

INTEGRATED MANAGEMENT OF TOBACCO CATERPILLAR AND CABBAGE BUTTERFLY WITH HOST PLANT RESISTANT AND ORGANIC AMENDMENT

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Abstract

Field study was conducted at Patuakhali Science and Technology University, Patuakhali during 2013-2014 to know the effect of cabbage variety and organic agriculture on the damage potential of *Spodoptera litura* F. and *Pieris brassicae* L. Two cabbage varieties viz., Atlas-70 (V₁) and Super tropic (V₂), and organic agriculture like, M₀ = control, M₁ = cowdung @ 6 kgplot⁻¹, M₂ = mustard oilcake @ 750gplot⁻¹, M₃ = Vermicompost @ 3 kgplot⁻¹ and M₄ = Trichoderma @ 3 kgplot⁻¹ were included in this study. Treatment combinations were V₁M₀, V₁M₁, V₁M₂, V₁M₃, V₁M₄, V₂M₀, V₂M₁, V₂M₂, V₂M₃ and V₂M₄. Results revealed that the lowest number of infested plants/plot and percent infested leavesplant⁻¹ were found in variety Super tropic and trichoderma (V₂M₄) applied plots followed by variety Atlas-70 and vermicompost (V₁M₃) applied plots on different dates of observation while the highest number of infested plantsplot⁻¹ and percent infested leaves plant⁻¹ were in variety Super tropic and mustard oil cake (V₂M₂) applied plots followed by variety Atlas-70 and control (V₁M₀) applied plots. The highest number and percent (4.00 plot⁻¹) and (20.00% plot⁻¹) of infested heads were found in variety Super tropic and mustard oil cake (V₂M₂) applied plots followed by variety Atlas-70 and control plots (V₁M₀) (16.65%). The highest number of healthy heads plot⁻¹ (19.67), healthy head yield (71.47 t ha⁻¹) and total head yield (72.14 t ha⁻¹) were recorded in variety Super tropic and Tricoderma (V₂M₄) applied plots followed by variety Atlas-70 and vermicompost (V₁M₃) (70.53 t ha⁻¹) applied plots while the lowest number of healthy heads per plot, healthy head yield and total head yield were recorded in in variety Super tropic and mustard oil cake (V₂M₂) applied plots followed by variety Atlas-70 and control plots (V₁M₀).

Keywords: Atlas-70, organic materials, trichoderma, Super tropic, vermicompost.

Introduction

Cabbage (*Brassica oleracea* L. var. *capitata*) is one of the most popular vegetables in the world. It is mostly grown in winter throughout Bangladesh. In Bangladesh, the annual production of cabbage is 217 thousand tons (BBS, 2014). The production and yield of cabbage is greatly hampered by many insect pests. Cabbage is also known to be infested by several insect pests viz., tobacco caterpillar, *Spodoptera litura* (Fab.), cabbage butterfly (*Pieris brassicae*),

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diamond back moth (*Plutella xylostella* Linnaeus) and cabbage aphid (*Brevicoryne brassicae* L.). Out of these, cabbage butterfly, diamond back moth and tobacco caterpillar are the most destructive pests causing severe yield loss to cabbage every year (Rao and Lal, 2005; Mahla *et al.*, 2005; Kumar *et al.*, 2007). Tobacco caterpillar is the most destructive insect pest sometimes cause complete failure of the crop. After hatching, the caterpillars start feeding on the under surface of the leaves. Leaves of heavily damaged plants have many feeding holes and sometimes the leaves take a 'sieve-like' appearance. It also destroys the leaves of cabbage by making holes in the head and greatly reduces its market value. As a result of feeding, the plants either fail to form compact cabbage heads or produce deformed heads (Uddin *et al.*, 2007).

