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Field Bio-Efficacy Evaluation of Plant Shield 0.6SL Against Diamondback Moth (*Plutella xylostella*) in Pechay

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***Abstract*: A study on the field bio-efficacy evaluation of Plant Shield 0.6SL against Diamondback moth (*Plutella xylostella*) in pechay was conducted to identify the best application rate of Plant Shield 0.6SL that can control the population of Diamondback moth in pechay; to determine the effect of Plant Shield 0.6SL to beneficial and non-target arthropods; to evaluate the presence of phytotoxicity of Plant Shield 0.6SL; and to compare the pechay yield between treatments. The treatments replicated four times were as follows: T1 Untreated control; T2 Plant Shield 0.6SL RR at the rate of 50 ml/16L water; T3 Plant Shield 0.6SL ½ RR at the rate of 25 ml/16L water and T4 Plant Shield 0.6SL 1.5 RR at the rate of 75 ml/16L water. The different treatments were evaluated following the procedure in RCBD. The results of the study revealed that the population of Diamondback moth was significantly reduced by the spray application of Treatment 4 Plant Shield 0.6SL 1.5 RR at the rate of 75 ml/16L water, lowered the percentage of damage caused by Diamondback moth and produced the highest number and heaviest weight of marketable yield of pechay plants per plot and computed marketable yield in tons/ha. It can be recommended that Treatment 4 is the most effective against Diamondback moth infesting pechay plants. No adverse effect on beneficial insect due to the application of various rates of Plant Shield 0.6SL was observed. Moreover, no phytotoxicity on pechay plants was encountered due to the spray application of organic insecticide under study.**

***Keywords*: Plant shield 0.6sl, matrine, organic insecticide, BAFS, diamondback moth.**

1. Introduction

Plant Shield 0.6SL is a natural plant extract which is refined and produced from several wild medical plants such as Sophora flavescens Ait, Vetarum nigrum L, and A. carmichaeli. The active ingredient of this plant extract is matrine, which is known to act on the central nervous system of pests, thus, lead to breath inhibition and motion imbalance. Plant shield is registered to various crops in China such as tea trees, rice, fruit trees, and vegetables. Its insecticidal efficacy showed remarkable control to insects such as aphids, diamondback moth, armyworm, spider mites, and other lepidopterous pests. Diamondback moth (*Plutella xylostella*), sometimes called the cabbage moth, is a moth species of the family Plutellidae and genus *Plutella*. The small grayish-brown moth sometimes has a cream-colored band that forms a diamond along its back (Wikipedia). Plant damage is caused by larval feeding. Although the larvae are very small, they can be quite numerous, resulting in complete removal of foliar tissue except for the leaf veins (Capinera, 2000). The larvae squirm actively when disturbed and produce many small holes on the host plant. Adult moths migrate in throughout the growing season. There is therefore often an overlap in generations, and all stages may be present at one time (Jimenez et al, 2000). Increased used of traditional pesticides, especially pyrethroids are the popular way of controlling this insect pest but poses high risk in terms of food safety and occupational hazard among farm workers. Insect resistance have also been observed, most specially in pyrethroid insecticides (Capinera, 2000). Pechay (Brassica rapa L. cv group Pak Choi) is an erect, biennial herb cultivated as an annual about 15-30 cms tall in vegetative stage (Jimenez et al., 2000). National production of native pechay and Chinese pechay were 47,302.46 and 51,454.44 metric tons, respectively in 2019 (PSA Database). Consumed popularly as a main vegetable or ingredient to viands and soups, it is available year-round and easily planted in traditional farms or within the backyard. And since various insect pests infest pechay, it is of vital importance to have an organic pest control solution to this perennial problem. The Bureau of Agricultural and Fisheries Product Standards regulates organic pesticides to certify its effectiveness in controlling the target pests and to ensure that this product promotes food safety to consumers. With this, the general objective of this study was to evaluate the bio-efficacy of Plant Shield 0.6SL against Diamondback moth in pechay.

Specifically, it aims to:

1. Identify the best application rate of Plant Shield 0.6SL that can control the population of diamondback moth in pechay;
2. Determine the effect of Plant Shield 0.6SL to beneficial and non-target arthropods in pechay;
3. Evaluate the presence of phytotoxicity of Plant Shield 0.6SL on pechay; and

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4. Compare the pechay yield between treatments.

2. Methodology

1) Time and Place of the Study

The experiment was conducted in Brgy. Bantug, Science City of Muñoz, Nueva Ecija, from March to May 2021.

