THE CHEMICAL CONTROL OF THE TWIG CATERPILLAR (*ECTROPIS BHURMITRA*) IN TEA

W. Danthanarayana & D. J. W. Ranaweera

Studies on the life cycle of the Twig Caterpillar indicate that the most appropriate time for chemical sprays is when the caterpillars are in the second and third stages of their development, that is, during the fourth and the fifth week after the emergence of the moths. Of fifteen insecticides evaluated, only two gave significantly lower counts of caterpillars than the untreated, two weeks after treatment. DDT at the rate of six pints per acre and Sandoz 6538 at the rate of one pint per acre proved to be effective. The control obtained with Sandoz 6538 appeared to be superior to that obtained with DDT.

Introduction

Twig caterpillar (*Ectropis bhurmitra* Warr.) infestations are known to cause considerable damage to tea. There are reasons to believe that the present outbreaks in Ceylon have resulted from side-effects of dieldrin spraying against Shot-hole Borer (*Xyleborus fornicatus* Eichh.). The biology of the Twig Caterpillar is being studied in detail. So far, two hymenopterous parasites and a number of hyperparasites (parasitic on parasites) have been obtained from caterpillars collected from different districts. The two parasites, which have not yet been fully identified, belong to the same group of parasites as *Macrocentrus homonae* Nixon, the commonest parasite of the Tea Tortrix (*Homona coffearia* Nietner). It appears that the twig caterpillar outbreaks following dieldrin spraying are caused by the parasites being destroyed in the course of shot-hole borer control, as it happens with the parasites of Tea Tortrix. The work that is being conducted to combat and eliminate the Twig Caterpillar has been outlined earlier (Danthanarayana 1966). The present paper describes the experiments carried out on the chemical control of this pest. The results obtained are conclusive and enable definite recommendations to be made. This should eliminate any doubts that may have existed in selecting the most effective insecticides to control the caterpillars.

Life-history and timing of insecticide spraying

Experiments on the biology of the Twig Caterpillar are being conducted in an unsprayed area at Goorookoya Estate, Nawalapitiya. Based on these studies, which were begun in October 1965, a diagram of the life-cycle is presented in Figure 1. The lines representing larval stages in Figure 1 have been drawn to scale to represent the correct proportion of each larval (caterpillar) stage or instar, surviving at various times during the life-cycle.

It will be noticed from this diagram that a complete life-cycle, from egg to egg lasts about ten weeks, so that there may be five generations of this insect in a year. The life-cycle can be stated as follows :

Egg stage	—	8–9 days
Larval (caterpillar) stage	—	4–5 weeks
Pupal period	—	2–3 weeks
Moth (adult)	—	3–5 days

