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Efficacy of Biological Control Measures on Pine Needles Caterpillar Metanastria latipennis Walker in Pinus Kesiya Royel ex Gordon Plantation in Southern Shan State, Myanmar

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Abstract: The study was carried out to investigate the efficacy of *Bacillus thuringiensis* sub sp. *kurstaki* (*Btk*), bio insecticide Azadirachtin and established natural enemies (Mantids) on *Metanastria latipennis* in *Pinus kesiya* Plantation in Southern Shan State of Myanmar. The experiment was conducted in pine plantations established in 2010 in Taung Lay Lone Reserved Forest, Taungyi Township, at about latitude 25˚ 40' N and longitude 96˚ 51' E at an altitude of approximately 1160 m. Research was conducted from May, 2017 to August, 2019. A Randomized Complete Block Design (RCBD) was used with four replications. Each block containing the four treatments randomly assigned to test the effect of *Btk*, Azadirachtin, released the Mantids on pine caterpillar *Metanastria latipennis*. Sampling was done on a sample plot measuring 20m × 20 m with 20 sample trees. In control measures, (i) 30 ml of *Btk* per 10 litres of water, (ii) 0.75 % Azadirachtin 112.5 ml per 10 litres of water, (iii) biological control (established the mantids), and (iv) control were tested. In this experiment, *Btk* and Azadirachtin treatments significantly reduced the level of infestation compared to the control. Biological control by predators was not significantly different with the control.

Key words: *Metanastria latipennis, Bacillus thuringiensis* sub sp. *kurstaki*, Azadirachtin, Bio control agent (Mantises), *Pinus kesiya* plantations, Southern Shan State (Myanmar)

1. Introduction

The pine needles caterpillar *Metanastria latipennis* is an important defoliating pest of *Pinus kesiya* plantations and also seriously suffers from this caterpillar attack and outbreak of infestation has been occasionally reported in Myanmar. Young and old pine plantations and pure natural stands ranging in age from 8 to 20 years are susceptible to outbreaks of this caterpillar in four year interval for last decades and currently in every year. The caterpillar *M. latipennis* generally affects and widespread outbreak defoliation had been faced in one or two interval years since 1981 in *Pinus kesiya* plantations [1]. The account of the "Ecology and Control of the Forest Insects of India and the Neighbouring Countries" included *Metanastria grisea, M. ampla, Lebeda nobilis* and *Heliothis armigera* as Lepidonteran insect defoliators of *Pinus kesiya* in the Union of Burma [2]. Although *M. latipennis* has long been recognized as an important pine pest, an attempt at controlling this pest is presently far from successful due to the inability to predict the outbreaks well in advance. Because, changing in sizes of population are variable between the localities and between years so that sudden appearance of *M. latipennis* population followed by serious outbreak was unpredictable.

Pine caterpillar *Metanastria punctate* is a major pest of *P. massoniana* plantations in central and southern China. There are between 2 and 4 generations per year

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depending on climatic conditions. Usually trees are not killed by this caterpillar; the main affect is retardation in growth of trees.

In the forest pest control, biological insecticide can be an alternative to use of synthetic pesticides, because they have low toxicity to natural enemies and mammals [3]. Botanical pesticides are widely used for the control of insect pests [4, 5]. Therefore the use of biological and botanical insecticides has been recommended as a suitable alternative of plant protection with minimum negative risks [6, 7].

Azadirachta indica A. Juss (Neem) extracts has been used recently as a natural insecticide [8, 9]. The effects of Azadirachtin on insects include feeding and oviposition deterrence, growth inhibition, fecundity and fitness reductions, and it has low mammalian toxicity and low persistence in the environment [10, 11]. Several studies have reported the effect of Azadirachtin on nutrition and development of caterpillar [12-14] and that extracts have little impact on non-target organisms like parasitoids, predators and pollinators [15].

The *Bacillus thuringiensis* sub sp. *Kurstaki (Btk)* is used to control lepidopteran pests [16]. The use of *Btk* preparations has the acceptance in field and laboratory treatments by international organizations for 40 years [17]. Predators of pine needle caterpillar include praying mantises, wasps, katydids, predatory true bugs, spider and bird [18].

The pine plantations seriously suffer from caterpillar *Metanastria latipennis* attack and outbreak of infestation has been occurring every year in our country. Therefore, objective of the present study was assigned to investigate the efficacy of (a) *Bacillus thuringiensis* sub sp *kurstaki (Btk)* (b) botanical insecticide, *Azadirachtin* and (c) introducing the predator (mantises) on pine needle caterpillar *Metanastria latipennis* under field conditions.

