THE PATTERN AND PERSISTENCE OF DEPOSITS OF SEVIN, WITH AND WITHOUT SURFACTANTS, ON THE FOLIAGE OF FRUIT TREES II. APPLICATION BY HIGH VOLUME SPRAYER[1]

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Introduction

In a previous paper (5) an account was given of the distribution and decline of deposits of Sevin (1-naphthyl *N*-methylcarbamate), using a method of extraction applicable to the deposit on one side of a single leaf. The influence of Plyac (active ingredient, polyethylene 629) on these deposits was also investigated. Those investigations were made using the 'concentrate' air-blast method of spraying. In concentrate spraying the wet deposit on foliage consists of a dense pattern of drops. These drops have coalesced from the smaller drops in the air that have fallen on the leaves. By correct manipulation of the sprayer, these drops do not coalesce to the point where irregular patches of fluid occur, i.e., to the point of 'incipient run-off' (3). In high volume spraying, on the other hand, the foliage is deliberately drenched with large quantities of fluid, much of which ultimately falls to the ground. The film of water retained produces an insecticide deposit, which on drying, is different in many ways from that produced by concentrate spraying. In this paper an account is given of some characteristics of the deposits from high volume application. Points of comparison and contrast are made with the findings in the previous paper (5) in which concentrate spraying was used.

Methods

The methods, trees, and sampling arrangements were as previously described (5) except in a few important respects.

The sprayer used was a truck-mounted, gun-type machine. It was operated at a pump pressure of 400 pounds per square inch. The cherry trees were sprayed very thoroughly, approximately 20 Imperial[3] gallons being used per tree. Sevin, 50 per cent wettable powder, was applied at a rate of one pound per 100 gallons, and, Plyac, when included, at one pint per 100 gallons. This is one-sixteenth the concentration used in the concentrate application (5). Leaf samples were taken immediately after the deposits were dry, and six days later.

In place of the device previously used (5) a new piece of apparatus was constructed that allowed the simultaneous, but separate, removal of the deposits from the two faces of the same leaf. This apparatus is described elsewhere (6). Since both faces of each leaf were analyzed for insecticide it was possible to test for correlation between deposit size for the two surfaces. This was not possible in the former study.

Chemical analysis of the extracts was made according to the method of Miskus, Gordon and George (4).

Results

The mean values of deposits grouped according to sampling time, leaf surface, and treatment are shown in Table I. Ratios, showing the relation

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[3] Imperial measure used throughout.

TABLE 1.—The Influence of Surface, and Presence of Plyac, on the Mean Deposits of Sevin Produced on Cherry Foliage by High Volume Spraying.

Time	Surface	Mean deposit of Sevin, micrograms per sq. cm. With Plyac	Without Plyac	Ratio: with/without
Day 0	Lower, L	1.76	3.12	**0.56***
	Upper, U	1.39	2.43	**0.57***
	Ratio: L/U	**1.27***	**1.28***	
Day 6	Lower, L	0.78	1.64	**0.48***
	Upper, U	0.49	0.87	**0.56***
	Ratio: L/U	**1.59***	**1.89***	

* All ratios significantly different from the null hypothesis value of 1.0.

between deposit size on the two leaf surfaces and between treatments, are also included in the table. It will be seen that, as in concentrate spraying (5) deposits are heavier on the lower surfaces of leaves. A conspicuous effect, but in the reverse direction to that observed with concentrate spraying, is also obvious as a result of Plyac treatment.

To see whether the values for deposit size on the lower leaf surfaces ranged independently of those on the upper surfaces, coefficients of correlation were calculated. For deposits sampled on the day of spray application, the coefficient of correlation between the lower and upper deposits was 0.3695 when Sevin plus Plyac was used; where Sevin was used alone it was 0.3797. Examination of Table VI in Fisher and Yates Statistical Tables (1) shows that these values are highly significant ($P = 0.01$). At the sampling on the sixth day the values of the coefficient were, respectively, 0.3057 and -0.1382. The former value is significant ($P = 0.05$) but the latter is not. It would appear, therefore, that initially there is a slight tendency for a heavy deposit on one surface to be associated with a heavy deposit on the other, and vice versa; but this relation tends to disappear or be reduced with time.

TABLE 2.—Sevin Deposits on Cherry Foliage. Samples Taken Immediately the Spray Had Dried. Means and Variances for Two Methods of Application, Presence Absence of Plyac, and for Upper and Lower Leaf Surfaces.