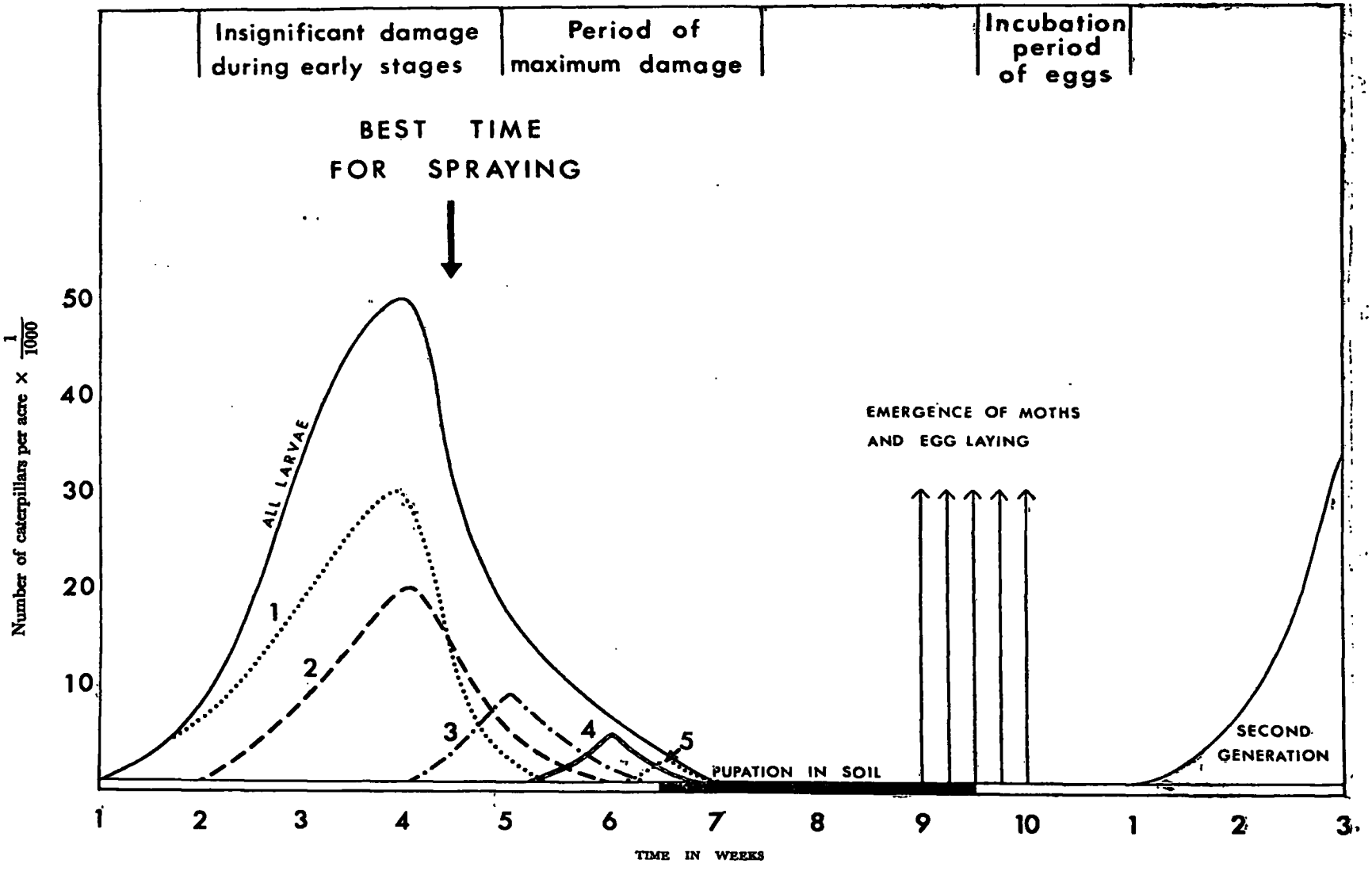

FIGURE 1 — *The development of the various stages in the life-cycle of the Twig Caterpillar with time — Curves 1 - 5 represent the five larvae stages (Instars 1 — 5)*

The eggs are normally laid in the crevices of the bark on shade trees, or on other trees near-by. The moths show a preference for *Grevillea robusta* for egg-laying, probably because the bark is very suitable for this purpose. When the eggs hatch after an incubation period of eight to nine days, the minute first instar larvae suspend themselves by silken threads and are dispersed onto the tea by wind. The caterpillars feed on tea leaves, mature within four to five weeks and then drop onto the soil under tea bushes for pupation, which takes place about one to two inches below the soil surface. The moths emerge in about three weeks, copulate soon after, deposit several hundreds of eggs in batches and then die once this main function of their life is over.

A brief description of the caterpillar was given in a previous paper (Danthanarayana 1966). There are five distinct larval instars (caterpillar stages). The larvae of different stages can be distinguished by their size, or more accurately, by measuring the widths of their head capsules. The approximate lengths of the successive caterpillar stages are as follows :

Instar 1	—	0.3 cm
Instar 2	—	0.8 cm
Instar 3	—	1.5 cm
Instar 4	—	2.4 cm
Instar 5	—	3.4 cm

The damage done by the small first and second instar larvae is negligible. This damage appears as small holes or edges bitten-off at the margins of immature tea leaves. During these two larval stages, there is a high degree of natural mortality, and it is also during these stages that maximum numbers are found on tea (Figure 1). The mature caterpillars of the third and fourth stages usually feed on the maintenance foliage and move upwards as the leaves below are fully consumed. The greatest damage to the tea bush is, therefore, done by the caterpillars of the third, fourth and the fifth instars.

