

FURTHER SMALL-SCALE FIELD EXPERIMENTS ON THE CHEMICAL CONTROL OF ATTACK BY SHOT-HOLE BORER (*XYLEBORUS FORNICATUS* EICH.) ON TEA IN PLUCKING

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Preliminary field trials on the chemical control of Shot-hole Borer of tea were described in a previous paper (Judenko, 1958a). It was reported that, associated with the known activity of the beetles in the lower parts of tea bushes, spray applications to the lower parts of tea bushes in plucking, using high dosages of dieldrin and chlordane, were effective in reducing borer populations for up to nine months after treatment. These high dosages may, of course, be uneconomic. In the present paper, results are reported from a further series of small-scale field trials designed to assess the effects of lower dosages of the insecticide applied in the same way, under varied climatic conditions.

Details of trials

Sixteen small-scale field trials were carried out on twelve estates in the low-country and the mid-country. Each trial (except 62/57) was of a randomized-block design with five replicates of four plots each; the exception (62/57) is an earlier experiment done at Rye Estate and partly described as Experiment 1 in Table 2 by Judenko (1958a). In fourteen of the trials, in addition to the plots with the experimental dosages of insecticide, there were, for comparison, both unsprayed plots and also plots sprayed with a very high dosage of dieldrin (6-14 lb. in 130-270 gal. of water per acre), previously designated *maximum-kill* treatments (Judenko, 1959). Large amounts of rain fell between spraying and assessment, varying from 24" in five months in No. 14 of Table 2 to 216" in 25 months in No. 10 of Table 1.

Trials were planned to cover a range of experimental dosages from 0.7 to 5.5 lb. of dieldrin per acre and 1.9 to 20.8 lb. of technical chlordane per acre, usually applied in about 100 gal. of water per acre. Dieldrin was used as a proprietary miscible oil formulation which contains certain resins, designed to give additional weathering properties (*Dieldrex Extra*). Chlordane was used as a 50* proprietary miscible oil formulation (*Clordox*). Spraying was carried out using Birchmeier *Automat* self-acting knapsack sprayers fitted with single Horto-Sapphire fog nozzles of 0.55 mm. orifice; in experiment 62/57, however, *Duro* nozzles, of 1.65 mm. orifice, were used instead. Applications to the maximum-kill plots were always made with the *Duro* nozzles, to give a higher gallonage per acre.

*The suppliers state that *Clordox* contains 10 lb. of active ingredient per gallon.

TABLE 1.—Percentage reductions in Shot-hole Borer infestations after spraying with chlordane (Chlord) and dieldrin (Dldrn)

No.	Expt.	Estate (height of spraying)	Chem.	Dosage lb. and gal. per acre	Date of spray	Condition of bush (rain)	Counts made: months after spray	No. of live adults in control	% reduction in live adults
1	12/58	Kuattpitiya (1½')	Chlord	19.2 (128)	25.3.58	dry (0.55")	8	231	67
2	"	"	"	"	"	"	14	520	44
3	"	"	Dldrn	6.8 (135)	24.3.58	dry (0.08")	8	231	87
4	"	"	"	"	"	"	14	520	83
5	"	"	Dldrn	13.6 (271)	25.3.58	dry (0.55")	8	231	82
6	"	"	"	"	"	"	14	520	85
7	62/57	Ryc (½')	Chlord	38.3 (102)	10.9.57	wet (0.30")	18	263	77
8	"	"	"	"	"	"	25	607	45
9	"	"	Dldrn	5.4 (109)	9.9.57	dry (0.14")	18	263	91
10	"	"	"	"	"	"	25	607	62
11	7/58	Alupolla (1')	Chlord	15.3 (102)	18.2.58	dry (0.39")	9	289	47
12	"	"	"	"	"	"	15	662	33
13	"	"	Dldrn	5.1 (102)	24.2.58	dry (0.41")	9	289	77
"	"	"	"	"	"	"	15	662	72
15	"	"	Dldrn	12.1 (242)	19.2.58	dry (0.46")	9	289	92
16	"	"	"	"	"	"	15	662	70
17	1/58	Niriella (1' & 1½')	Chlord	14.9 (99)	16.1.58	dry (0.23")	4	64	0
18	"	"	Dldrn	5.1 (102)	15.1.58	dry (0.09")	4	64	86
19	"	"	Dldrn	9.8 (195)	15.1.58	wet (0.09")	4	64	78
20	9/58	Pelmadulla (1½')	Chlord	16.1 (107)	4.3.58	dry (nil)	7	41	63
21	"	"	Dldrn	4.9 (99)	3.3.58	dry (0.03")	7	41	85
22	"	"	Dldrn	11.6 (223)	3.3.58	dry (0.03")	7	41	85