2. Material and Methods

The study was conducted in a pine plantation established in 2010 in Taung Lay Lone Reserved Forest, Taungyi Township, Southern Shan State at about latitude 25°40' N and longitude 96°51' E at an altitude of approximately 1160 m. Research was conducted from May, 2017 to August, 2019. Individual trees were between 5 m to 7 m in height and 6.2 cm to 13 cm in diameter. A Randomized Complete Block Design was used with four blocks having a size of 25 hectares. Each block containing four plots randomly assigned to test the effect of *Btk*, Azadirachtin, release natural enemies (mantises) and control. Sampling was done on a sample plot measuring 20 m × 20 m with 20 sample trees, the spacing of 9 ft. by 9 ft. The buffer zones were then established to avoid cross contamination from treatments between the blocks and plots.

To assess the average number of caterpillars per tree, three small branches (top, middle and lowest) of main branches at 3 sites were collected randomly in each tree and observed for the presence of number of caterpillars. This was conducted at fortnight and monthly intervals and average number of branches infested with pests was calculated and the values were recorded within pest infection period.

Treatment application was carried out May to August 2019. The different formulations of each insecticide were used for evaluating the effectiveness on *Metanastria letipennis*. Mixed 30 ml of *Btk* per 10 litres of water and 0.75% Azadirachtin 112.5 ml per 10 litres of water were applied using back pack sprayers in 1st week of May, June and July, 2019 in field conditions.

Collected adult mantises (Thirty) and an egg case (ootheca) were released only once onto each sample plot.

Mean values of insect pest attacking numbers was analyzed by using MS Excel 2000, SPSS Version 23. One-way analysis of variance (ANOVA) was used to test differences between non-treatment or control and other treatments. Dunnett's multiple range test (DMRT) was also used to examine the difference among treatments.

3. Results and Discussion

A survey to record biology and habitat of pine needle caterpillar was conducted within study period; found that moths laid the eggs in groups or rows on needles, branches and stem. We collected some of egg masses to rear in laboratory conditions, and found that they hatch in about 10 days. The larvae of *Metanastria latipennis* emerge in late April and early May then complete feeding in July or August for first generations in field conditions. The larvae move on the trees by wind with silk. First-instar larvae prefer needles of current year, but fourth and final instar larvae prefer one-year old needles. They pupate in large double-walled cocoons of mingled silk and hair, usually on the branches among leaves; etc., and a pupa period is about 2-3 weeks. The first generation of moths emerge in August and the second generation in November/December. According to our finding, *M. latipennis* has two or more generations per year in field condition in Myanmar.

Mean infestation level of caterpillar *Metanastria latipennis* was about 35% within sample plots in May 2018. The incidence was in progress 50% in June. The pupae and adult stages were found in late July and early August 2018. Therefore, we continually conducted the data collection of second generation impacts on experimental plots from September to November, 2018. Mean infestation level was about 40% in September 2018. The infestations increased to 57% in November 2018.

3.1 Efficacy of Different Treatments on Caterpillars

We carried out the individual treatments in May, 2019. Before the treatment, we collected the data on level of the infestation of needle caterpillar to compare with after treatment. The mean number of caterpillars was about 27.78 in May, 2019 before applying the control measures (Fig. 1). In study area, in 95% confident level that all treatments differ with control was the highest mean thrust. The *Btk* and Azadirachtin

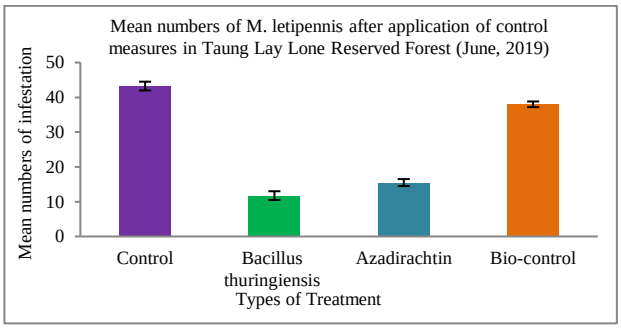

Fig. 1 Mean numbers of pest before application of control measures in May, 2019. Error bars indicate standard errors.

provided acceptable results, as far as number of mean level was concerned after spraying.

Although *Btk* and Azadirachtin significantly reduced the number of caterpillar *M. latipennis*, the release of mantises did not show satisfactory result. In addition, there was no significant difference effect between *Btk* and Azadirachtin. The statistical analysis did not show a significant difference between the control and biological control.