An important feature, in the occurrence of the caterpillars, is that there is a certain amount of overlapping of the various larval stages (Figure 1). This arises as a result of protracted egg-laying by the moths, because all moths do not emerge at any one time. The feeding preferences of the caterpillar and the overlapping of the different stages calls for the proper timing of chemical sprays, if control measures are to be successful. *Insecticides must be applied after the hatching of the eggs is complete, but before the caterpillars mature and migrate into soil for pupation.* It has also been observed that chemical sprays are more effective when the caterpillars are young. The best time for insecticidal application is during the second and third instars, that is, between the fourth and fifth week after the emergence of the moths. Proper timing of spraying could be important in the elimination of successive generations, or at least in reducing the intensities of subsequent attacks. Indeed, the most successful twig caterpillar control has been achieved in many instances by resorting to this type of spraying.

The numbers of larvae indicated in Figure 1 are based on experimental findings in Goorookoya Estate, and therefore may not be the same in other places or at other times. However, the times of occurrence of various stages in the life-cycle and timing of spraying are applicable to any infestation. This diagram indicates that spraying of insecticides for the control of second generation caterpillars (if this becomes necessary) should be ten weeks later.

Methods

The insecticidal experiments were carried out in two heavily infested fields at Maha Uva Estate, Harasbedde, during May and July 1966. The experiments were of the randomized block design, with four replicates. There were two experiments, one with eleven treatments and the other with ten treatments. The size of the plots were about one-thirtieth of an acre (45 ft × 30 ft). Spraying was done with knapsack sprayers using 60 gallons of water per acre.

The effectiveness of diffierent treatments was evaluated twice, once at the end of the first week after spraying and again at the end of the second week after spraying. For this a sample of ten bushes was taken from each plot and the total number of caterpillars surviving was recorded. The bushes to be sampled were selected at random but covered all rows in a plot so that the sample was similar to a 'stratified random sample' (Snedecor 1962). This method of sampling was considered to be suitable in view of the heterogeneous distribution of the twig caterpillar larvae. Bushes sampled once were not sampled again on the second occasion.

Experiment E26

In this experiment, the following insecticides were evaluated :

1	—	Metacil	3—methyl-4-dimethylaminophenyl-N — monomethyl-carbamate
2	—	Unden (Arprocarb)	2-iso-propoxy-phenyl-N—methylcarbamate
3	—	Vapona (DDVP)	2, 2-dichlorovinyl dimethyl phosphate
4	—	Dipterex (Trichlorfon)	Trichloroxyethyl-0,0-dimethyl-phosphonate
5	—	Lebaycid	0,0-dimethyl-0-(4 methylmercapto - 3 - methyl) — phenyl-thiophosphate
6	—	Fenitrothion	0,0-dimethyl-0-(3-methyl-4-nitrophenyl) phosphorothioate
7	—	DDT	
8	—	Endrin	

In addition to the above treatments, an application of Dipterex in combination with Metacil in a proportion suggested by the manufacturers (1 lb Dipterex + ½ lb Metacil per acre) and soap in the form of BCC Sovereign Bar Soap were tested. Soap was included in this experiment because a number of Superintendents indicated to us that they obtained twig caterpillar control with Sovereign Bar Soap. All insecticidal treatments were compared with an untreated control.

The results of this experiment are given in Table 1. At the end of the first week, none of the treatments differed significantly from the untreated controls. When the mean numbers of caterpillars per sample was considered, however, it appeared that DDT gave very much better control than the other treatments. The results at the end of the second week were more conclusive (Table 1) ; DDT and fenitrothion were significantly better than the untreated controls. The mean number of caterpillars per sample indicates that DDT gave a better kill than fenitrothion.