The indirect effects of fertilization practices acting through changes in the nutrient composition of the crop have been reported to influence plant resistance to many insect pests. Vermicompost are produced through the interactions between earthworms and microorganism in the breakdown of organic wastes and to convert into nutritional rich humus (Sinha *et al.*, 2010). The vermicompost promote growth from 50-100% over conventional compost and 30-40% over chemical fertilizers (Sinha *et al.*, 2010). Crop losses due to insects and diseases are reduced with organic farming (Merrill, 1983). Vermicomposts are rich in humic acid and phenolic compounds. Phenolic compounds act as feeding deterrents and hence significantly influence pest infestation (Mahani *et al.*, 2008; Bhonwong *et al.*, 2009). Stevenson *et al.* (1993) reported that inhibition of *S. litura* development by phenolic compound from the wild groundnut. Meyer (2000) argues that soil nutrient availability not only affects the amount of damage that plants receive from herbivores but also increase the ability of plants to recover from herbivory; however, these two factors are rarely considered together. Describing the effects of soil fertility on both the degree of defoliation and compensation for herbivory for *Brassica nigra* plants damaged by *Pieris rapae* caterpillars (Meyer, 2000). Keeping these views in mind, the present study was conducted to evaluate the combine effect of varieties of cabbage and organic agriculture on the damage potential of *S. litura* and *P. brassicae* infesting cabbage.

Materials and Methods

The study was conducted at the agricultural farm of Patuakhali Science and Technology University, Dumki, Patuakhali during *rabi* season of 2013-2014. Two cabbage varieties *viz.*, Atlas-70 (V_1) and Super tropic (V_2) were included in this study. Organic agricultural components were used as treatments were M_0 = control, M_1 = cowdung @ 6 kgplot⁻¹, M_2 = mustard oilcake @ 750gplot⁻¹, M_3 = Vermicompost @ 3 kgplot⁻¹ and M_4 = Trichoderma @ 3 kgplot⁻¹. Treatment combinations were V_1M_0 , V_1M_1 , V_1M_2 , V_1M_3 , V_1M_4 , V_2M_0 , V_2M_1 , V_2M_2 , V_2M_3 and V_2M_4 . Experiment was laid out in randomized complete block design (RCBD) with three replications. The entire field was divided into three blocks and each block was again divided into ten plots. The distance between both

blocks and plots was 1.0 m. The area of each experimental plot was 9 m². Seeds of the selected cabbage cultivars were sown in the month of November and were transplanted in December. Thirty day-old cabbage seedlings were transplanted in the plot of 9 m² area with 45cm × 45cm spacing on 29 December, 2013. The chemical fertilizers viz., urea, TSP and MP were applied at the rate of 285, 145 and 218 kg ha⁻¹. Fertilizer, irrigation and all other agronomic practices were carried out in the experimental field whenever necessary. Harvesting of cabbage heads were started on 02 February and continued till 28 February 2014. Weekly observations were done since one week of transplanting till maturity of the crop. The number of infested plants plot⁻¹, the number infested leaves plant⁻¹ and infested head were separated carefully and healthy and infested leaves were counted and recorded. After each harvest, the number of healthy and infested heads were sorted, counted and recorded separately. The weight of healthy and infested heads per plot was recorded separately for each treatment replicates. Treatment wise percent head infestation was calculated from the pooled data of ten observations. The total yield of cabbage ha⁻¹ for each treatment was calculated in tons from cumulative head harvested from a plot. Data were analyzed after appropriate transformation following RCBD using computer MSTAT C and MS excel programs. Means were compared by DMRT.

Results and Discussion

Combined effects of cabbage varieties and organic agriculture on the number of infested plants plot⁻¹ varied significantly on different dates of observations (Table 1). On 8th January, the number of infested plants plot⁻¹ ranged from 1.50 -3.50. The lowest number of infested plants plot⁻¹ was 1.50 for the treatment combination of V₂M₄ (Super tropic + trichoderma) which was statistically identical to V₁M₁ (1.50) and V₂M₁ (1.50). The highest number of infested plant plot⁻¹ was 3.50 for the treatment combination of V₂M₂ (Super tropic + mustard oil cake) which was statistically similar to V₂M₀ (Super tropic + control).

On 15 January, the number of infested plants plot⁻¹ ranged from 1.00 to 3.50. The lowest number of infested plants plot⁻¹ was recorded for the treatment combination of V₁M₃ (var. Atlas + vermicompost) which were statistically similar to V₂M₄ (Super tropic + trichoderma). The highest number of infested plant plot⁻¹ was for variety Super tropic and mustard oil cake (V₂M₂) applied plots which were statistically similar to V₂M₀ (Super tropic and control).

On day 22 June 2014, the number of infested plants plot⁻¹ ranged from 0.50 to 3.00. Significantly the lowest number of infested plants plot⁻¹ was for the treatment combination of V₁M₃ (Atlas + vermicompost). The higher number of infested plants plot⁻¹ was recorded in V₂M₁ (Super tropic + cowdung) which was statistically similar to remaining all other treatment combinations.