The infestation was decreasing one month after the treatments. All control measures except biological control by predators significantly reduced the infestation compared to the control. The most effective treatment was *Btk* where mean number was 7 while control was 52. The second most effective was Azadirachtin where mean number was 10. However, the mean number of surviving caterpillars in the plots was 41 where mantises were released and there was no statistically significant difference with the control plots (Fig. 4). At the $\grave{\alpha} = 0.05$ significance level, there was enough evidence to conclude that the mean thrust differs among the four treatments.

Table 1 Results of an ANOVA on survival rate of caterpillar *M. latipennis after* the different kinds of treatments at 0.05% significant level of probability.

Source	Sum of Squares	df	Mean Square	F	Sig
Treatment	5909.083[a]	3	1969.694	24.247	.000
Replication	10.083	3	3.361	.041	.989
Monthly	6.000	2	3.000	.037	.964
Error	3168.083	39	81.233		
Corrected Total	9093.250	47			
CV% = 32					

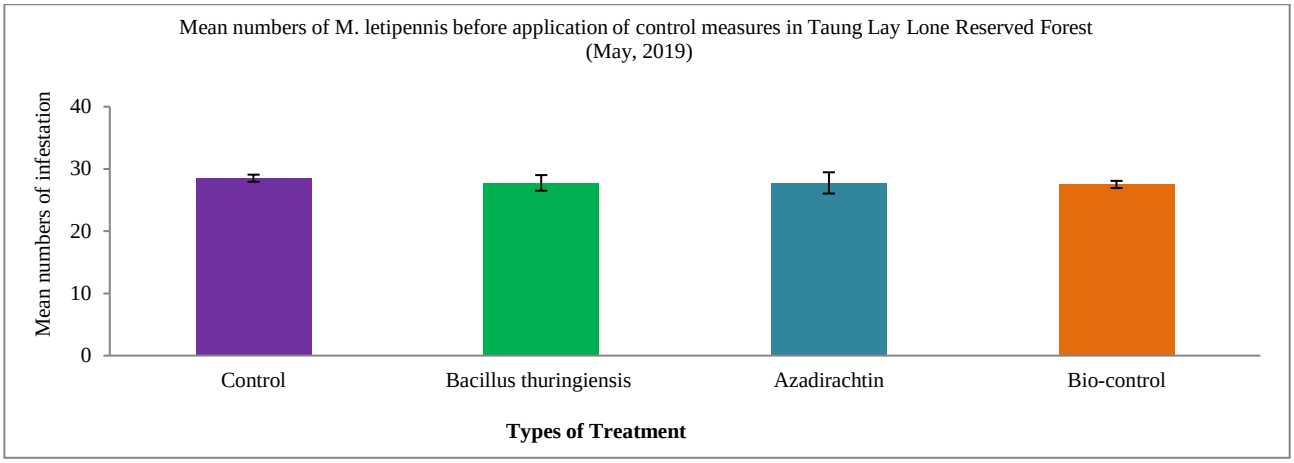

Fig. 2 Mean numbers of pest after application of control measures in June, 2019. Error bars indicate standard errors.

