DISTRIBUTION PATTERN OF TEMEPHOS GRANULES APPLIED BY THE HORN SEEDER®[1]

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ABSTRACT. To investigate the distribution pattern of granules applied by the Horn Seeder®, 9 individuals calibrated the device at various settings, and the 4 individuals applying closest to the desired mean and with a low coefficient of variation were further examined for their application under woodland conditions. While calibration rates varied between the 9 individuals, a setting of 1 was judged most appropriate for 5 lbs. granular celatom formulation/acre (5.6 kg/ha). Under woodland conditions, generally the mean application rate and its variation increased, and overtreatment was more associated with a small target area. The overall probability estimate for sampling areas receiving 0.5-2X the expected amount was 52%.

INTRODUCTION

An estimate of the potential value of a new insecticide in mosquito control and its possible impact on non-target organisms is derived from a large segment of research which eventually yields the recommended dosage rates (lbs/acre, g/ha) and any environmental precautions to be taken. The insecticide applicator strives to conform with these rates and precautions. Generally, based upon the amount of insecticide used and the total acreage treated, the rate of application will average close to that specified on the insecticide label. However, within the acreage treated or within each acre, the rate varies depending on equipment, weather conditions and personnel. If extreme, the variation is very important. A low rate in one area may result in incomplete mosquito control, while a higher rate in a nearby area may involve environmental hazards in excess of those cautions on the label. A previous study of the application by helicopter of Abate® (temephos) granules (Sutherland et al. 1974) indicated under some conditions the probability of applying granules at 0.5-2X the recommended application rate to a sample area of 1.69 ft^2 (0.16 m^2) was approximately 50%. While 100% probability was not expected, some control personnel may defend this low value and suggest that the helicopter is capable of applying granules more uniformly than other application equipment such as the Horn Seeder®. Since such information for this latter apparatus was not available, a study was conducted with the objective of investigating uniformity of application. The results which are reported here were obtained in a cooperative study on the practical use of the Horn Seeder® reported elsewhere (Schmidt 1976).

MATERIALS AND METHODS

New Horn Seeders® (Cyclone Seeder Company, Urbana, Indiana) were used in the study. The aluminum foil roasting pans (12 in × 20.25 in × 2 in depth; 30.5 cm × 51.4 cm × 5.1 cm) for collecting granular samples and their handling were as previously described (Sutherland et al. 1974). Prior to each use, Seeders were half-filled with untreated celatom granular carrier MP-78 instead of 2% temephos/celatom granules.

CALIBRATION. Nine graduate students in entomology were involved in the calibration, each with a different Seeder. The

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individuals, who were inexperienced in this activity, were shown the method of swinging (Anon. 1974), but were allowed to develop their own modification in a brief practice session. At a point halfway on a 40 ft (1.2 m) calibration course of clear level ground, 15 pans were placed in a row across the course, their long sides touching. The center pan was removed to provide a path between the remaining 14 pans, 7 on each side. Each individual traversed the course, swinging the Seeder, and the time interval and number of swings were noted. Settings calibrated were 1.0, 1.5, and 2.0.

FIELD PERFORMANCE. In contrast with the site for calibration, field performance was studied in a woodland area containing small woodland pools and obstacles such as ground depressions and trees. Two pools, 7 and 10 ft (.2-.3 m) diameter, were selected and a winding route established for the applicator to follow in the treatment of the pools with a Seeder setting of 1. Pans were laid in a set pattern to cover the surface of the water, 9 pans/pool I, 12 pans/pool II. Each individual traversed the course, and the time interval and number of swings were noted. The pans were removed from the water surface, and their bottoms dried to insure that the granules remained dry during collection into vials.

ANALYSIS OF DATA. Data on the weights of granules per pan were subjected to enumeration statistics. The desired application rate for 2% temephos granules at 0.1 lbAI/acre (112 g/ha) is equivalent to 85 mg granules/pan. An arbitrary range of acceptance for application rate was established as 0.5-2X desired application rate (42.5-160 mg/pan). The following parameters were determined.

$$\text{Coefficient of variation} = \frac{\textit{Standard deviation}}{\text{mean}}$$

$$\text{Probability estimate } (\hat{P}) = \frac{\textit{Number of pans with .5-2X dosage}}{n}$$

$$\text{Confidence interval of } \hat{P} = Z_{.95}\sqrt{\frac{(\hat{P})\,(1-\hat{P})}{n}}$$

RESULTS

Nine individuals calibrated a Seeder at settings of 1, 1.5 and 2. The profiles of distribution for 2 individuals (A,B) representing the extremes of variation between individuals are shown in Fig. 1. On the calibration course, A at all settings applied to the pans approximately 50% of that applied by B. An examination of data for all individuals indicated that a setting of 1 was best for an application rate of 5 lbs./acre (5.6 kg/ha, 85 mg/pan). The data for this setting are given in Table 1, with a grand mean of 90.7 mg, 5.7% above the desired rate. Only B applied granules outside the acceptance range 0.5-2X with this setting.