On 29 January 2014, no significant differences were observed among different treatment combinations in respect of the number of infested plants plot⁻¹ (Table 1).

On 5 February 2014, number of infested plants plot⁻¹ ranged from 0.0 to 3.00. No plant was infested in treatment combinations of V₂M₄ (Super tropic +

trichoderma) and the lowest number was recorded in V₁M₄ (0.50) (Atlas + trichoderma) applied plots. The higher number of infested plants/plot was in V₁M₀ applied plots which was statistically identical to V₁M₁ (Atlas + cowdung) (3.00) but statistically similar to treatment combinations of V₁M₀ V₁M₂ on the same date.

On 12 February 2014, the number of infested plants plot⁻¹ ranged from 2.00 to 6.50. The lowest number of infested plants plot⁻¹ was observed in variety supertropic and trichoderma (V₂M₄) applied plots which was statistically identical to V₁M₄ (2.00) and V₂M₀ (2.00) applied plots. The higher number of infested plants/plot was found in variety Atlas-70 and mustard oil cake (V₁M₂) applied plots which was statistically similar to V₁M₁ (5.50) i.e., variety Atlas -70 and cowdung plot followed by V₁M₀ (5.00) i.e., variety Atlas-70 and untreated control plot (Table 1).

Table 1. Combined effects of cabbage varieties and organic manures on the number of infested plants plot⁻¹ by *S. litura* and *P. brassicae* on different dates of observations

Treatment combinations	Number of infested plants plot ⁻¹ observed on						Average number of infested plants plot ⁻¹
	8 Jan.	15 Jan.	22 Jan.	29 Jan.	05 Feb.	12 Feb.	
V ₁ M ₀	2.50ab	2.50b	1.50b	2.00	3.00a	5.00b	2.75
V ₁ M ₁	1.50c	2.50b	2.50a	2.50	3.00a	5.50ab	2.92
V ₁ M ₂	2.00b	2.00c	2.50a	2.00	2.50a	6.50a	2.92
V ₁ M ₃	2.50ab	1.00d	0.50c	0.50	0.00d	2.50de	1.67
V ₁ M ₄	2.00b	2.50b	2.50a	1.50	0.50cd	2.00e	1.83
V ₂ M ₀	3.00a	3.00a	1.50b	1.00	1.00c	2.00e	1.92
V ₂ M ₁	1.50c	2.50b	3.00a	1.00	2.00b	3.00d	2.17
V ₂ M ₂	3.50a	3.50a	3.00a	1.50	2.50a	4.00c	3.00
V ₂ M ₃	2.50ab	2.00c	3.00a	2.00	1.50bc	3.50cd	2.42
V ₂ M ₄	1.50c	1.50cd	1.00b	0.50	0.00d	2.00e	1.08
LSD	0.502	0.499	0.610	-	0.562	0.611	-
Level of significance	**	**	**	NS	**	**	-
CV (%)	4.75	3.80	3.76	6.48	1.65	5.40	-

Values are averages of 3 replications

Means within a column followed by different letters are significantly different from each other at 5% (*) and 1% (**) level of probability by DMRT

V₁=var. Atlas-70; V₂ = Super tropic;

M₀ = control, M₁ = cowdung @ 6 kg plot⁻¹, M₂ = mustard oilcake @ 750g plot⁻¹, M₃ = Vermicompost @ 3 kg plot⁻¹ and M₄ = Trichoderma @ 3 kg plot⁻¹

On day 8 January 2014, the percentage of infested leaves plant⁻¹ varied from 7.79% to 58.69% but significantly the lowest percentage of infested leaves plant⁻¹ was recorded in variety Super tropic and trichoderma (V₂M₄) applied plots and the highest percentage of infested leaves plant⁻¹ was observed in variety Super tropic and mustard oil cake (V₂M₂) applied plots (Table 2).

On 15 January 2014, significantly the lowest percentage of infested leaves plant⁻¹ (4.17%) was recorded in variety Super tropic and trichoderma (V₂M₄) applied plots and the highest percentage of infested leaves plant⁻¹ (66.67%) was observed in variety Atlas-70 and untreated control plot (V₁M₀)

On 22 January 2014, the lowest percentage of infested leaves plant⁻¹ (3.34%) was recorded in variety Super tropic and trichoderma (V₂M₄) applied plots which was statistically similar to V₂M₃ (3.57%) applied plots. The highest percentage of infested leaves plant⁻¹ (61.61%) was observed in variety Super tropic and mustard oil cake (V₂M₂) applied plots which was statistically similar to V₁M₀ (58.93%) (Atlas-70 + untreated control plot).