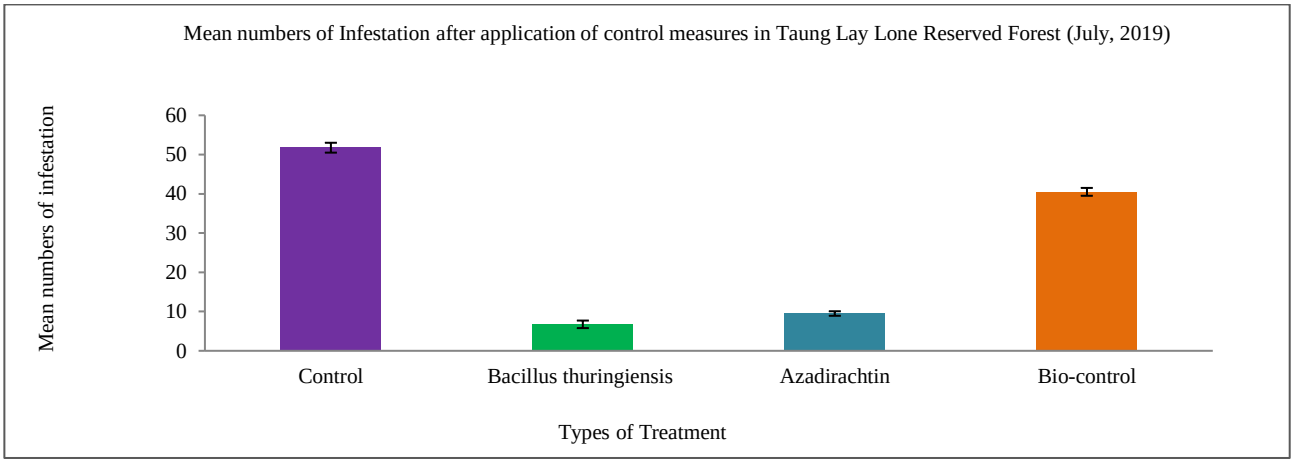

Fig. 3 Mean numbers of pest after application of control measures in July, 2019. Error bars indicate standard errors.

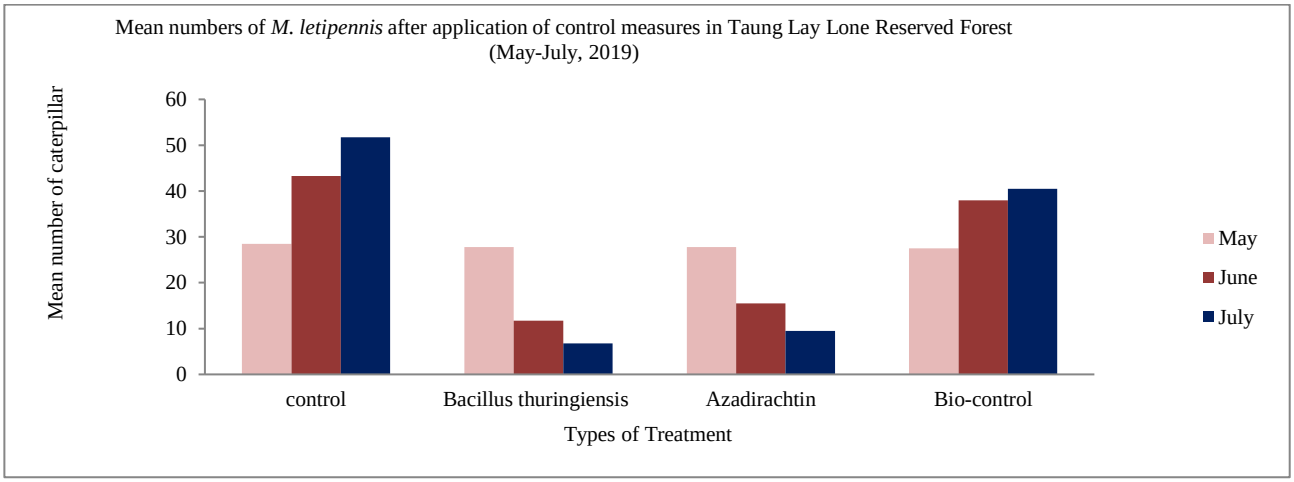

Fig. 4 Reducing means value after application of control measures in May-July, 2019.

Commercial preparations of various *Bacillus thuringiensis* sub sp *Kurstaki* were used against pine needle caterpillar *Metanastria latipennis* by several researchers. According to their studies, the larval mortality rates were 71-80% [19], 89-100% [20], 95-98% [21], 85% [22]. The results of our analysis gave about

45%, 42% and 11% with *Btk*, Azadirachtin and bio control agent respectively. The results show that *Btk* and Azadirachtin obviously reduced the number of caterpillars emerged from late April, early May and October or November. However, the use of Azadirachtin is preferable as it is much cheaper than *Btk* and readily available in Myanmar. Although natural enemy mantises were released, it could not show satisfactory results. The number of released mantises may be too small to see the impact. Whatever in natural conditions, biological control plays an important role in forest ecosystems and regulating the population densities of insect pest outbreaks. Therefore, it is necessary to establish the natural enemies of pine pest in pine plantations. Creating the environmental conditions that favour the existence of these biological control agents will greatly help in controlling pine moth populations and minimize the use of pesticides [23].

4. Conclusion

The objective of this research was to assess the efficacy of *Btk***,** Azadirachtin and predator mantises on caterpillar *Mentanastria latipennis*. Results show that *Btk* and azadirachtin reduced the number of caterpillars. Although the natural enemies (Mantises) were released in this study, there was no significant effect on *M. latipennis*. *Bacillus thuringiensis* sub sp *kurstaki* (*Btk*) and Azadirachtin insecticide should be applied to prevent the outbreak level. Control action should be taken immediately upon discovery of *M. letipennis* detection in the plantations.

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