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Full Length Research Paper

Efficacy of a botanical and biological method to control the diamondback moth (*Plutella xylostella* L.) in cabbage (*Brassica oleracea* var *capitata* L.) under open field conditions at Anse Boileau, Seychelles

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Three field trials were conducted from August 2007 till December 2007, October 2007 till January 2008* and February 2008 till April 2008 at the Vegetable Research Station in Anse Boileau, Seychelles to evaluate the efficacy of one botanical and one biological method for controlling the diamondback moth (*Plutella xylostella* L.) in cabbage (*Brassica oleracea* var *capitata* L.) under open field conditions. The treatments were Thuricide (*Bacillus thuringiensis),* garlic extract and the control repeated four times in a randomized complete block design. The results showed significant differences between treatment plots, where Thuricide was applied as compared to the other two treatments. The means percentage of head damage in the first two trials for Thuricide treatments was significantly lower (9, 10%) compared to garlic extract (89, 90%) and the control (94, 98%). In the third trial, the non-treated plots obtained a maximum mean percentage of head damage of 92%, followed by 74% for garlic extract and 13% for Thuricide application. These results demonstrated that the Thuricide application is effective for controlling the diamondback moth pest on cabbage.

Key words: Thuricide, Diamondback moth, cabbage, pest.

INTRODUCTION

Plutella xylostella (L.) (Lepidoptera: Yponomeutidae), commonly known as the diamondback moth (DBM), is one of the most important pests of cruciferous crops throughout the world, and can cause serious economic losses if not controlled. In the warm, humid tropics, this insect breeds throughout the year, and can have more than ten generations annually. The destructiveness of DBM, coupled with the fact that it has the capacity to develop resistance very rapidly to any control measure used singly, has made this pest the focus of IPM research in many parts of the tropical world. Practically, all the available methods and pest control technologies have been tried at some time or another for the management of DBM (Glare and Gallagham, 2000).

The adults are small, grayish-brown moths with three diamonds on their body, and are more distinct on males than females. They lay yellow eggs singly on the underside of the leaves near the veins. The larvae are green and feed under the leaf epidermis first and later on feed on the outer layer of the leaf. Larvae feed on leaves, buds, flowers, seedpod, the green outer layer of the stems, and occasionally, the developing seeds within the older seed pods of canola and mustards. The amount of damager varies greatly, depending on plant growth stage, larval densities and size. When larvae are small, damage is evident as small irregular holes of “shot hole” in the leaves. If larvae are numerous, they may eat the entire leaf, leaving only the veins (Serafinchon, 2001).

DBM attacks cabbage, collards, greenhouse plants, and some ornamentals such as alyssum, candytuft, and wallflower. Imported from Europe, this insect now occurs all over the U.S. It gets its name from a row of diamond-shaped yellow spots which run down the back of the moth. The moths spend the winter hidden among crop

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Table 1. Mean percent head damage on cabbage in trials conducted at Anse Boileau research station, % mean ± SEM of head damage[b] / trial.

Treatments	1st Trial	2nd Trial	3rd Trial
Thuricide (*B. thuringiensis)*	8.6 ± 0.66[a]	10.3 ± 0.33[a]	13.0 ± 0.00[a]
Garlic extract	89.0 ± 0.00[b]	98.6 ± 0.25[b]	74.0 ± 0.00[b]
Control	93.5 ± 0.00[b]	97.8 ± 0.75[b]	92.0 ± 0.00[c]

[a]Trials were conducted on the following dates: (1st) August - December 2007, (2nd) October - January 2008, (3rd) February - April 2008. [b]% moth severity damage index.

remnants. The larvae seldom exceed one-third inch in length, are pale green in colour, and are much more numerous than other cabbage worms.

but is now found throughout the Americas and in Europe, Southeast Asia, Australia and New Zealand. It was first observed in North America in 1854, in Illinois, but had spread to Florida and the Rocky Mountains by 1883, and was reported from British Columbia by 1905. In North America, diamondback moth is now recorded everywhere that cabbage is grown. However, it is highly dispersive, and is often found in areas where it cannot successfully overwinter, including most of Canada.

The objective of this project is to evaluate the efficacy of one botanical and one biological method for controlling diamondback moth (*P. xylostella* L.) in cabbage (*Brassica oleracea* var *capitata* L.) under open field conditions.

MATERIALS AND METHODS

Plant culture and field transplant

Polypots filled with sterilized media were placed inside the nursery under shelter temperature 28 ± 2°C. The polypots were watered thoroughly and a small hole was made in the middle to a depth of 1 cm. One seed of cabbage (*B. oleracea* var *capitata* L.) was sown per hole and the polypots were covered with dumped treated gunny bags. Eventually, the gunny bags were removed when 75% of seeds had germinated. The seedlings were watered with 100 ml of water daily to keep the soil moisture constant. A stock solution composed by 97.5 g of Urea, 45 g of MAP, and 112.5 g of potassium nitrate mixed in 130 L of water was applied two times a day for 4 days. One week before transplanting, the water application was reduced 100 ml/day to harden the seedlings. Seedlings were irrigated prior to and after transplanting into the open filed. The seedlings with 5 - 6 true leaves were transplanted in a spacing of 45 cm between rows and 50 cm between plants within each treatment plot. Four applications with compound fertilizer NPK (12: 12: 17) at the rate of 250: 250: 300 Kg/ha were applied (Ripjma, 1991) at least sixty days from the transplanting date, immediately after each application, the plants were irrigated at a rate of 50 ml/h.