TABLE 1—*Control of the Twig Caterpillar with insecticides*

Insecticide tested	% Active Ingredient evaluated	Dosage/acre	Mean no of caterpillars/sample of 10 bushes	
			1 week after spraying	2 weeks after spraying
Metacil 80% W. P.	0.1	1 lb	664	662
Unden (Arprocarb) 20% EC	0.1	2 pints	1022	668
Vapona (DDVP) 24% EC	0.05	8 fl oz	719	592
DDT 18% EC	0.28	6 pints	144	151*
Dipterex SP 80	0.2	2 lb	463	542
Lebaycid 50% EC	0.1	15 fl oz	1123	642
Endrin 20% EC	0.01	5 fl oz	677	551
Fenitrothion (Sumithion 50% EC)	0.1	1 pint	293	240*
Metacil ½ lb + Dipterex 1 lb per acre	—	—	655	604
BCC Sovereign Bar Soap	—	2 lb	800	682
Untreated	—	—	774	556

*Significantly different from the untreated at $P < 0.05$

Experiment E27

This experiment was conducted to evaluate certain insecticides not included in the previous experiment, to compare these with DDT and fenitrothion which gave satisfactory results in the previous experiment and also to evaluate two levels of fenitrothion, one being double the dosage used in the former experiment. The insecticides evaluated were :

1 — Carbicron — 3–(dimethoxyphosphinyloxy)-N, N-dimethyl-cisc-rotanamide.

2 — Ciba C-8949 — 2–chloro-1-(2, 4-dichlorophenyl) vinyl diethyl phosphate.

3 — Sandoz 6538 — A phosphoric acid ester compound, the chemical nature of which is not yet made known.

4 — Sevin — 1 naphthyl N—methylcarbamate

5 — Birlane — 2-chloro-1- (2,4-dichlorophenyl) vinyl diethyl phosphate

6 — Perthane — ethyl analogue of TDE

7 — DDT

8 — Fenitrothion at 2 levels

Altogether there were ten treatments including the untreated control. The results of this experiment are presented in Table 2. At the end of the first week Sandoz 6538, DDT, fenitrothion, perthane and Sevin gave significantly better results than the untreated. When compared with the other treatments, the mean numbers of caterpillars per sample were less in plots treated with Sandoz 6538 and DDT

respectively. In the second sampling, only DDT and Sandoz 6538 showed significantly lower counts than the untreated. Comparison by taking the mean number of caterpillars per sample, of these two insecticides only, indicates that Sandoz 6538 appears to be about as twice as good as DDT in eliminating the caterpillar.

TABLE 2—*Control of the Twig Caterpillar with various insecticides*

Insecticide tested	% Active Ingredient evaluated	Dosage/acre	Mean no of caterpillars/sample of 10 bushes	
			1 week after spraying	2 weeks after spraying
Fenitrothion (Folithion 50% EC)	0.1	1 pint	1627*	1303
Fenitrothion (Sumithion 50% EC)	0.2	2 pints	794*	1216
DDT 25% EC	0.3	6 pints	262*	226*
Carbicron 50 EC	0.04	9 fl oz	2556	1679
Ciba C-8949 50% EC	0.2	2 pints	3810	1583
Sandoz 6538 25% EC	0.05	1 pint	129*	98*
Birlane 24% EC	0·2	2 pints	3552	1880
Sevin 85% sprayable	—	1½ lb	1718*	1451
Perthane	—	1½ lb AI	896*	1087
Untreated	—	—	2481	1600

* Significantly different from the untreated at $P < 0.05$

NB — Analysis of variance was carried out on $\sqrt{n}$ values

Field Trial

Subsequent to these experiments, a field trial was conducted at Maha Uva estate to determine the efficacy of Sandoz 6538 and DDT when used on a large scale. In addition to the dosage of one pint per acre of Sandoz 6538 tested in the previous experiment, half this dose was also tried out. Plots were one acre in extent and treatments were unreplicated. The insecticides were sprayed in 60 gallons of water per acre, using knapsack sprayers.

A pre-treatment sample was taken before spraying by counting the caterpillars on 25 bushes selected at random from each plot. The next sampling was done one week after spraying by counting the survivors in 50 bushes from each plot. The results are presented in Table 3 and support the findings of the previous experiments and indicate that Sandoz 6538 at the rate of one pint per acre and DDT (25% EC) at the rate of six pints per acre controlled the Twig Caterpillar satisfactorily. One pint of Sandoz 6538 appeared to be superior to 6 pints of DDT ; the lower dose of Sandoz 6538 gave a kill interior to that given by DDT.