For field performance studies (Table 2) 4 individuals (A,C,D,E) were chosen, whose calibration (mean and coefficient of variation) for setting 1 came closest to the desired application rate. Generally A, C, D and E applied granules in the field at a higher rate (mean 1.27X) than in their calibration studies (mean 0.895X). Individual C was the exception, with his field application mean rate for both pools being less than his calibration mean rate. Individual A, whose mean calibration rate and variation was judged best in calibration studies, overapplied in the field studies more than C, D and E. Presumably this is related to A's large number of swings of the Seeder.

Although the terrain around the pools was essentially the same, Pool I consistently was more highly treated (1.61X) per sampling area than was Pool II (1.04X). The water surface of Pool I was approximately 70% of that of Pool II, and, therefore, presented a smaller target. The rate of treatment of Pool I was so high that its total treatment (4.91 gms/pool for 4 individuals) was actually 1.067 times the total treatment of the larger Pool II (4.61 gms).

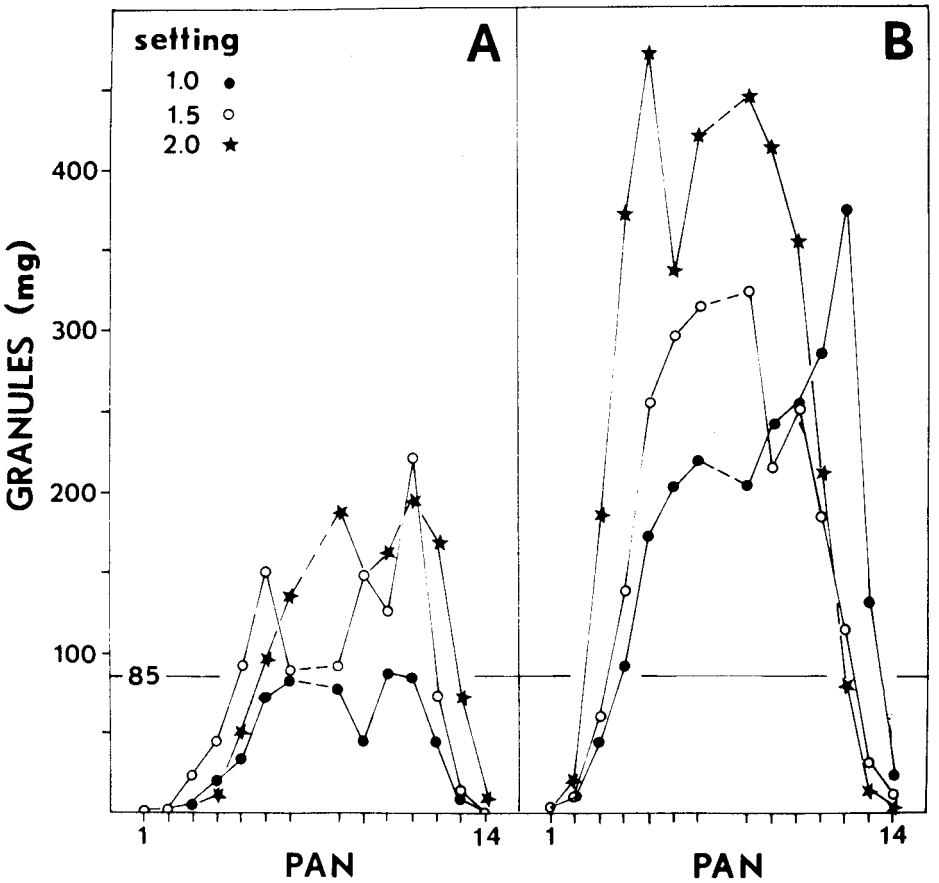

Fig. 1. Profiles of granular application by two individuals (A, B) with the Horn Seeder®, settings 1, 1.5 and 2.

Table 1. Sample means, standard deviation (D) and coefficients of variation of granular applications by 9 individuals in a calibration of the Horn Seeder®, setting 1.

Individual	Mean mg granules per pan	SD	Coefficient of variation	Number of Swings	Time, Sec.	No. Swings/ Time, Sec.
A	70.86	18.47	0.261	17	13.5	1.26
B	201.55	91.62	0.455	30	29	1.03
C	89.72	35.22	0.393	26	23	1.13
D	73.20	23.57	0.322	26	17.5	1.49
E	70.66	43.85	0.621	18	15	1.2
F	84.71	66.80	0.789	25	23	1.09
G	67.30	41.79	0.621	19	16	1.19
H	102.72	55.67	0.542	20	17	1.18
I	55.56	41.04	0.739	20	15.5	1.29

Combined mean for A, C, D, E=76.11.

Table 2. Sample means and standard deviation of granular applications by 4 individuals to 2 woodland pools, setting 1.

