

Full Length Research Paper

Field treatments of Foray 76 B and VBC 60074 against *Thaumetopoea pityocampa* (Den. and Schiff.) in Fethiye-Turkey

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Thaumetopoea pityocampa (Den. and Schiff.) is the most important coniferous pest in Turkey. Although several methods have been used in attempting to control this major forest pest up to now, the problem still remains largely unsolved in Turkey. In order to control this pest, we planned and applied field treatments for experiment. Foray 76B and VBC 60074 bioinsecticides including *Bacillus thuringiensis* subsp. *kurstaki* were sprayed on *Pinus brutia* trees. The experiment was two-factor randomised complete block design within three blocks having a size of 1.5 ha. Each block was subdivided into three plots having a size of 0.5 ha. The buffer zones were then established to avoid cross contamination from treatments between the blocks and plots. Foray 76B was applied at the rate of 2.5 l 50 BIUha⁻¹ and VBC 60074 at the rate of 0.6625 kg + 2.5 l water 50 BIUha⁻¹ on three plots during December 19, 2005 by Micronair AU 8000EH sprayer. Bioinsecticides caused a mortality ranging from 95 to 99%.

Key words: *Bacillus thuringiensis* subsp. *kurstaki*, biological control, pine, pine processionary moth, mortality percentage.

INTRODUCTION

The pine processionary moth (PPM), *Thaumetopoea pityocampa* (Den. and Schiff) is the most important coniferous pest in Turkey. Defoliation of this pest results in not only the damage to coniferous species but also the decreases of annual diameter increment on host trees. In addition, defoliated trees attract secondary insects. For this reason, damage of this pest has to be permanently taken under the control.

The PPM was firstly recorded in Istanbul Princes in 1929 (Hovas, 1929). Later on, Schimitschek (1944) reported this pest in various regions of Turkey from 1937 to 1939. Since then, General Directorate of Forestry has been collecting data about its infestation levels and distribution. According to the data, this pest expanded its distribution range more than other *Thaumetopoea* species in Turkey. PPM increased its distribution range from 249,690 ha in 1938 (Besceli, 1969) to 1,500,000 ha in

2009. This pest continuously expands its range as a result of insufficient parasitoid and predator activities, global warming and pest management preferences. Although PPM does not require the high temperatures for survival, because of global warming the pest expanded its range to upper altitudes and inner parts of Turkey where ecological conditions are favourable for larval feeding. Therefore, the protection of coniferous forests requires regular application of various control methods. The control methods involve in mechanical-physical, chemical, bio-technical and biological measures against PPM. As far as control concerned, the measures mainly based on destroying egg-batches and winter nests (111,463 ha), using by various chemicals (79335 ha), pheromone traps (2,761 ha) and parasitoids-predators (63,747 ha) in Turkey during 2007.

There are considerable limitations to the control methods widely used in Turkey. The use of mechanical-physical control methods in mature stands put forward to some difficulties due to prove costly over large and the height of the trees. In addition, the health risks associated with PPM's urticant hairs (Turkmen and Oner, 2004) which

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cause pustules and wounds on the oral and nasal mucosa of humans seriously limit the extent to which labour-intensive mechanical removal of nests can be used as a control method. Since cutting out winter nests on terminal buds deform the host trees and the death of parasitoids-predators into the burned nests, the mechanical-physical methods are insufficient and inappropriate measures. The applications based on chemical preparations effect negatively on environment and the natural enemies of pest are susceptible to these treatments. Furthermore, Kanat and Sivrikaya (2004) reported the need for scientists to explore and focus on alternative biological methods due to population levels of PPM increased rapidly in the year following the chemical application. Pheromone traps which are used for monitoring of PPM populations are considered as an insufficient control measure when these are applied lonely against the pest in infected areas. Kucukosmanoglu and Arslangundogdu (2002) tested different types of pheromone trap during 1993 in Turkey. The mean number of PPM captured by one trap was 100 during two weeks. If the egg-batches are supposed to contain about 270 eggs, the collecting of one egg-batch equals to almost activity of three traps. Therefore, this control method should be combined with the others for the aim of assistance. Although some of biological methods such as vegetal oils, entomopathogenic fungi, parasitoids-predators resulted in noteworthy outputs according to activations against pest in laboratory, there is no detailed literature about field experiments in Turkey. Since the use of *Bacillus thuringiensis* preparations for 40 years, they have the acceptance for field and laboratory treatments by international organizations (WHO, 1999).

