Studies on the efficacy of bio - products in the management of teak skeletonizer *Eutectona machaeralis* Walker (Pyralidae: Lepidoptera)

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ABSTRACT

Teak Skeletonizer, *Eutectona machaeralis* walker (Pyralidae: Lepidoptera) was reported as a highly serious foliage feeder in the Cauvery delta regions of Tamil Nadu, in a survey conducted during 2005-06. Hence, the present study on the management of *E. machaeralis* using various bio-products was conducted to find out the effective product at effective dose. Among the group of bio-product *viz., Metarhizium anisopleae, Beauveria bassiana*, *Bacillus thuringiensis*, Grub kill (a commercial formulation of the combination of 33% *Metarhizium anisopleae,* 33% of *Beauveria bassiana* and 33% of *Bacillus subtilis*), Neem seed kernel extract (NSKE), neem oil (Azadirachtin 0.03% based commercial formulation) and five leaves extract (a traditional preparation of five different plants such as *Adhatoda vasica*, *Vitex negundo*, *Azadiracta indica*, *Ricinus communis* and *Pongamia glabra*) tested against third, fourth and fifth instars of *E. machaeralis, Bacillus thuringiensis* @ 1.5 % was effective. This was followed by Grub kill @ 2% and five leaves extract @ 6% in the field.

Key words: Biocontrol, *Eutectona machaeralis,* teak pest

INTRODUCTION

Complete defoliation of teak (*Tectona grandis* Linnaeus f.) trees over large area is regularly caused by the first brood of caterpillars of *Eutectona machaeralis* in the Cauvery delta region of Tamil Nadu, India during September - October every year after the appearance of new foliage. Repeated annual defoliation stimulates the production of epicormic branches as illustrated by Laurie and Griffith (1942) and Khan and Chatterjee (1944). Such deformed plants do not yield desired revenue at the time of harvest. Unfortunately losses due to deformity are difficult to compute, though such losses are far greater than the losses in the mean annual increment (Stebbing, 1980). The earliest attempt to calculate the financial loss resulting from defoliation was that of Mackenzie (1921). He projected that 6.6 per cent loss of annual increment in volume was due to defoliation in India which resulted in significant financial loss. Champion (1934) recorded that the increment loss due to defoliation in 3 year old teak plantation at Dehradun was 65 per cent. One of the cubic feet-quoted estimates of loss due to defoliation is that of Beeson (1931 and 1941), who made a slight improvement over Meckenzie's estimate based on monthly observations and recorded 8.2 per cent loss of annual increment in volume due to defoliation.

The average loss of 4 per cent in potential volume increment in 4-9 year old teak plantations was attributed to defoliators (Beeson, 1921, 1928, 1930; K.F.R.I., 1981). A study conducted in a nursery of teak at western Ghats of Karnataka by Basalingappa and Ghandhi (1994), showed that 10 out of 26 plots (each of 500 seedlings of teak) showed 100 per cent infestation while the remaining 16 plots had infestations ranging from 98.6 to 99.8 per cent and most of the teak plants were completely defoliated. The defoliator and skeletonizer drastically reduced the photosynthesizing leaf surface and resulted in loss of 44 per cent of the potential volume increment in young plantations (Nair *et al*., 1996). Insecticides had been sprayed aerially for suppressing the epidemic populations of pests in the last decades. However their use in forestry, as a principle, is not considered safe and desirable for several obvious

reasons. Hence, search for new areas of pest management, preferably non-toxic and environmentally safer alternatives continues. The control through only insecticides is not, therefore possible and is changing, in line with a general trend in pest control towards integrated pest management (Sundararaj, 2012.). Efficacy of *Bacillus thuringiensis* (Chadhar, 1996; Meshram *et al.,* 1997; Shamila Kalia and Pant, 1999; Intachat *et al.,* 2000), *Serratia marcescens* (Patil and Thontadarya, 1981), *Beauveria bassiana* and *Metarhizium anisopliae* (Sakcoowong, 2002) and NPV (Ahmad *et al*., 1989; Ahmad, 1995; Nair *et al*., 1996) were reported earlier in the laboratory assays and very few in nurseries but not in the field. This instigated the present study to investigate the efficacy of *Metarhizium anisopleae*, *Beauveria bassiana*, *Bacillus thuringiensis*, Grub kill (a commercial formulation of the combination of 33% *Metarhizium anisopleae*, 33% of *Beauveria bassiana* and 33% of *Bacillus subtilis*), neem seed kernel extract (NSKE), neem oil (Azadirachtin 0.03% based commercial formulation) and five leaves extract such as *Adhatoda vasica*, *Vitex negundo*, *Azadiracta indica*, *Ricinus communis* and *Pongamia glabra* in the field conditions.

