AERIAL DISTRIBUTION OF PELLETTED MATERIALS

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Summary

The aerial distribution of pelleted DDT insecticide/fertilizer admixtures and the resultant herbage DDT residues were compared. Results showed flying at an altitude of 80 ft and at wing-span (36 ft) intervals gave an even spread when the material was released from the hopper mouth. Swath displacement data under varying conditions showed that accurate swath placement was not possible and in consequence application from the hopper mouth was unsatisfactory.

Based on overseas reports it is recommended that spreading devices to be tested as they give a distribution pattern approaching the ideal. As the effects of swath placement errors are reduced with them, it appears that good ground cover from aerial application of pelleted insecticides is possible.

INTRODUCTION

WHILE it was anticipated that the Agricultural Chemicals (Insecticide) Regulations 1964 would reduce the hazards of contamination of animal foodstuffs, they nevertheless caused considerable concern regarding future insect control. The new DDT formulations had been shown to reduce herbage levels of DDT to a satisfactory level (Dorofaeff, 1962), and some had been shown to have a high insecticidal activity. There was some doubt regarding the adequacy of ground cover of aerial applied pelleted materials.

Wet- and dry-mix superphosphate had previously been found relatively satisfactory for control of grass-grub (*Costelytra zealandica* (White)) and the porina caterpillar (*Wiseana* spp.) when applied from the air. This was due to the fine particles of DDT in dry-mix and the finer particle superphosphate containing DDT in wet-mix superphosphate drifting considerable distances. J. M. Telford (pers. comm.) showed that particles passing 100 B.S. mesh were blown a distance of $\frac{1}{4}$ mile in a 5 m.p.h. wind when dropped from an altitude of 60 ft. Such drift resulted in the application of DDT being reasonably evenly distributed under conditions where the spread of superphosphate was most uneven.

The change to granular or pelleted formulations of DDT meant that very little fine-particle DDT was present and that the DDT distribution would be similar to that of the pellets. Even distribution thus assumed vital importance, and because few data were available distribution investigations were undertaken at Invermay Research Station.

Fig. 1: Effect of varying swath widths.

DISTRIBUTION FROM THE HOPPER MOUTH

EXPERIMENTAL

The initial experiment investigated the rate of application of the materials approved under the Agricultural Chemicals (Insecticide) Regulations 1964 in zones of high concentration, when applied by light aircraft. Width of effective spread, displacement of the swath, and degree and extent of DDT contamination of pasture were also examined.

The materials compared were granulated superphosphate and separate admixtures of Stauffer pellets* and aerial superphosphate, and DDT prills† and aerial superphosphate. Recovery was made in carbon tetrachloride which was subsequently analysed for DDT content by the method of Palmer-Jones *et al.* (1954). This was done in order to check whether DDT dust had abraded off the granules and pellets. The findings of Harrison *et al.* (1964) showed that this could be important; they found that only 8% of the DDT had drifted in a spinner topdresser trial but this fraction caused 40% of the pasture contamination.

The distribution pattern was measured by placing sixteen jars 6 ft apart in the centre portion of a grid and four 12 ft apart at both sides. Three cross-sections were placed out for each of 12 air drops. Counts of prills and Stauffer pellets were made from the jar collections. Dry collection in conical shaped plastic catchers enabled a check to be made on the fertilizer distribution as well as that of DDT distribution. Turfs carrying pasture of suitable composition were placed out in trays (1 ft 6 in. square) and sampled for subsequent DDT analysis by the method of Harrison *et al.* (1963).

Twelve airdrops were made from an altitude of 80 ft; six in the absence of wind (from 0 to 3 m.p.h.) and six in stronger cross-winds (up to 6 m.p.h.). Material was released from the hopper mouth.

RESULTS

Mean widths of spread are shown in Table 1.

TABLE 1: WIDTH OF BAND RECEIVING MORE THAN THE FOLLOWING LB/ACRE DDT

(Each figure represents the mean of three cross-sections on each of four separate swaths)

	$\frac{1}{4}$	$\frac{1}{2}$	1	2	Total detectable width
Prills+super.	48	46	40	35	65
Stauffer pellets+super.	42	42	32	25	57
Granulated DDT super.	49	49	39	30	65

Statistical examination showed that the above materials did not differ significantly in width of spread. The spread of Stauffer pellets + superphosphate appears narrow but in all likelihood was due to a lower rate of release from the aircraft. From the mean of all materials a distribution curve has been established and is shown in Fig. 1. In Fig. 1(a) runs are overlapped at the swath distance which gives the most even spread. This can be seen to be 36 ft—the wing-span of the aircraft. It will be noted that the intended

* Produced by the Stauffer Chemical Company, New York, and hereafter referred to as Stauffer pellets.

† Prills produced by Farm Chemicals Co., Port Mapua, New Zealand, and hereafter referred to as prills.

level of DDT application of 2 lb per acre is exceeded by $\frac{1}{4}$ lb per acre with this spacing. Reducing the rate of release slightly would reduce this to the correct rate (2 lb per acre) without materially affecting the width of spread or distribution pattern (Scott, 1965). In practice, pilots fly further apart than 36 ft and as a result certain areas will receive more than 2 lb per acre DDT and other areas will receive less. In Fig. 1(b) the effect of flying 44 ft apart using the same distribution patterns shows the unsatisfactory spread resulting from a small placement error of 8 ft. In this case only 44% of the area received 2 lb per acre DDT or more.