Some studies and experiments have been conducted to evaluate the effectiveness of *B. thuringiensis* preparations against PPM by ground spraying in Turkey. Besceli (1969), Ozkazanc (1986) and Ozcankaya and Can (2004) tested different pesticides at different rates, including *B. thuringiensis* formulations by spraying pine plantations. The results obtained were encouraging but the commercial preparations of *B. thuringiensis* did not lead to a wide usage because of difficulties of obtainable products. Besceli (1969) performed with Bactospeine, the first commercial preparation available from France while Ozkazanc (1986) applied to Thuricide-HP and Tarmik-3 consisting of *B. thuringiensis* spores against PPM. Ozcankaya and Can (2004) sprayed MPV commercial preparation on infected trees. Despite of its efficacy and environmentally friendly profile, *B. thuringiensis* usage has not been one of the control agents of PPM in Turkey while it is the most widely used method in control of PPM in the EU (Avtzis, 1998; Battisti et al., 1998; El Yousfi, 1990; Martin et al., 2003; Niccoli and Pelagatti, 1986; Sanchis et al., 1990; Vanderbrouck, 2007).

In Turkey, our aim was to investigate the efficacy of the improved *B. thuringiensis* bioinsecticides with higher potency formulations, on PPM populations by ground

application.

MATERIALS AND METHODS

This study was conducted between September 2005 and February 2006 on 12 year-old *Pinus brutia* stands at 460 m altitude in Fethiye-Ovacik. In order to have an idea about population density and infestation levels of PPM, the previous winter nests remaining from 2005 and egg batches on shoots were observed in the pine forests at the beginning of September 2005. Target trees were selected based on how many winter nests and egg batches they had. The trees having more than four winter nests and egg batches were considered as appropriate trees to spray bioinsecticides. L₁ and L₂ instars were determined visually and bioinsecticides were applied when most of the eggs hatched and they were either in L₁ or L₂ instars.

Two different *B. thuringiensis* formulations were used for checking the effectiveness on PPM in this study; (1) Foray 76B having a potency of 16.700 I.U per mg is a water based formulation, (2) VBC 60074 having a potency of 64 B.I.U per kg is a wettable granule formulation. Both bioinsecticides contain the spores and crystals of *B. thuringiensis*.

The experiment was two-factor randomised complete block design within three blocks having a size of 1.5 ha. Each block was subdivided into three plots having a size of 0.5 ha. The buffer zones were then established to avoid cross contamination from treatments between the blocks and plots. Foray 76B was applied at the rate of 2.5 l 50 BIUha⁻¹ and VBC 60074 at the rate of 0.6625 kg + 2.5 l water 50 BIUha⁻¹ on three plots. These bioinsecticides were sprayed at 14°C, 4 kmh⁻¹ wind speed and in partly cloudy weather conditions on December 19, 2005 by Micronair AU 8000EH sprayer (Figure 1). During the spraying, the spray droplet size was 100 µ. Twenty-five nests were collected from each plot on January 17, 2006 (P₁), February 08, 2006 (P₂) and February 28, 2006 (P₃) and dead and live larvae were counted in each nest (Figure 2). A total of 270 nests were collected from shoots and branches of trees during P₁, P₂ and P₃. To calculate the percentage of larval mortality, the dead larvae numbers were divided by the dead and live larvae numbers for each nest. Data were analysed using ANOVA. Before performing ANOVA, data transformation was done with Arcsin. Means were compared with Duncan multiple range test at alpha level of 0.05.

