included adding petcock, air regulators, air pressure gauges and an outside inlet to provide for a constant tank pressure. A portable air tank was used as the external air supply to provide a constant source of air for tank pressure (Fig. 1).

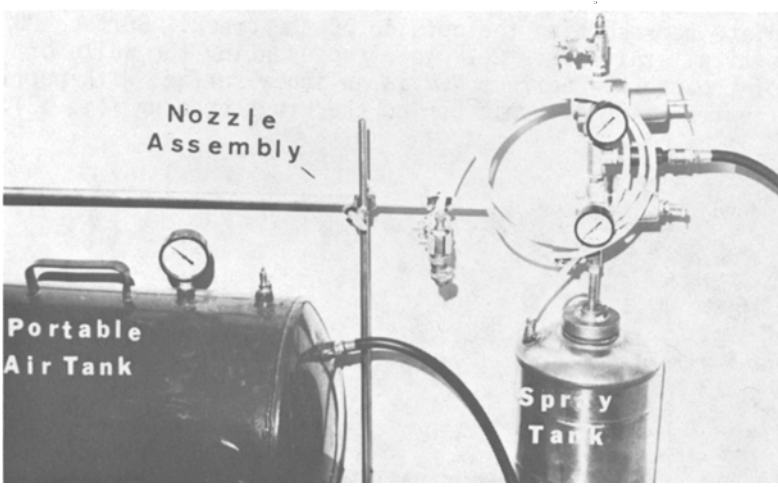

Fig. 1. Application Equipment

The spray nozzle was mounted on an adjustable base so that height from target surface and angle of spray could be adjusted. The nozzle assembly was then mounted on a motorized track device that provided for a constant speed during application. Speed of application could be adjusted to optimum rates.

The test apparatus was designed to simulate a crack. This "artificial crack" was constructed of aluminum and stainless steel. The artificial crack consisted of a base, base plate, and surface plates (Fig. 2).

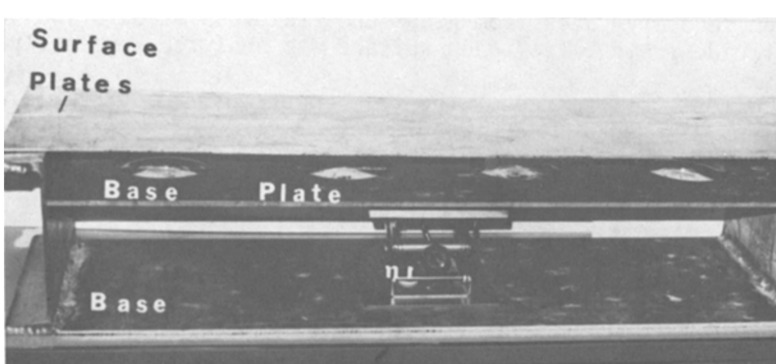

Fig. 2. Side view of test apparatus

The base provided a foundation for the test surfaces. The base plate was constructed to hold four petri dishes. The petri dishes provided a void area behind the crack opening. The surface plates served as a base for four sample areas which collected the insecticide residues. These sample collection areas has three surfaces for each area. Surface "A" is a horizontal stainless steel plate representing the outside of the crack. Surface "B" is a vertical stainless steel plate representing the walls or sides of the crack. Surface "C" is an inner surface with petri dishes representing the void behind the crack opening (Fig. 3).

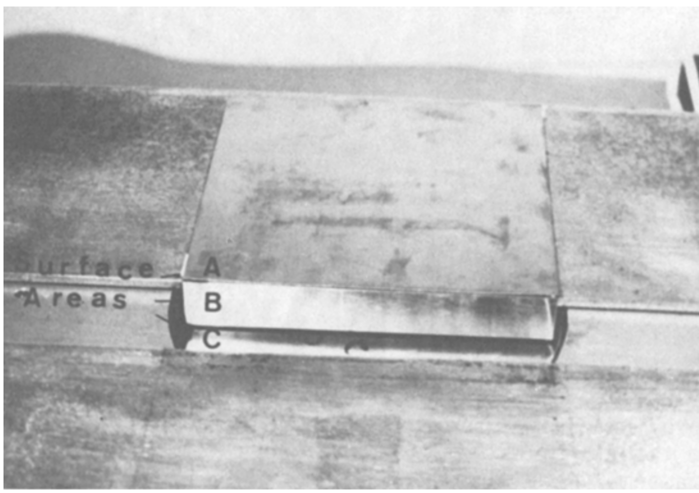

Fig. 3. Sample area with sample plates

The amount of insecticide deposited on test surfaces was determined through the use of gas chromatography. Insecticide samples were removed from sample area by using a solvent wash. Pre-test indicated recovery rates of 97 to 103% using benzene as the solvent wash. Test also indicated less than 1% variation between recovery rates from glass and stainless steel. The insecticide residue from each surface was analyzed seperately.