Notes.—1. In the seventh column is given the amount of rain that fell on the day of spraying after spraying had been done.

2. Dieldrin at roughly 5 lb. per acre, even though applied just before rain of up to 0.41", produced considerable reductions in beetles 14 to 15 months and even 25 months after spraying; heavier dosages of dieldrin produced no better results.

3. The results of spraying with chlordane were always inferior to those with dieldrin at similar cost.

TABLE 2.—Percentage reductions in Shot-hole Borer infestations after spraying with moderate dosages of dieldrin or chlordane (marked*)

No.	Expt.	Estate (height of spraying)	Dosage lb. and gal. per acre	Date of spray	Condition of bush (rain)	Counts made: months after spray	No. of live adults in control	% reduction in live adults
1	6/59	Hantane (1½')	3.3 (133)	28.1.59	dry (nil)	5	97	98
2	"	"	12.0 (240)	27.1.59	dry (nil)	5	97	97
3	8/59	Oodewella (1')	3.2 (128)	7.2.59	dry (nil)	5	85	95
4	"	"	10.8 (216)	6.2.59	dry (nil)	5	85	98
5	10/58	Watapota (1½')	*9.6 (128)	10.3.58	dry (0.78")	4	195	7
6	"	"	3.1 (122)	11.3.58	wet (5.42")	4	195	32
7	"	"	13.4 (268)	11.3.58	wet (5.42")	4	195	56
8	9/59	Oodewella (1')	2.9 (115)	11.2.59	dry (nil)	6	83	96
9	"	"	11.6 (232)	10.2.59	dry (nil)	6	83	99
10	7/59	Hantane (1½')	2.8 (112)	30.1.59	dry (nil)	8	54	59
11	"	"	12.5 (250)	3.2.59	wet (nil)	8	54	98
12	6/58	Mahawela (1')	*6.8 (91)	13.2.58	dry (nil)	8	86	53
13	"	"	2.3 (91)	13.2.58	dry (nil)	8	86	86
14	10/59	Bandarapola (1')	2.1 (83)	21.2.59	Very wet (0.06")	5	22	0
15	"	"	8.3 (167)	20.2.59	wet (0.66")	5	22	82

- NOTES.—1. In the sixth column is given in brackets the amount of rain that fell on the day of spraying after the spraying had been done.
2. The chemical insecticide used was dieldrin except in the cases starred,* namely, numbers 5 and 12, where it was chlordane. The chlordane was less effective than an amount of dieldrin of similar cost.
3. The effectiveness of dieldrin was much reduced by wetness of the bushes at the time of spraying (Nos. 6 and 14).
4. When the bushes were dry at the time of spraying, the trial dosages of roughly 2-3 lb. of dieldrin per acre generally gave control similar to that of the maximum-kill dosages of 8-12 lb. per acre. No explanation is available for getting only 59% reduction in No. 10.

TABLE 3.—Percentage reductions in Shot-hole Borer infestations after spraying with low dosages of dieldrin

No.	Expt.	Estate (height of spraying)	Dosage lb. and gal. per acre	Date of spray	Condition of bush	Counts made: months after spray	No. of live adults in control	% reduction in live adults
1	11/59	Bandarapola (1')	1.8 (70)	26.2.59	dry	7	25	80
2	"	"	6.6 (133)	25.2.59	dry	7	25	92
3	6/59	Hantane (1½')	1.4 (138)	27.1.59	dry	5	97	85
4	"	"	12.0 (240)	27.1.59	dry	5	97	97
5	8/59	Oodewella (1')	1.2 (120)	6.2.59	dry	5	85	85
6	"	"	10.8 (216)	6.2.59	dry	5	85	98
7	7/59	Hantane (1½')	1.1 (104)	3.2.59	wet	8	54	39
8	"	"	12.5 (250)	3.2.59	wet	8	54	98
9	9/59	Oodewella (1')	1.1 (104)	10.2.59	dry	6	83	94
10	"	"	11.6 (232)	10.2.59	dry	6	83	99