Individual	Pool I Mean mg granules per pan	Pool I SD	Pool II Mean mg granules per pan	Pool II SD	Pool I & II Mean mg granules per pan	Pool I & II SD	Number of Swings	Time, Sec.
A	176.27	73.27	126.74	82.13	147.00	80.75	30	25
C	86.11	80.52	49.89	56.64	64.71	68.08	18	27
D	111.69	53.43	107.18	37.74	109.02	43.66	22	26
E	171.98	144.23	70.45	53.74	111.98	110.39	27	24
Overall	136.51		88.57		108.18			

The probability estimates ($\hat{P}$) for A, C, D, E are presented in Table 3. For Pool I $\hat{P}$ for all individuals was 0.4166, indicating a 42% chance of 0.5-2X application being achieved in the treated area. For Pool II $\hat{P}$ was higher, 0.5962. Overall $\hat{P}$ for both pools was 0.5227, indicating that, presented with the treatment situation and conditions in this study, the probability of these individuals applying granules at a rate of 0.5-2X was 52%.

DISCUSSION

There are many factors which can influence the rate of granular application by means of the Horn-Seeder®. These include setting of the Seeder, weight and particle size of the granules, the height and pace of the applicator, the angle of the horn, the arc, pattern and force of swing, the number of swings per unit distance, and the terrain. In these studies one of the most important was observed to be the setting. Previous to this study we have observed that a setting of 1.5 had been used for Abate 2G. However, results in this report indicate that the lowest setting of 1 should be employed, a conclusion also shared by Schmidt (1976). Although granular particles of various mesh sizes, densities, and shape were not examined in the current study, most likely this setting would be appropriate for an application of most granular insecticides at 5 lbs total formulation/acre (5.6 kg/ha).

While the setting is very important, the individual using this apparatus is probably more important. An analysis of an individual's physical attributes in relation to the swing of the Seeder would be very complex, and only the pace (time) and number of swings could be examined in this study. In calibration studies no apparent correlation between these parameters and the mean application rate was evident, with the exception of an individual, B,

Table 3. Probability estimates ($\hat{P}$) of granular applications (acceptance range of 0.5–2X dosages) by 4 individuals to 2 woodland pools, and the 95% confidence intervals (C.I.) for the estimates, setting 1.

Individual	Pool I $\hat{P}$	Pool I 95% C.I.	Pool II $\hat{P}$	Pool II 95% C.I.	Pool I & II $\hat{P}$	Pool I & II 95% C.I.
A	0.1111	$0.0000 \leq P \leq 0.3163$	0.5385	$0.264 \leq P \leq 0.8096$	0.3636	$0.1625 \leq P \leq 0.5647$
C	0.4444	$0.1198 \leq P \leq 0.7690$	0.3846	$0.1202 \leq P \leq 0.5048$	0.4091	$0.2037 \leq P \leq 0.6145$
D	0.6666	$0.3587 \leq P \leq 0.9745$	0.9231	$0.7783 \leq P \leq 1.0000$	0.8181	$0.6570 \leq P \leq 0.9792$
E	0.4444	$0.1198 \leq P \leq 0.7690$	0.5385	$0.2674 \leq P \leq 0.8096$	0.5000	$0.2911 \leq P \leq 0.7089$
Overall	0.4167	$0.2547 \leq P \leq 0.5787$	0.5962	$0.4620 \leq P \leq 0.7304$	0.5227	$0.4180 \leq P \leq 0.6274$

whose pace was slow and number of swings high. As expected, in this case this individual applied excess granular material.

The importance of the factor of terrain is evident when results of the calibration studies and field performance of A, C, D and E are compared. Calibration on level ground with no obstacles does not insure that the mean application rate during practical field conditions will not be higher than the calibration mean rate. Also according to these studies, in the field the variability of the application will be greater and the application rate seems to be related with the number of swings per unit distance traveled. Based upon the 2 pools of unequal size used in the field studies, small target areas will tend to be overtreated. Possibly, when confronted with a smaller target, the individual shortens the arc of his swing. The length of the swing probably only weakly influences the gravity-feed flow of granules through the setting aperture. As a consequence a shorter swing will deliver the granules to a smaller area and, therefore, yield a higher application rate.

In earlier helicopter studies (Sutherland et al. 1974) the probability estimate ($\hat{P}$) for 0.5-2X application of 5% granules was 0.5039. In current field studies with 4 individuals and 2% granules $\hat{P}$ was 0.5227. Since sample size, site, application rate, and experience of personnel differed between studies with the helicopter and the Horn Seeder®, strict comparison is not justified. However, it is of interest to note that the probability estimates are very close. The value of $\hat{P}$ for the Seeder was derived from 4 inexperienced individuals, and $\hat{P}$ varied greatly between individuals, the lowest being 0.3636 (A), the highest 0.8181 (D). Possibly further training of the 4 individuals would improve their application performance or indicate that a setting lower than 1 be established in the setting aperture. According to Schmidt (1976), trained mosquito control personnel also vary in their ability to apply granules within the desired application range, and "a system should be implemented . . . to monitor the application of . . . granules by employees with retraining of those employees found consistently applying too much . . .".

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