Garlic extraction

The garlic extraction was made by grinding 3 - 5 fresh garlic bulbs, added to two tablespoons of kerosene and allowed to stand for 24 h. One tablespoon of grated oil based soap was melted in 0.5 l of hot water and allowed to cool for 12 h. The soap solution was added to the garlic mixture, sieved through a piece of cloth and then water (10 l) was poured in the resultant sieved solution. This solution was used for the treatment applications.

Field trial preparation

Three field trials were conducted from August - 2007, October - January 2008 and February - April 2008 at the Vegetable Evaluation and Research Station in Anse Boileau, Seychelles. An experimental plot was selected of an area 495.6 m^2 and visible vegetation of other plant debris and stones were cleared prior to being ploughed to a depth of 30 cm. The micro-sprinklers were installed on the experimental plot to irrigate the soil before bed preparation. Four beds were raised 1.2 in wide, 20 cm high and 3 m long and demarcated according to the experimental layout with boards for each treatment. Three drips lines were installed on each bed, the spacing between drip lines was 45 cm and the holes were dug about 15 cm deep every 50 cm apart, following the drip along each pipeline. Well decomposed poultry manure was placed in each hole at a rate of 300 g/hole. The holes were covered with a layer of soil and it was ensured that no manure was left at the surface. The beds were irrigated immediately after manure application.

Treatments

The insecticide application started when the threshold action level of 1 diamondback moth larva was reached per plant from 10 plants randomly selected on experimental field using V-shape and repeated every seven days. Treatments were Thuricide with active ingredients *Bacillus thuringiensis* (5 g/L of water), garlic extract 2 L of solution per 10m^2 and the control (no treatment) in a randomized complete block design replicated four times. The treatment application with garlic extract was repeated every two weeks.

Assessment of treatments

Ten plants were selected randomly from the sample plot and were tagged and the moth severity of damage index was scored as follows: 0 = no holes, 1 = some scattered holes, 2 = more holes but no consequences in the plant development and 3 = severe damage infesting the head. Later, the diamond back moth severity damage was classified as follows: 0: no infestation, 1 - 2: medium infestation and 3: severe infestation (Table 1).

At harvest, the number of matured cabbage heads were counted and indexed in each sample plot per treatment. The percentage of head damage by the diamond back moth was calculated and all data obtained were statistically analyzed using the analysis of variance from the program “stat box” and the least significant difference test α = 0.05 was used to separate treatment means.

RESULTS AND DISCUSSION

The results showed that there is a significant difference between the treatment plots, where Thuricide was detected on the cabbage plants and heads, compared with 74 holes on cabbage head in garlic treatment and 92 holes for the non-treated. This clearly confirmed that the Thuricide application with active ingredient *B. thuringiensis* is more effective to control DBM in cabbage as shown above that no hole was detected on the cabbage plants and heads. This positive result corresponds to laboratory bioassays conducted by Goolaub (1995) as well as in field trials, and confirmed that *B. thuringiensis* provide great protection against DBM attack.

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Higher percent head damage were obtained by the non-treated (94 and 97%) and the garlic extract (89 and 99%) treatments, compared to 9 and 10% for the Thuricide from August 2007 - December 2007 and October 2007 - January 2008, respectively. This finding indicates that neither treatment were effective for controlling the DBM. These results confirmed that the DBM had shown certain resistance to the garlic extract as stated by Hutchinson et al. (2004). Although DBM has also developed resistance to numerous insecticides, including several *B. thuringiensis (Bt)* products, it appears that Thuricide is still effective against this pest.

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The results showed that significant differences exist between the three treatments. The non-treated plots obtained a mean percentage of head damage of 92%, followed by 74% for garlic extract and 13% for the Thuricide application. These results proved that Thuricide application is more effective to control the DBM, followed by garlic extract at a lower strength. These results supported the experiment using *B. thuringiensis* and cabbage cultivar resistance to the diamondback moth (Paul and Seth, 1997). They stated that cabbage plots treated with effective strains of *B. thuringiensis* had significantly fewer larvae per plant compared with untreated ones.

Conclusion

From the results obtained, Thuricide with active ingredient *B. thuringiensis* proved to be the most effective treatment to control diamondback moth in cabbage plants. The garlic showed very little resistance to the moth and therefore, it is recommended that further investigations be done during different seasons and also with a combination of resistance cabbage varieties to increase its potential efficacy. Thuricide can be applied on cabbage plants for protecting against damage due to the DBM larvae.

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