- NOTES.—1. In none of these experiments was there any rain on the day of spraying but in Nos. 7 and 8, 1.09" fell on the day before.
 2. There was not much difference, except when spraying on wet bushes, as in No. 7, between the results from low dosages of 1.1 to 1.8 lb. per acre and the maximum-kill dosages of 6 to 12 lb. per acre.

TABLE 4.—Percentage reductions in Shot-hole Borer infestations after spraying with very low dosages of dieldrin and chlordane (marked*)

No.	Expt.	Estate (height of spraying)	Dosage lb. and gal. per acre	Date of spray	Condition of bush (rain)	Counts made: months after spray	No. of live adults in control	% reduction in live adults
1	10/59	Bandarapola (1')	0.8 (73)	20.2.59	wet (0.66")	5	22	50
2	"	"	8.3 (167)	20.2.59	wet (0.66")	5	22	82
3	4/58	Galbode (2')	*2.3 (151)	12.2.58	dry (nil)	2	126	13
4	"	"	0.8 (148)	12.2.58	dry (nil)	2	126	36
5	"	"	11.7 (234)	29.1.58	dry (0.62")	3	126	78
6	11/59	Bandarapola (1')	0.7 (68)	25.2.59	dry (nil)	7	25	64
7	"	"	6.6 (133)	25.2.59	dry (nil)	7	25	92
8	11/58	Denawaka (1')	*1.5 (102)	15.3.58	wet (0.89")	7	27	0
9	"	"	0.6 (109)	14.3.58	dry (0.64")	7	27	33
10	"	"	11.2 (224)	18.3.58	dry (0.64")	7	27	80

- NOTES.—1. In the sixth column is given in brackets the amount of rain that fell on the day of spraying after the spraying had been done.
 2. The insecticide used was dieldrin, except in the cases starred,* namely, Nos. 3 and 8, when it was chlordane. The chlordane was less effective than dieldrin of similar cost.
 3. The trial dosages of dieldrin of 0.6 to 0.8 lb. in 68 to 148 gallons of water per acre gave control that was definitely inferior to that of the maximum-kill dosages of 6.6 to 11.7 lb. per acre.

Spraying was carried out only on the lower parts of the bushes. If the average height of the tea was 3 ft. or less, the bushes were sprayed to a height of 1 ft. above ground level; if the bushes averaged more than 3 ft. in height, spraying was done to a height of 1½ ft. above ground level. Two instances outside this rule are noted in the tables of results. Only one spraying round was made, at times varying from six to twenty-one months after the dates of pruning in the various fields used (except in experiment 62/57 when it was done one month after pruning). The precautionary measures used in the handling of the insecticides have been described previously (Judenko, 1958a) except that, in addition, spraying operators wore rubber boots, in accordance with the recommendation of the Planters' Association Estate Health Scheme.

Records were kept of whether the woody parts of the bushes were wet or dry before spraying, and of the rainfall on the same day, after spraying, and until assessment was completed.

Assessments of shot-hole-borer populations were carried out as comparisons of numbers of adult beetles in equal numbers (100-400) of prunings from treated and untreated plots, except in Experiment No. 5/58, when 75 standard units were dissected in each case (Judenko, 1958). Assessments were carried out once or twice in each trial, at times varying in the different trials from 2 to 25 months after spraying.