2) Experimental Design

A total of 250 square meter area was utilized in this study. It was laid out in a Randomized Complete Block Design (RCBD). The area was divided into four blocks representing the replication and further subdivided into 4 plots where the different treatments were randomly assigned. The size of the plot was 10 sq. m. (2m x 5m). Distance between blocks and plots was 1 meter.

3) Cultural Practices

- *Transplanting:* The Black Behi variety of pechay was used. Eighteen day old seedlings were transplanted on April 18, 2021 at a distance of 0.20 m between hills and 0.20 m between furrows.
- *Irrigation:* Watering was done immediately after transplanting. Succeeding watering was done twice a week or as the need arises.
- *Fertilization:* The RM-CARES organic fertilizer was applied before transplanting at a rate of 4.5 tons/hectare.
- *Weeding:* Hand weeding was employed.

4) Treatments and treatment application

The following treatments were evaluated:

Table 1
Treatments

Treatment Number	Treatments	Rate per 16L water
1	Untreated Control	_
2	Plant Shield 0.6SL RR	50 ml
3	Plant Shield 0.6SL 1/2 RR	25 ml
4	Plant Shield 0.6SL 1.5RR	75 ml

Treatment application was started at the day when any stage of diamondback moth (egg, larva/nymph, and adult) was visible in the experimental plots at 10% infestation level. The next application was done 10 days after the first treatment. Regardless of the schedule of the first treatment application, there were at least two spray applications during the cropping period. Beneficial arthropods, if present, on the whole plant was recorded every insect population assessment. For phytotoxicity assessment, crop injury, if any, was taken a day, 3 days, and 7 days after treatment application. Observation was made only from undamaged leaves.

5) Risk Management

The efficacy trial was conducted in an area solely allocated for organic-products testing. The area is away from growing areas where traditional fertilizer and pesticide products were used. The field has a perimeter fence around it and visual signages were erected once the efficacy trial was under way. A viable source of water is nearby and water containers abound, making sure that any accidental spillage was immediately dealt with.

3. Data Gathered

1. The population of the Diamondback moth (*Plutella xylostella*) was assessed a day before (DBTA), a day after, and 3 days after, and 7 days after treatment application (DATA). Visual counts of all the stages of insects (young larvae, mature larvae and pupae) per treatment were based on ten randomly-tagged sample plants/plot. Observation was done in the morning.
2. Damage Rating - this was based on the relative damage of insect pests in pechay leaves. Ten sample plants per plot were labelled and assessed throughout the experiment. The nature of the damage was noted if it was due to chewing insects or it was caused by sucking insects. For the damage of chewing insects, it was the percent leaf that was eaten while for the sucking ones, it was percent damage due to yellowing wilting, curling, and drying.
3. Effect on Beneficial arthropods- the number of beneficial arthropods present was counted every insect population assessment. This also included those non-target organisms in the top soil.
4. Phytotoxicity- observation was made only from undamaged leaves using the 1-9 rating scale
5. Yield and yield parameters - weight of damaged, undamaged marketable, and non-marketable leaves were obtained at harvest. The former was included in data gathering since sometimes there are slightly damaged leaves that can be considered marketable. Also, there were undamaged leaves that can't be considered marketable due to its abnormal size (smaller than the normal size).

Table 2
Leaf damaged

Scale	Description
1	No damage
3	1-10% leaf area damaged
5	11-25% leaf area damaged
7	26-50% leaf area damaged
9	Above 50% leaf area damaged

Table 3
Crop injury

Scale	Description
1	No crop injury
3	1-10% crop injury
5	11-20% crop injury
7	21-30 crop injury
9	>30% crop injury

1) Gantt chart of activities

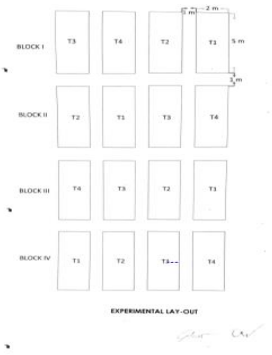
Table 4
Gantt chart of activities

Activities	March	April	May	June
Land Preparation and Lay-outing	xx			
Pechay Transplanting		xx		
Treatment Applications and Data Gathering		xx	xx	
Data Consolidation and Analyses			xx	
Report Writing				xx

1) Statistical analysis

Summarized data was analyzed using Analysis of Variance

(ANOVA) in RCBD and means was compared using Tukey's HSD Range Test.