MATERIALS AND METHODS

A group of bio-product *viz.*, *Metarhizium anisopleae*, *Beauveria bassiana*, *Bacillus thuringiensis*, Grub kill (a commercial formulation of the combination of 33% *Metarhizium anisopleae*, 33% of *Beauveria bassiana* and 33% of *Bacillus subtilis*), Neem seed kernel extract (NSKE), Neem oil (Azadirachtin 0.03% based commercial formulation) and five leaves extract (a traditional preparation of five different plants such as *Adhatoda vasica*, *Vitex negundo*, *Azadiracta indica*, *Ricinus communis* and *Pongamia glabra*) were tested against *E. machaeralis* first in the laboratory to identify the effective bio product and dose by following bio-assay and then the selected products were tested in the field to verify their consistency.

Laboratory bioassay

To find out the efficacy and effective dose levels of various bioproducts against laboratory reared third, fourth and fifth instars of *E. machaeralis*, bio-assays were conducted by following poison food technique and topical application method. There were seven treatments excluding control with three replications. A stock solution of 4 per cent concentration of each product was first prepared in distilled water and from which 0.0125, 0.25, 0.5, 1.0 and 2.0 concentrations were prepared by serial dilution and tested.

Poison food technique

The larvae obtained from the laboratory culture maintained on natural diet were starved for three hrs before the experiment. The above mentioned concentrations of the bio-products were applied on both sides of the defined size of teak leaf discs (15 cm diameter) by using camel hair brush individually; air dried and kept in sterilized Petri dishes (150 mm). Ten numbers of pre-starved larvae were released on the treated leaves and after fed they were transferred to untreated leaves. Three such replicates were run and with each replicate a control was also maintained in which larvae fed with leaves sprayed with distilled water.

Topical application technique

All the products at various concentrations mentioned above were sprayed topically on third, fourth and fifth instars of *E. machaeralis* by using an atomizer and then allowed to feed on untreated leaves. Ten numbers of the respective instars were used per treatment. Distilled water was sprayed on the control sets. Three replications were maintained. Larval mortality was recorded at 6, 12, 18, 24, 48 and 72 hrs after exposure and the cumulative per cent mortality was worked out. Mortality of the larvae in the treated sets was adjusted for mortality with the control (if any) using Abbots formula (Abbot, 1925). The data were subjected to probit analysis for estimating LC 50 values (Finney, 1977).

Field trial

The effective formulations at effective dose levels were tested under field conditions. A trial was carried out in an 8-9 years old teak plantation at vallampadugai, Chidambaram Taluk during the epidemics of *E. machaeralis* between September and October. Three blocks of about 50 trees each with a buffer zone in between were selected. Each block was considered as a replication. Each block

Table 1. Susceptibility of the larval instars of *E. machaeralis* to various bioinsecticides by poison food technique

Bioinsecticides	Larval instars	χ^2	LC_{50} (95%CI)	Slope 'b'	Intercept 'a'
	III	1.57	0.66 (0.41 - 1.07)	1.86	-0.25
M. anisopliae	IV	1.96	1.75 (0.56 - 2.00)	1.96	-0.53
	V	0.31	2.93 (1.22 - 7.00)	1.36	0.26
	III	1.31	0.50 (0.36- 1.05	1.52	-0.21
B. bassiana	IV	0.99	1.33 (0.9- 1.9)	1.63	-0.81
	V	1.26	2.02(0.98- 2.84)	1.21	0.30
	III	0.16	0.55 (0.37 - 0.61)	2.25	-1.16
B. thuringiensis	IV	0.07	0.92 (0.41 - 1.26)	1.24	0.92
	V	0.18	1.23 (0.92 - 1.71)	2.01	0.46
	III	0.32	0.42 (0.31-0.86)	1.20	0.51
Grub kill	IV	0.92	1.02 (0.72-2.06)	1.82	0.80
	V	0.45	1.53 (1.02-2.82)	1.84	0.83
	III	1.08	6.45 (5.67-7.33)	2.77	0.29
NSKE	IV	1.54	15.6 (3.14-62.12)	2.10	0.47
	V	1.21	27.00 (6.77-107.71)	2.20	0.48
	III	1.01	4.85 (2.62-6.10)	1.60	0.36
Neem oil	IV	0.92	5.43(3.01-10.62)	1.49	0.42
	V	0.46	13.97(9.27-17.83)	2.00	0.51
	III	0.32	2.61 (2.10-3.86)	1.30	0.45
Five leaves extract	IV	0.08	3.94 (2.61-4.81)	1.42	0.21
	V	0.92	5.35 (4.67-7.33)	1.07	0.36