TABLE 5.—*Number of Shot-hole Borers (adults) in 75 standard units before and after spraying. Galbode Estate. Sprayed on 11-2-58, at 1½' above ground. There was no rain on the day before the spraying and the wood was dry, but 0.21" fell on the day of spraying. In brackets are shown the percentage increases in beetle numbers compared with the numbers before spraying*

No.	Time	Control	Chlordane 1.6 lb. in 104 gal. of water per acre	Dieldrin 0.7 lb. in 130 gal. of water per acre	Dieldrin 9.8 lb. in 195 gal. of water per acre
1	Before spraying	4	11	17	10
2	At 2½ months after spraying	28 (600%)	24 (118%)	7 (-59%)	2 (-80%)
3	At 6 months after spraying	22 (450%)	35 (218%)	14 (-18%)	0 (-100%)

NOTE.—As in Table 4, the very low dosage of dieldrin used did not reduce the population as much as the maximum-kill dosage. Again, chlordane was less effective than dieldrin at comparable cost.

Results

(1) The results of one trial (8/57 at Pelmadulla) are not given, the number of beetles having been too low to justify any conclusions. The remaining results are given in Tables 1 to 5; some of the maximum-kill controls are given more than once in Tables 2-4.

(2) In Tables 1-4, the numbers of beetles found by sampling the experimental treatments and the maximum-kill controls have been expressed as percentage

reductions of the number found in the untreated control on each occasion. These percentages are given in the last column of each of the tables 1-4. The actual numbers of beetles found in the untreated control are also given (last column but one), as an indication of the degree of infestation.

(3) The effect of climatic conditions on the day of spraying was very marked; in the tables is recorded whether conditions were wet or dry. Wet conditions are here defined as those in which the woody parts of the bushes were wet when the spray was applied. If rain fell *after* spraying on the same day, the amount is recorded in the same column. No conclusions can be drawn concerning the effect of the amount of rain after the day of spraying, except that, provided initial conditions were dry, it did not appear to affect the result greatly. Data on subsequent rainfall are therefore omitted from the tables.

(4) The results of nine trials that were begun in 1958 showed clearly that chlordane was markedly inferior in effect to dieldrin when compared at dosages of the same cost (based on prices at Colombo in early 1958, namely, Rs. 6.50 per lb. of technical chlordane and Rs. 20/- per lb. of active ingredient of dieldrin). Chlordane was therefore omitted from the later trials.

(5) Dosages of dieldrin as low as 1.1 lb. per acre applied in about 100 gallons of water per acre usually worked well when the woody parts were dry at the time of spraying (exception—No. 10 in Table 2). In these circumstances, 1.1-3.3 lb. of dieldrin per acre gave results only slightly less good than those of the maximum-kill controls at 10-14 lb. of dieldrin per acre. Results from using 0.6-0.8 lb. of dieldrin per acre were inferior and this dosage is evidently too low even in dry conditions; 1½ lb. per acre would appear to be a reasonable minimum.

(6) When spraying was carried out when the branches and stems of bushes were already wet, dosages of below 8 lb. gave poor results and even the maximum-kill control at over 13 lb. was not as good as with dry wood at spraying time (e.g. Table 2, No. 7). If the wood was dry when sprayed but some rain fell later in the same day, there seemed to be some reduction in effectiveness, both at 5 lb. and at around 12 lb. per acre, but this is quite uncertain.

Summary and Conclusions

The results are reported of sixteen small-scale field trials on the chemical control of Shot-hole Borer (*Xyleborus farnicatus* Eich.) in tea. Only the lower parts of the bushes were sprayed, up to a height that depended on the height of the bush and was never more than two feet. Chlordane was markedly inferior in effect to dieldrin when compared at dosages of the same cost. The minimum effective dosage of dieldrin was 1.1 lb. in about 100 gal. of water per acre; this gave results roughly comparable with those from over 10 lb. of dieldrin in about 200 gal. of water per acre when applied on dry days. If the woody parts of the bushes were already wet when the spray was applied, the minimum effective dosage was 8 lb. per acre. Rain *after* spraying, but on the same day, seemed to have a slightly detrimental effect on the results.

The results permit the planning of large-scale experiments on the influence of dieldrin sprays on (a) yield of tea (b) insecticide residues in made tea (c) taint (off-flavour) and quality of made tea (d) side effects on other tea pests, notably Tea Tortrix (*Homona coffearia* Nietn.) by destruction of the parasite *Macrocentrus homonae* Nixon.

No practical recommendations on the use of dieldrin can yet be made.

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References

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