Type of spraying	Plyac	Leaf surface	Sevin deposit, Micrograms per sq. cm. Mean	Variance
Concentrate air-blast	Present	Lower	3.309	1.922
		Upper	1.885	1.227
	Absent	Lower	2.456	1.662
		Upper	1.405	0.953
			general mean, concentrate: 2.264	
High volume, hydraulic	Present	Lower	1.761	0.245[2]
		Upper	1.387	0.306[2]
	Absent	Lower	3.119	0.519[1]
		Upper	2.427	0.501[1]
			general mean, high volume: 2.178	

[1] Significantly lower than corresponding variance for concentrate application.
[2] Significantly lower than when Plyac absent in high volume application.

There was much less variation in deposit from leaf to leaf than was observed with concentrate application. The variances, for both leaf surfaces, and both treatments, are shown, together with the values for the mean, in Table 2. Also included in this table are some relevant figures from the previous study on concentrate application (5) together with values for the variance which were not previously published. The general mean for high-volume spraying was 2.178 micrograms per square centimeter; that for the concentrate application of the previous study was 2.264 micrograms. The closeness of mean deposit in the two series of experiments emphasizes the validity of comparison of various criteria for the two methods of application.

Discussion

The results summarized in Table 1 show that, as with concentrate spraying (5), significantly more Sevin is deposited on the lower surfaces of the leaves. With time this ratio increases as a result of a more rapid loss from the upper surfaces. Also, as in the previous work (5), the addition of Plyac does not alter the ratio of the initial deposits between lower and upper surfaces. Unlike the results previously obtained with concentrate spraying, however, there is no evidence that Plyac reduces the rate of decline of deposits.

However, the most noteworthy point of this investigation is that the addition of Plyac, instead of producing an increase in deposit of Sevin, as with concentrate spraying (5), reduced the initial deposits by nearly half. This reversal of effect, which holds for apple as well as cherry, has been referred to in a preliminary account (7). Plyac is generally described as a sticker-spreader (2). However, these results, in combination with those of the previous paper (5) suggest that the spreading properties are predominant in high volume spraying whereas the sticking properties are predominant in concentrate application. The abundance of water used in high volume application, and the ready wetting properties of the surfactant, ensure not only the production of a thin film of fluid on the leaves, but facilitate, all too well, run-off of the surplus fluid. On the contrary, with efficient concentrate application, no run-off occurs (3). Run-off is particularly wasteful with concentrated spray fluids. The Plyac additive cannot, under these conditions, promote film-formation nor enhance the efficiency of run-off. The increased deposits obtained in this form of spraying have been attributed to reduced loss from rebounding spray drops, and improved adhesion of the discrete clusters of particles of Sevin (5).

In Table 2 another important effect of the addition of Plyac in high volume spraying is apparent. There is much less variability in magnitude of deposits, between leaves when this material is present. The variance, for either upper or lower surfaces, was reduced to approximately one half by the addition of Plyac. On the other hand, the addition of Plyac did not produce any significant difference in variance in concentrate spraying. In the light of the comments in the previous paragraph this is what one might expect. Spreading properties, such as those shown by Plyac in high-volume spraying, tend to promote uniformity. But there is no reason why the sticking qualities, more apparent in concentrate spraying, should promote a more uniform deposit.

Another point, apparent in Table 2, is that even in the absence of Plyac, leaf-to-leaf variance is two or three times greater in concentrate than in high-volume spraying. This

virtue of reduced variance, however, is bought at the price of a greatly increased amount of insecticide per acre for in high-volume spraying a large proportion of the spray fluid runs off the foliage and is lost on the ground. The proportion lost varies with the stage of foliar growth of the trees. However, in general, high-volume spraying uses twice as much insecticide per acre, and about 20 times as much water, to do the same job of insect control (3).

The low value of correlation between fresh deposits on the two surfaces shows there is a tendency for a heavy deposit on one surface to be associated with a heavy deposit on the other. The relation is not very marked, however, and it tends to disappear with time presumably as a result of the equalizing effects of weathering and loss processes.

Summary

A study of the inter-leaf pattern of deposits of Sevin on cherry foliage has been made using high-volume methods of spray application. The results are contrasted with previous studies in which concentrate air-blast spraying was used. As in the latter case there were no significant differences in mean deposit up to a height of 14 feet; nor were there any differences associated with different quadrants of the trees. Initially, deposits were approximately 27 per cent higher on the lower than on the upper surfaces of the leaves. Subsequent erosion was more rapid on the upper surface so that this disparity increased with time. This relation was not, however, as marked as in concentrate application. The addition of one pint of Plyac to one pound of 50 per cent Sevin resulted in decreased initial deposits; the reverse of the relation with concentrate application. However, the addition of Plyac markedly reduced the leaf-to-leaf variance; in contrast to concentrate spraying, where Plyac made no change. The variance was always less in high volume than in concentrate spraying. There was only a slight tendency for a high deposit on a lower surface to be associated with a high deposit on an upper surface; and vice versa. This correlation was significant but low immediately after application; after six days it was reduced or absent.

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