TABLE 3—*Control of the Twig Caterpillar with insecticides sprayed over a large area*

Treatments	Mean No of caterpillars per bush		
	Before spraying	After spraying	% Kill
DDT (25% EC) — 6 pt/acre	106	30	72
Sandoz 6538 — 1 pt/acre	199	36	82
Sandoz 6538 — ½ pt/acre	181	68	62
Untreated control	83	60	28*

*This should be attributed to natural causes

Conclusions

These experiments have shown that Sandoz 6538 and DDT are the most effective insecticides to control the Twig Caterpillar. DDT has already been recommended by the Institute to individual estates that have experienced twig caterpillar outbreaks. Although effective, DDT does not always afford the clean-up action which is very much needed in controlling this pest. Judging from the experimental evidence, Sandoz 6538 should prove itself to be more effective than DDT.

Recommendations

The present recommendation to control the Twig Caterpillar with DDT (TRI Wall Chart 1966 ; Danthanarayana 1966) still stands. **Use 6 pints of DDT (18% or 25% EC) in 50-60 gallons of water per acre using knapsack sprayers or in 15 gallons of water per acre using mist-blowers.** The advantage of spraying when the caterpillars are in the second and the third stages of development were pointed out earlier. *The bushes should be thoroughly sprayed from above and also from the sides to secure proper coverage. Two applications with an interval of one week between applications may be necessary in severe infestations. Spraying should be done immediately after a plucking round and the next plucking round should be after a safety period of* **seven** *days.* **The tea made from sprayed areas must be bulked with ten times as much tea made from unsprayed areas.** If such bulking is not possible, allow a safety period of **fourteen** days, either by discarding one plucking round or by resting the tea. If Red Spider Mite attacks are anticipated after DDT spraying, the incorporation of ½ pint of Kelthane MF or 1 pint of Tedion V-18 into the DDT solution will minimize these.

Sandoz 6538 (25% EC) is not yet available on the market. When it is obtainable, the following dosage is recommended : One pint in 50-60 gallons of water per acre **using knapsack sprayers only.** Mistblowing is **not** recommended, in view of the high toxicity of the concentrated product. *The spraying should be done immediately after a plucking round and the next plucking round should be after a safety period of* **14** *days. The tea made from sprayed areas must be bulked as in the case of DDT spraying.*

Great care must be taken when handling the undiluted form of Sandoz 6538. Precautions given in the TRI Entomology Wall Chart 1966, Section A must be adhered to, with special reference to rule 1.

Summary

1 — The life history of Twig Caterpillar (*Ectropis bhurmitra* Warr) and its implications on the proper timing of spraying, when control measures are taken are discussed.

2 — Insecticides should be sprayed when the caterpillars are in their second and third stages of development which is usually between the fourth and the fifth week after the moths emerge.

3 — Of the insecticides evaluated, only DDT and Sandoz 6538 caused a significant reduction of caterpillar numbers.

4 — DDT (18–25% EC) at the rate of 6 pints per acre either by knapsack spraying or by mistblowing is recommended for Twig Caterpillar control. In severe infestations, a second round of spraying after an interval of one week is suggested. Sandoz 6538 is not yet available in the market. When it is obtainable, spraying at the rate of one pint in 60 gallons of water per acre is recommended, *using knapsack sprayers only.*

Acknowledgements

We wish to gratefully acknowledge the co-operation of the Superintendents of Maha Uva and Goorookoya Estates where these experiments were carried out. We also thank Mr. P. Kanapathipillai for the statistical analysis; other members of the Entomology Division, TRI, for their assistance; A. Baur & Co. Ltd., Hayleys Ltd., and the Shell Co. of Ceylon Ltd. for providing free samples of insecticides for testing.

References

DANTHANARAYANA, W. (1966). Twig and Looper Caterpillar outbreaks. *Tea Quart.* **37** : 106–113.

SNEDECOR, G. W. (1962). *Statistical Methods-Applied to experiments in Agriculture and Biology.* The Iowa State University Press, Ames, Iowa. 534 pp.

(*Accepted for publication — 1st October 1966*)