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Comparison of yield loss on cabbage from Diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) using two insecticides

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Abstract

Damage caused by the Diamondback moth (DBM), *Plutella xylostella* L. on head cabbage (*Brassica oleracea* var. capitata) was assessed, by applying. *Bacillus thuringiensis* (Bt) var. kurstaki and a pyrethroid insecticide, λ-cyhalothrin at different growth stages. Yields were increased by 36.1% and 49.4%, respectively in the first season (November planting) and 85.2% and 91.2% in the second season (April planting), using Bt and λ-cyhalothrin, respectively. These yield losses equate to 12 and 20.7 tons/ha in the first season and 27 and 48.7 tons/ha, respectively in the second season. The pre-heading stage was observed to be the critical period of DBM infestation suggesting the need to protect the crop during this growth stage until threshold data are available for use in DBM management.

Keywords: Diamondback moth; Cabbage; Yield loss; Growth stages; Bt; λ-Cyhalothrin

1. Introduction

Diamondback moth (DBM) is a most destructive insect pest of cabbage, with extensive studies on its biology and control world-wide, but information on the yield loss is limited (Talekar and Shelton, 1993). In India, Krishnamoorthy (2004) reported a 52% yield loss on cabbage, while virtually nothing has been published about losses in the area of small-holder production in Africa, despite its importance (Kibata, 1996). The insect inflicts heavy damage to brassica crops in the central Rift Valley region of Ethiopia, with complete crop failure common in seasons of heavy infestation. In the absence of yield loss data in Ethiopia, this study to estimate yield loss due to DBM and the critical period of infestation on head cabbage was conducted.

2. Materials and methods

2.1. Experimental sites

The experiment was conducted during the cold dry season from November 2001 to February 2002 and the hot dry season from April to July 2002 at the Melkassa Center of the Ethiopian Agricultural Research Organization (EARO). Seedlings of the locally popular cabbage variety, Copenhagen Market, were raised in the field and transplanted bare rooted at the four to five leaf stage on 20th of November 2001 and 19th of April 2002, respectively. Cultural practices (fertilization, irrigation, weeding, etc.) were carried out according to recommendations of the horticulture division of the research center. Urea and diamonium phosphate (DAP) were mixed and applied at the rate of 50 and 150 kg/ha one day before transplanting. Urea at 50 kg/ha was applied at the early heading stage. Plots were furrow irrigated twice weekly during seedling stage and once weekly there after. Plot size was eight rows of 4 m length each with a spacing of 40 cm between plants and 60 cm between rows. A randomized complete block design (RCBD) with nine treatments replicated four times was used. Spacing between plots and replications were 2 and 2.5 m, respectively. The bio-pesticide *Bacillus thuringiensis* (Bt) var. *kurstaki* (Dipel) and a pyrethroid insecticide, λ-cyhalothrine (Karate), were used to control DBM. Both were applied at different growth stages as defined by Meier (1997): seedling, pre-heading, heading and throughout the crop-growing period, in addition to the

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Table 1
Treatment details of the DBM yield loss assessment experiment, Melkassa, 2001/2002

Growth stages of head cabbage[a]	Application dates of pesticides	
	November planting	April planting
1. Untreated	—	—
2. Seedling (S)	12, 18, 25, Dec. 2001	9, 14, 21, 27 May and 3 June
3. Pre-heading (PH)	1, 8, 15, 22, Jan. 2002	11, 17, 25 June and 2 July
4. Heading (H)	29 Jan., 5, 12 Feb. 2002	9, 16, 23 July
5. S + PH + H	All of the above dates	All of the above dates

[a]Meier (1997) scale.

untreated check. To compare the two pesticides and their interaction with the treatments, a factorial RCBD was used by excluding the untreated plot. Bt was applied at the rate of 0.5 kg/ha and λ-cyhalothrin (Karate, 5 EC) at 16 g a.i./ha. Sprays were applied with a manually operated knapsack sprayer at 600 l/ha using a flat fan nozzle. The dates of spray applications for the different treatments for the two experimental seasons are shown in Table 1.