4. Results and Discussion

1) Diamondback moth, Plutella xylostella

The population of the Diamondback moth (*Plutella xylostella*) was assessed early in the morning. The different observation periods were: a day before the treatment application (DBTA), a day after treatment application (DATA), 3 DATA and 7 DATA. Visual counts of all the stages of insects (young larvae, mature larvae and pupae) per treatment were based on ten randomly tagged sample plants per plot. First treatment application was done on April 25, 2021 due to the appearance of target pest. A day before first treatment application, there was insignificant number of Diamondback moth counted from the different treatments. However, one and three days after the first treatment application Treatment 4, the spray application of Plant Shield 0.6 SL 1.5 RR at the rate of 75 ml/16L water obtained the lowest population of Diamondback moth comparable with Treatment 2, the application of Plant Shield 0.6 SL RR at the rate of 50 ml/16L water. Seven days after the first treatment application, plants grown on plot under Treatment 4, the spray application of Plant Shield 0.6 SL 1.5 RR at the rate of 75 ml/16L water produced the lowest count of Diamondback moth among the rest of the treatments.

During the second treatment application on May 25, 2021, at 1 DBTA until 3 DATA, the results were insignificant for Treatment 4 and Treatment 2 in producing the lowest number of Diamondback moth. However, 7 DATA application of Plant Shield 0.6 SL 1.5 RR at the rate of 75 ml/16L got the lowest population of Diamondback moth when compared to the rest of the treatments. This treatment determined the effectiveness and the effective level of Plant Shield 0.6 SL in controlling the increase of population of the target pest. Obviously, plants grown on the untreated control plots had the highest insect pest population during the first to second spraying periods (Table 1).

2) Percent Damage of Diamondback Moth

Presented on Table 2 the percent damage caused by Diamondback moth on pechay leaves. The data was assessed at 7 days after each treatment application. Results revealed that among the different treatments used, Treatment 4 the application of Plant Shield 0.6SL 1.5RR at the rate of 75 ml/16L water got the lowest percent damage of Diamondback moth observed from first to second spraying of treatments. The lowest extent of damage done by Diamondback moth was observed on plants sprayed with the highest rate of Plant Shield 0.6SL. It indicates and determine the effectiveness and the effective level of the organic product used. Highest extent of damaged was observed from the untreated control.

3) Effect on Beneficial Insect

The organic product was tested on its negative effect on beneficial insect. As presented on Table 3, only spider was observed in the experimental plots during the study period. Count of spider per plot was done 3 and 7 days after each treatment application. Insignificant results were observed which showed that various rates of Plant Shield 0.6SL has no negative effects on the beneficial insect comparable to the untreated control.

4) Phytotoxicity

No phytotoxicity was observed in pechay plants treated with various rates of Plant Shield 0.6SL.

5) Number and Weight of Marketable Plants

Organic insecticide such as Plant Shield 0.6SL implies that there was a significant effect on the number and weight of marketable pechay plants. Highest marketable yields by both number and weight were obtained with the application of Plant Shield 0.6SL 1.5RR at the rate of 75 ml/16L water. It can be noticed that with regards to the number of marketable produced by plants treated with Plant Shield 0.6SL 1.5RR at the rate of 75 ml/16L water, it was significantly comparable with the application of the recommended rate of Plant Shield 0.6SL at the rate of 50 ml/16L water (Table 4).

6) Number and Weight of Non-marketable Plants

Among the rest of the treatments, T1 the untreated control produced the highest number and heaviest weight of non-marketable plants per hectare. Lowest number and lightest weight of non-marketable plants was produced by Treatment 4 which was significantly the same with Treatment 2 (Table 5).

5. Conclusion

Based on the result of the study, it was therefore concluded that:

1. Plant Shield 0.6SL at various rates were effective in reducing the population of Diamondback moth and percent damage in pechay, but the most effective was the application of Plant Shield 0.6SL 1.5RR at the rate of 75 ml/16L water.
2. Plant Shield 0.6SL at various rates have no direct effect on the beneficial and non-target arthropods.
3. Plant Shield 0.6SL does not have any phytotoxic effect on the pechay plants.
4. Plots treated with Plant Shield 0.6SL 1.5RR at the rate of 75 ml/16L water yielded the highest number and heaviest weight of marketable plants.