To test performance of the test apparatus, an .08% Chlordane solution was used. Tank pressure was .7 g/cm² with an application rate of .4 m/sec. This combination provided conditions favorable for test of apparatus's sensitivity to change in crack width and depth.

Tests were conducted using a randomized order of treatments with treatments being defined as one possible combination of four crack widths (3, 6, 9, 12 mm) and four crack depths (5, 10, 15, 20 mm). This gave a total of sixteen treatments, each providing twelve samples (four samples and three surfaces) which were analyzed individually[6]. The spray system was activated after the crack width and depth were set and the angle and distance from target surface checked. The nozzle was allowed to make one pass over the sample areas. After the insecticide was applied it was allowed to evaporate until the surface was dry (3 to 5 minutes). Sample plates and petri dishes were then removed from test apparatus and insecticide residues were washed into glass tubes for subsequent analysis. Insecticide residues were diluted for analysis. All results were corrected for dilution.

RESULTS AND DISCUSSION

Analysis of variance of the data for surface "A" -outside of crack- showed that there was no significant effect due to depth, width, or interaction between these factors. The amount of insecticide deposited on surface "A" (Table 1) ranged from 238 to 261 mg/liter with a mean deposit of 250 mg/l. This indicates that the amount of insecticide deposited on the outside of a crack will remain relatively constant at all widths and depths used in this test. This can be observed in figure 4.

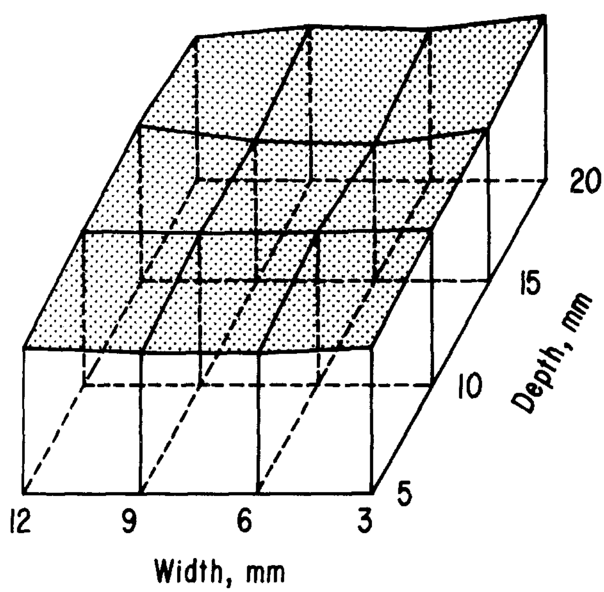

Fig. 4. Three dimensional surface derived from Table 1 for test surface A depicting amount of insecticide deposited at various crack widths and depths.

Analysis of variance for surface "B" showed that there was a significant effect due to depth, width and width by depth

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[6]Thanks are due to R. D. Morrison, Statistics Department, Oklahoma State University, Stillwater, who made the statistical analysis.

interaction. Figure 5 shows that as depth increases the amount of insecticide deposited also increases. The amount of insecticide deposited also increases as width increases up to 12 mm at which point there is a decrease in the amount of deposit. It will be noted that at the lower depths, 5 and 10 mm, there is a reduction in the amount of deposit as crack width is changed from 3 mm to 6 mm. (Fig. 5).

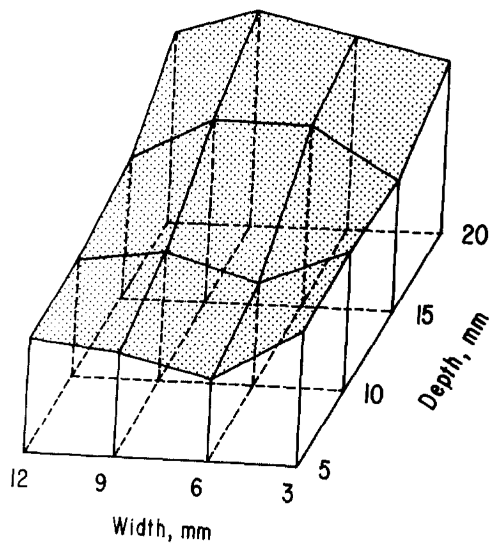

Fig. 5. Three dimensional surface derived from Table 1 for Test Surface C depicting amount of insecticide deposited at various crack depths and widths.