was demarked as 7 plots. 5 trees were in each plot and in between the plots buffer strip of two meters were left. In each block, treatments were allotted to plots at random.

The spray suspension was prepared by diluting the respective stock with water to obtain desired concentration. Before spraying sticker (Tween 80) was added at a concentration of 0.2 per cent if needed. Each tree with in the treatment plot was individually sprayed using a rocker sprayer. The quantity of spray solution applied per tree ranged from 2 to 2.5 litres, depending on the total fresh foliage present. To assess the reduction in the larval numbers due to treatments, larval counts and per cent foliage damage were made as described below after 15 days of spraying. Two sprayings were given once in 15 days. The control plot was left untreated.

The number of larvae was counted visually by employing trained labor once in a week. The tree canopy was divided into top, middle and bottom levels and four shoots representing four directions were sampled from each level. The number of larvae found on each shoot was counted and recorded. Mean number of larvae and mean per cent foliage loss was worked out per tree (Varma *et al*., 2001). The intensity of defoliation was estimated using a visual scoring system and expressed as the percentage foliage loss. Score I=<5% foliage loss, ScoreII =6 – 25% foliage loss, Score III=26–50% foliage loss, Score IV=51-75% foliage loss and Score V=75-100 % foliage loss.

The data recorded were subjected to analysis of variance (ANOVA) under randomized block design by adopting the procedures described by Gomez and Gomez (1984). Necessary data transformation was made before analysis and the computer based IRRISTAT package was used for analysis.

RESULT AND DISCUSSION

Laboratory bioassay

The LC_{50} values of various bio-products showed an inverse relation between larval instars and susceptibility. The results of the bio assay by following poison food technique revealed that *B. thuringiensis* was found effective than others to all the three instars tested and followed by Grub kill, *B.bassiana* and *M.anisopliae.*

Table 2. Susceptibility of the larval instars of *E. machaeralis* to various bioinsecticides by topical application method

Bio-insecticides	Larval instars	χ^2	LC_{50} (95% CI)	Slope 'b'	Intercept 'a'
	III	1.56	0.79 (0.47-1.33)	1.69	0.07
M. anisopliae	IV	0.52	2.19 1.09-4.39)	1.51	-0.05
	V	0.65	3.44 (1.48-7.99)	1.55	-0.50
	III	0.79	0.54 (0.33-0.86)	1.82	0.03
B. bassiana	IV	0.45	1.50 (0.87-2.59)	1.72	-0.45
	V	0.75	2.41 (1.40-4.20)	2.03	-1.86
	III	0.48	16.99 (1.07-269.01)	1.10	0.33
B. thuringiensis	IV	0.26	71.06 (14.51-78.72)	0.86	0.80
	V	0.24	73.21 (16.3- 427.18)	0.19	0.56
	III	0.73	0.70 (0.42 - 1.18)	1.60	0.47
Grub kill	IV	0.66	1.36 (0.68 - 2.70)	1.26	1.05
	V	1.79	1.88 (0.88 - 3.42)	1.30	0.75
	III	0.29	12.57 (1.14 -138.76)	1.01	0.85
NSKE	IV	0.32	18.29 (1.26 -147.20)	1.30	0.92
	V	0.72	74.32 (12.21-381.10)	0.91	0.68
	III	0.18	8.61 (1.41 - 29.37)	1.21	0.71
Neem oil	IV	0.24	14.26 (3.77 - 58.41)	1.28	0.52
	V	0.29	62.12 (9.71 -286.77)	1.36	0.43
	III	0.09	28.91 (5.63 - 48.53)	1.82	0.38
Five leaves extract	IV	0.39	36.89 (9.71 -150.77)	1.55	0.42
	V	0.31	63.93 (18.57-370.71)	1.99	0.46

Among the botanicals, five leaves extract was found effective in causing mortality on third and fourth instars than NSKE and Neem oil (Table 1). When exposed to botanicals most of the fifth instar stages pupated immediately.