RESULTS AND DISCUSSION

Results showed that bioinsecticide treated plots had significantly more mortality than control plots, but, there was no significant difference between mortality rates of bioinsecticides in both plots treated with Foray 76 B and VBC 60074 (Table 1). Both bioinsecticides seemed very effective for controlling PPM, as far as larval mortality was concerned, in 28 days after spraying (Table 2). These results were similar to the results of other authors studying on the Bt-based products (Avtzis, 1998; Battisti et al., 1998; Besceli, 1969; Ozcankaya and Can, 2004; Ozkazanc 1986).

Various *B. thuringiensis* commercial preparations were used against PPM by several researchers. According to their studies, the larval mortality rates were 89 - 100% (Avtzis 1998), 96% (El Yousfi, 1990), 75 - 98% (Martin et al., 2003) 71 - 80% (Niccoli and Pelagatti, 1986), 93 - 99% (Sanchis et al., 1990) and 100% (Vanderbrouck,



Figure 1. Micronair AU 8000EH and spraying operation.



Figure 2. Counting out dead and live larvae in the nest.

Table 1. Percentages of larvae mortality.

Bioinsecticide	Periods		
	January 17, 2006 (P ₁)	February 08, 2006 (P ₂)	February 28, 2006 (P ₃)
Control	1.30 ^a ± 0.60 n = 30	1.48 ^a ± 0.34 n = 30	0.79 ^a ± 0.31 n = 30
Foray 76B	97.67 ^b ± 0.82 n = 30	96.48 ^b ± 1.13 n = 30	95.51 ^b ± 6.89 n = 30
VBC 60074	98.26 ^b ± 1.36 n = 30	95.48 ^b ± 1.70 n = 30	99.48 ^b ± 0.47 n = 30

*Means ± SD with different superscript letters are statistically significant for bioinsecticides within the same column and for nest collection periods within the same row as determined by Duncan multiple range test ($P < 0.05$).

2007) in EU and in some Mediterranean countries. Ground applications of the *B. thuringiensis* resulted in larval mortality 100% (Besceli, 1969), 94% (Ozcankaya and Can, 2004) and 40 - 99% (Ozkazanc, 1986) in Turkey. The results of our analysis coincide with those

mentioned authors. Our mortality percentages reflected the fact that applications of *B. thuringiensis* from ground provided superior results when *B. thuringiensis* preparations were sprayed under proper environmental conditions and optimal timing for application.

Table 2. Tests of between-subjects effects dependent variable: Percentages of larvae mortality.

Source	Type III sum of squares	df.	Mean square	F	Sig.
Corrected model	34154.755	10	3415.475	237.064	0.000
Intercept	85599.647	1	85599.647	5941.375	0.000
Blocks	35.817	2	17.909	1.243	0.315
Applications	34001.902	2	17000.951	1180.017	0.000
Periods	35.163	2	17.581	1.220	0.321
Applications * periods	81.873	4	20.468	1.421	0.272
Error	230.518	16	14.407		
Total	119984.920	27			
Corrected total	34385.273	26			

Although remaining significantly lower than the mortality rate in the treatment plots, average of percentage mortality rates of control plots showed a slight decrease throughout the survey periods although remaining significantly lower than the mortality rate in the treatment plots. The mortality rate differences among P₁, P₂ and P₃ within the control plot can be attributed to the effect of parasitical, predatorial, pathogenetic factors. The low mortality results obtained in the control plot revealed that the biotical factors were not favourable to the natural control of the PPM in the area. The percentage mortality values in the control plot were 1.48% after 22 days and 0.79% after 42 days (Table 2). However, the results were not consistent with the study conducted in Greece by Avtzis (1998). The author obtained 40.5 and 52.3% of larval mortality in control plots at almost similar time intervals.

These results suggest that the spraying of Foray 76B and VBC 60074 gave satisfied results against PPM when applied in proper conditions in Turkey's pine forests. Both insecticides gave statistically similar results.

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