Prior to each pesticide application, five randomly selected plants from border rows of each plot were examined for young larvae, mature larvae and pupae of DBM. At the same time, the intensity of aphid (*Brevicoryne brassicae*) infestations were determined, using a simple scoring system (0—no aphid colonies, 1—one colony, 2—two colonies; and 3—three and above colonies).

Marketable yield from the central two rows of each plot was recorded by removing the outer damaged leaves and discarding heads with less than 4 cm in diameter.

2.2. Statistical analysis

Analysis of variance (ANOVA) was performed on insect count data for different sampling dates. The numbers were subjected to square root ($\sqrt{(x+1)}$) transformation before analysis. In addition, mean number of DBM (pooled for all the sampling dates) and aphid colonies (*Brevicoryne brassicae* L.) per plant were analyzed. Means were separated using S–N–K test. The SAS statistical software (SAS, 1999) was used for analysis.

2.3. Economic analysis

The relative economic returns of the treatment were calculated by subtracting the cost of insecticide and their application costs from the gross return. The price of Bt per kg and λ-cyhalothrin per l is estimated at USD 22.98 and 17.24, respectively. Application cost is estimated at 8.05 USD per ha (7 man-days per ha; 1.15 USD per man-day).

3. Results

3.1. Diamondback moth density at different growth stages

3.1.1. November planting

Overall insect populations were relatively low in the November season ranging between 0 and 4.1 DBM (larvae and pupae) per cabbage. Differences between treatments at early and mid growth stages were very low, but from week eight after planting, plots treated with Bt or λ-cyhalothrin throughout the growing period had significantly lower ($P<0.05$) DBM counts than the untreated check (Fig. 1).

3.1.2. April planting

DBM population was considerably higher than in the November planting and ranged between 0 and 10.9 DBM

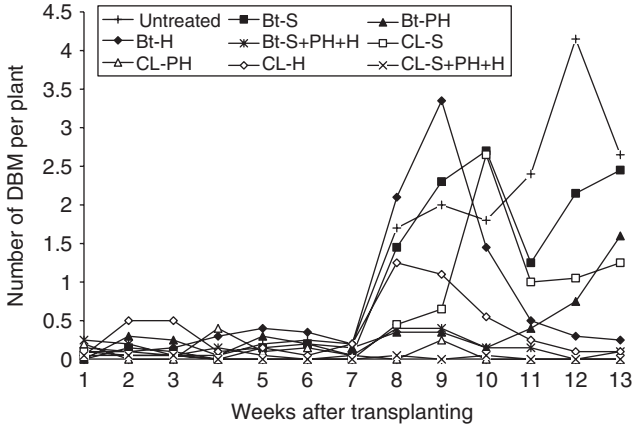

Fig. 1. Effect of the application of Bt and λ-cyhalothrin (CL) during different growth stages of cabbage (S = seedling, PH = preheading, H = heading) on diamondback moth numbers (November 2001–February 2002, Melkassa, Ethiopia).

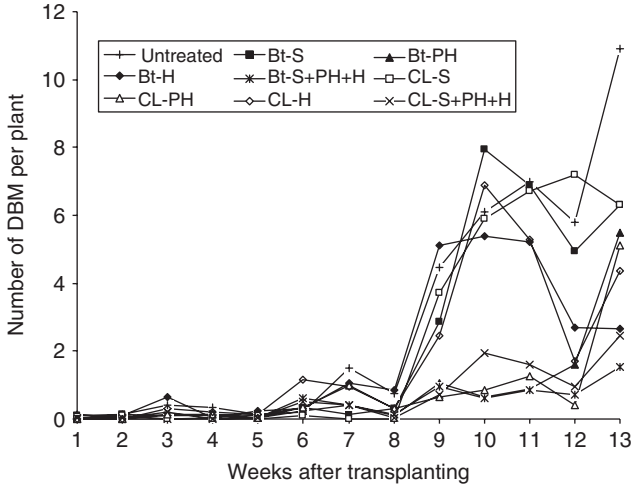

Fig. 2. Effect of the application of Bt and λ-cyhalothrin (CL) during different growth stages of cabbage var. Copenhagen Market (S = seedling, PH = preheading, H heading) on diamondback moth numbers (April 2002–July 2002, Melkassa, Ethiopia).