6. Recommendation

Among the various rates of Plant Shield 0.6SL tested, it is recommended that the most effective control of Diamondback moth infesting pechay plants was the spray application of Plant

Table 5
Mean population of Diamondback moth, P. xylostella observed per plot based on 10 sample plants/plot as affected by different rates of Plant Shield 0.6SL

Treatments	**First Spraying**				**Second Spraying**			
	1 DBTA	1 DATA	3 DATA	7 DATA	1 DBTA	1 DATA	3 DATA	7 DATA
T1-Untreated Control	5.25[a]	8.00[a]	14.25[a]	21.75[a]	33.00[a]	37.75[a]	47.50[a]	54.75[a]
T2-Plant Shield 0.6SL RR	8.25[a]	5.50[bc]	5.00[bc]	9.50[c]	11.00[c]	7.75[c]	5.50[c]	11.75[c]
T3-Plant Shield 0.6SL ½ RR	6.50[a]	6.25[b]	6.50[b]	14.25[b]	16.75[b]	14.00[b]	14.50[b]	20.00[b]
T4-Plant Shield 0.6SL 1.5RR	7.50[a]	4.50[c]	3.75[c]	6.00[d]	7.75[c]	4.75[c]	3.00[c]	5.75[d]

Table 6
Percent damage of Diamondback Moth (Plutella xylostella) on pechay leaves 7 days after treatment applications based from 10 randomly tagged sample plants per plot as affected by different rates of Plant Shield 0.6SL

Treatments	**First Spraying**	**Second Spraying**
T1-Untreated Control	31.67[a]	55.56[a]
T2-Plant Shield 0.6SL RR	20.56[b]	23.89[c]
T3-Plant Shield 0.6SL 1/2 RR	23.33[b]	33.61[b]
T4-Plant Shield 0.6SL 1.5RR	16.67[c]	18.33[d]

Table 7
Count of spider 3 and 7 days after treatment applications per plot as affected by different rates of Plant Shield 0.6SL

Treatments	**First Spraying**		**Second Spraying**	
	3 DATA	7 DATA	3 DATA	7 DATA
T1-Untreated Control	0.50[a]	1.00[a]	1.75 [a]	2.00 [a]
T2-Plant Shield 0.6SL RR	1.00[a]	1.25 [a]	2.00 [a]	2.25 [a]
T3-Plant Shield 0.6SL 1/2 RR	0.75[a]	1.00 [a]	1.50 [a]	1.75 [a]
T4-Plant Shield 0.6SL 1.5RR	0.75[a]	1.25 [a]	1.75 [a]	2.25 [a]

Table 8
Number and weight of marketable plants based from 10 randomly tagged sample plants, based on 10 sq. m plot and computed tons/ha as affected by different rates of Plant Shield 0.6SL

Treatments	Number and Weight of Marketable					
	Per 10 sample plants		Per 10 sq m plot		ComputedPer ha	
	Number	Weight (g)	Number	Weight (kg)	Number	Weight (tons)
T1-Untreated Control	4.25[c]	368.40[d]	140.25[c]	12.16[d]	140250.00[c]	12.16[d]
T2-Plant Shield 0.6SL RR	8.75[a]	940.50[b]	288.75[a]	31.04[b]	288750.00[a]	31.04[b]
T3-Plant Shield 0.6SL 1/2 RR	7.00[b]	788.35[c]	231.00[b]	26.02[c]	231000.00[b]	26.02[c]
T4-Plant Shield 0.6SL 1.5RR	9.25[a]	1070.63[a]	305.25[a]	35.33[a]	305250.00[a]	35.33[a]

Table 9
Number and weight of non-marketable plants based from 10 randomly tagged sample plants, based on 10 sq. m plot and computed tons/ha as affected by different rates of Plant Shield 0.6SL.

Treatments	**Number and Weight of Non-Marketable**					
	Per 10 sample plants		Per 10 sq. m plot		Computed Per ha	
	Number	Weight (g)	Number	Weight (kg)	Number	Weight (tons/ha)
T1-Untreated Control	5.75[a]	391.43[a]	189.75[a]	12.92[a]	189750.00[a]	12.92[a]
T2-Plant Shield 0.6SL RR	1.25[c]	93.48[c]	41.25[c]	3.08[c]	41250.00[c]	3.08[c]
T3-Plant Shield 0.6SL % RR	3.00[b]	219.98[b]	99.00[b]	7.26[b]	99000.00[b]	7.26[b]
T4-Plant Shield 0.6SL 1.5RR	0.75[c]	60.53[c]	24.75[c]	2.00[c]	24750.00[c]	2.00[c]

Shield 0.6SL 1.5 RR applied at the rate of75 ml/16 L of water.

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