This implies that where the surface area of the crack is small, there will be less insecticide deposited. This is further strengthened by the fact that at the 6 mm width and at 15 and 20 mm depths, there is a sharp increase in the amount of insecticide deposited. It can be said that as crack width and depth increased, the amount of insecticide deposited increased until a point where the crack is so wide that some insecticide is apparently lost, as at the 12 mm width in this study. It is likely that at this width the air turbulence is such that some insecticide is blown out of the crack or into the void beyond the crack walls. Figure 6 shows that there is a marked increase in the amount of insecticide deposited at the 12 mm depth on surface "C."

The width by depth interaction for surface "B" indicates that as the crack gets wider and deeper the amount of insecticide deposited increases. The amount of insecticide deposited on surface "B" ranged from 1.8 to 4.6 mg/1 with an overall mean of 3.2 mg/1.

Analysis of variance for surface "C" showed that depth, width and depth by width interaction was highly significant. It can be seen (Fig. 6) that as width increases, the amount of insecticide deposited increases.

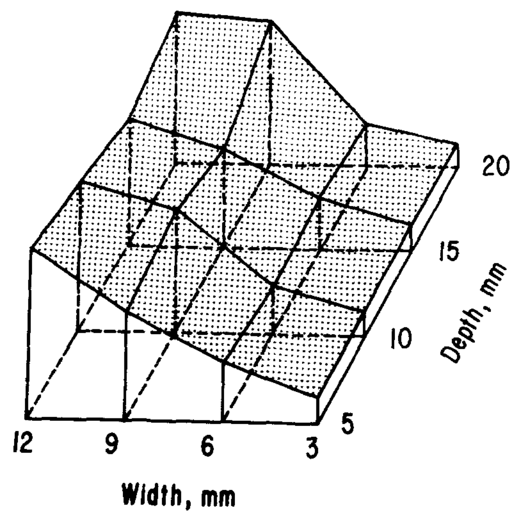

Fig. 6. Three dimensional surface derived from Table 1 for test surface C depicting amount of insecticide deposited at various crack depths and widths.

It can also be observed that while the depth effect is significant, it has a small effect on the amount of deposit. It appears that the amount of material deposited on surface "C" is affected by each depth only when the crack is more than 15 mm deep and only when it is more than 6 mm wide.

CONCLUSION

A crack's width and depth have very little effect on the amount of insecticide deposited on the outside of the crack. Factors such as rate of application, concentration of insecticide, tank pressure and air turbulence would have a more direct effect on the amount of deposit. While other factors such as humidity and temperature were not considered in this study, other researchers have shown their importance in spray deposition.

The amount of insecticide deposited along the interior of a crack is strongly influenced by the width of the crack. The wider the crack opening, the more insecticide deposited.

Data collected using the test apparatus has shown that the apparatus is able to provide a great deal of information about the factors influencing the amount of insecticide in crack and crevice treatments. The apparatus and techniques utilized during this study have proved to be accurate and sensitive to changes in crack width and depths. This method also gives valuable information as to the efficiency of the application equipment that was used in this study.

The next step is to test the apparatus using pressures. Concentrations, and methods presently being using by pest control operators.

REFERENCES

1. SHORE, J.: Pest Control, 42, 24 (1974).
2. WRIGHT, C. G. and W. D. JACKSON: Bull. Environ. Contamin. Toxicol. (1975).

TABLE 1

The total means of the amount of chlordane in milligrams deposited on three test surfaces

Depth[1]	Width[1]	Surface		
		A	B	C
5	3	248.385	3.016	2.899
5	6	239.804	1.862	6.193
5	9	248.555	2.283	11.043
5	12	248.080	2.540	16.574
10	3	255.545	3.041	2.631
10	6	251.673	2.233	5.269
10	9	261.335	3.342	13.101
10	12	255.209	2.479	15.824
15	3	255.761	2.870	2.887
15	6	244.890	3.999	5.730
15	9	254.817	3.917	10.468
15	12	255.423	3.054	13.770
20	3	256.048	3.660	2.198
20	6	246.666	4.171	4.646
20	9	250.868	4.627	14.727
20	12	238.253	3.753	15.848

[1]Measured in millimeters.