The LC_{50} recorded with Grub kill was lower when compared with other products in the topical application method. This was followed by *B. bassiana* and *M. anisopliae*. The other products such as *B. thuringiensis*, NSKE, Neem oil and Five leaves extract were failed to cause considerable mortality in the topical assay and the projected LC_{50} values for the treatments were very high (Table 2). In the laboratory bio assays Grub kill, *B. bassiana* and *M. anisopliae* were performed well in the topical application method when compared with poison food technique. But, *B. thuringiensis*, NSKE, Neem oil and five leaves extract were better in causing mortality while following poison food technique than in the topical assay. *Bacillus thuringiensis* at 1.5 per cent, 2.5 per cent, *M. anisopliae* at 3 per cent, Neem oil at 6 per cent and Five leaves extracts at 6 per cent were selected as treatment for field trial. These at 2 per cent, *B.bassiana* at concentrations were fixed on the basis of LC_{50} values.

Field trial

The data (Table 3) on field trial showed that all the treatments were more effective than control. *B. thuringiensis* @ 1.5 per cent was found superior to all other treatments. This was followed by Grub kill (*B.bassiana+M.anisopliae+ B.subtilis*) @ 2 per cent, Five leaves extracts @ 6 per cent, *B. bassiana* @ 2.5 per cent and *M.anisopliae* @ 3 per cent. Our findings are in accordance with Meshram *et al.* (1997) who found that *B.t* var. *kurstaki* at 2 per cent was most effective, giving 77.5 per cent mortality after three days in the nursery and disagree with the findings of Chadhar (1996) who reported that *B.t* var. *kurstaki* spray at 0.083 per cent was effective. Five leaves extract was not tested against *E. machaeralis* earlier; but, the few individual components of five leaf extract such as Grub kill, adathoda, nochi and neem seed were reported effective by Mohindra Pal (1993) and Eungurijarnpanya and Yinchareon (2002) respectively.

CONCLUSION

It is concluded that the teak skeletonizer, *E. machaeralis* can be managed by spraying any one

Table 3. Field efficacy of various bioinsecticides on the larvae of *E. machaeralis*

Treatment	Pretreatment count		15 DAS After 1st spray		15 DAS After 2nd spray	
	#Number of larvae/ tree*	##Per cent foliage damage/ tree*	#Number of larvae/ tree*	##Per cent foliage damage/ tree*	#Number of larvae/ tree*	##Per cent foliage damage/ tree*
B.thuringiensis 1.5%	43.6a	36.5a	29.4a	28.2a	10.7a	7.9a
Grub kill 2%	43.9a	37.2a	33.9c	30.6a	16.2c	13.4b
B.bassiana 2.5%	42.3a	36.6a	31.5b	30.9a	15.4b	14.1b
M.anisopliae 3%,	41.7a	35.4a	37.8e	32.7b	20.6e	17.8c
Neem oil 6%	43.3a	36.0a	40.2f	33.0b	30.9f	26.4d
Fiveleaves extracts 6%	42.4a	35.0a	35.7d	29.0a	18.3d	13.0b
Control	43.0a	36.7a	52.3g	45.1c	54.7g	46.8e
CD (p- 0.05)	0.6	12.58	0.02	3.9	0.01	1.9

Values mean of three replications; *Mean of 3 trees; Values are square root# /arcsine## transformed

of the following bio – products at the respective concentration *B. thuringiensis* @ 1.5%, Grub kill @ 2 % and five leaves extracts @ 6 %. Normally two sprays are needed to reduce the population with an interval of 15 days. It was observed that a few of the pupae in the soil under the trees treated with grub kill, found infected and dead. This should be investigated thoroughly; because, the positive results in this line may turn the application technique easier. Instead of foliar application, soil application can be recommended so as to kill the pupae which normally pupate inside the soil under the tree. This may reduce the application rate and cost of protection.

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