The above results might be taken to indicate that the distribution of these materials released from the hopper mouth is quite satisfactory provided the swath width is 36 ft. The writer would not subscribe to this view because of the near impossibility for pilots to place swaths accurately 36 ft apart. In Fig. 1, for example, the distribution is shown where the pilot flies only 8 ft off course. Other experiments (Scott, 1964 and 1965) with fertilizer, seed, and insecticides have been conducted under ideal conditions. Marker boards have been used to direct pilots, wind socks and smoke pots have been used to indicate drift, long approaches have been possible, and experienced pilots have been engaged. In spite of these aids, the placement of fertilizer from the air has been extremely inaccurate. For example, in the experiment described earlier in this paper, half the runs were applied in the absence of wind or with extremely light winds and the distances of the modal point of the swath from the intended point (down the marker boards) was 7 ft. Half the runs were made in winds up to 6 m.p.h. with a reasonable cross-wind component and under such conditions the modal point of the swath was 25 ft removed from the intended point. From these figures, together with the results shown in Fig. 1, it is apparent how unevenly DDT is being applied in practice. Pilots have no set markers and have to rely on remembered landmarks and guess distances. Finally, they have to contend with changing slopes, variable winds and different winds in gullies compared with ridges. All these factors alone or in combination can give partial or complete overlapping and lead to large areas of untreated pastures.

Flying at higher altitudes does not improve the evenness of spread or increase of swath width significantly. Table 2 shows the changes in width of spread of aerial and granulated super (96% passed the 7 and retained on 25 B.S. mesh) at increasing altitude where a rate of 2 cwt per acre was applied.

TABLE 2: SWATH WIDTH (FT) OF AREA RECEIVING
1 CWT PER ACRE OR MORE
(Each the mean of 3 cross-sections from 8 runs — 4 with and
4 without cross wind)

Altitude (ft)	Aerial Super.				Granulated Super.			
75				28.8	.....	.....	.....	30.1
100				29.5	.....	.....	.....	33.2
200				27.6	.....	.....	.....	37.1
400				26.0	.....	.....	.....	40.0

Results show little increase in swath width between 75 and 100 ft. At a higher altitude of 200 ft, the width with granulated superphosphate is increased slightly more. With aerial superphosphate it actually decreased, although width of detectable superphosphate

was much wider. This was because most of it was going on at less than 1 cwt per acre. The situation is clear: if altitudes above 75 to 100 ft are flown, an increased width of only 3 to 6 ft can be expected. Where higher altitudes are flown, the large errors in placement more than offset the small benefit of greater width of spread.

Pastures were sampled for DDT analysis 3 days after treatment. Levels of DDT were variable with a few very high levels. No difference was detected in herbage level of DDT as a result of the formulation of material applied.

Excluding a few anomalous levels, calculations were made using the data of Dorofoeff (1962) and Harrison (1962) by extrapolating herbage levels recorded at 3 days to those for the 14-day withholding period. This reduced herbage DDT for the higher group of original levels to levels considered unsafe for dairy cows (Harrison, 1962) but marginally safe for dry sheep using the figures quoted by Matthews (1964).

SPREADING DEVICES

The writer has little experimental evidence regarding the performance of spreading devices other than from personal observation. There is, however, a large amount of literature on this subject — largely from U.S.A. To quote some of the results: Roth (1954) recorded widths of 80 to 90 ft with rice seeds, and Wieck and Roth (1954) recorded a width of 58 to 60 ft with wheat seed. Powell (1959), using another type of spreader, obtained a width of 60 ft using granular fertilizer. Nelson (1960), using pelleted urea and granular ammonium nitrate, obtained widths of up to 100 ft with rates of application ranging up to 200 lb per acre when applied from altitudes no higher than 30 ft. Henry (1961), using 30–60 B.S. mesh granular clay (insecticide base), recorded swath widths of 60 ft. In Hawaii, Roth (1961) developed a spreader in which there were special louvres which permitted the application of rates of granular materials as high as 400 lb per acre without "choking". He obtained swath widths ranging from 60 to 80 ft at altitudes of 25 to 50 ft. A very large volume of further evidence can be assembled.

In view of the above, there is little doubt that wider spreads of pelleted materials are possible where fairly light rates of application are applied. Possibly, where rates of 200 lb per acre or more are attempted, the performance of spreading devices becomes doubtful.

It appears that these spreading devices provide the most likely means at our disposal for obtaining a reasonably even spread of pelleted insecticide materials. Not only is the distribution pattern of the majority of them wide but it is also even and lacking the high bands of concentration that occur when material is released directly from the hopper mouth. With fewer swaths, there is less chance of overlap errors on a given area. Furthermore, the type of pattern obtained is usually trapezoidal — a wide, even pattern which falls off evenly at both sides. Such a pattern is most satisfactory because, where overlap errors are present, the resultant distribution is not excessively high.

A great deal of testing of these spreading devices is necessary to ensure that they operate correctly. This is especially important with spreading devices which are dependent on intricate rigging adjustments to operate correctly.

Provided that the spreaders have been tested and found to give a satisfactory distribution pattern, and provided that errors such as those described are guarded against, a satisfactory spread of pelleted insecticides for good insect control should be possible.

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