On 29 January 2014, significantly the lowest percentage of infested leaves plant⁻¹ (4.17%) was obtained in variety Atlas-70 and vermicompost applied plots and the highest (53.96%) was observed in variety Super tropic and mustard oil cake (V₂M₂) applied plots.

On 5 February 2014, significantly the highest percentage of infested leaves plant⁻¹ (61.67%) was observed in variety super tropic and mustard oil cake (V₂M₂) applied plots which differed significantly from all other remaining treatments. The lowest percentage of infested leaves plant⁻¹ (3.57%) was recorded in variety Atlas-70 and trichoderma (V₁M₄) applied plots (Table 2). No leaf infestation was observed in variety Atlas-70 and vermicompost (V₁M₃) (0.00%) and variety Super tropic and trichoderma (V₂M₄) (0.00%) applied plots.

On 12 February 2014, the lowest percentage of infested leaves plant⁻¹ (18.18%) was recorded in variety Atlas-70 and vermicompost applied plots which was statistically similar to V₁M₁ (22.35%). The highest percentage of infested leaves plant⁻¹ (76.93%) was observed in variety Super tropic and mustard oil cake (V₂M₂) applied plots followed by variety Super tropic and cowdung (V₂M₁) (62.15%) applied plots (Table 3). No significant differences were observed among variety Atlas-70 and control plots (V₁M₀) (55.77%), V₁M₂ (54.95%) and V₂M₀ (51.25%) applied plots (Table 2).

Table 2. Combined effects of cabbage varieties and organic manures on the percentage of infested leaves plant⁻¹ caused by *S. litura* and *P. brassicae* on different dates of observations

Treatment combinations	Percentage of infested leaves plant ⁻¹ on						Mean percentage of infested leaves plant ⁻¹
	8 Jan.	15 Jan.	22 Jan.	29 Jan.	05 Feb.	12 Feb.	
V ₁ M ₀	51.12b	66.67a	58.93a	46.88b	36.64b	55.77c	52.05
V ₁ M ₁	31.45d	36.67c	28.57d	36.36c	39.56b	22.35f	32.08
V ₁ M ₂	40.41c	43.69b	34.88c	39.74c	29.12c	54.95c	40.45
V ₁ M ₃	12.78f	25.00e	19.23e	4.17g	0.00e	18.18f	13.05
V ₁ M ₄	17.45e	11.31g	15.11f	17.86e	3.57d	43.34d	17.85
V ₂ M ₀	36.14c	31.22d	30.77d	34.38cd	36.36b	51.25c	36.47
V ₂ M ₁	40.36c	42.86b	41.19b	20.83e	38.92b	62.15b	40.78
V ₂ M ₂	58.69a	46.88b	61.61a	53.96a	61.67a	76.93a	59.45
V ₂ M ₃	30.19d	17.86f	3.57g	27.09d	39.74b	41.67d	31.07
V ₂ M ₄	7.79g	4.17h	3.34g	7.69f	0.00e	31.47e	8.59
LSD	4.40	3.84	2.62	3.61	3.12	4.30	-
Level of significance	**	**	*	**	*	*	-
CV (%)	8.52	7.31	4.80	5.90	6.74	5.12	-

Values are averages of 3 replications

Means within a column followed by different letters are significantly different from each other at 5% (*) and 1% (**) level of probability by DMRT

V₁=var. Atlas-70; V₂ = Supertropic;

M₀ = control, M₁ = cowdung @ 6 kg plot⁻¹, M₂ = mustard oilcake @ 750g plot⁻¹, M₃ = Vermicompost @ 3 kg plot⁻¹ and M₄ = Trichoderma @ 3 kg plot⁻¹

Significantly the highest number of healthy heads plot⁻¹ (19.67) was found in variety Super tropic and trichoderma (V₂M₄) applied plots which was statistically similar to V₁M₃ (19.33) (Atlas-70 + vermicompost). The lowest healthy heads (16.00) was in variety supertropic and mustard oil cake (V₂M₂) applied plots which was statistically similar to V₁M₀ (16.67) (Table 3). On the contrary, the lowest number of infested heads plot⁻¹ (0.33) was observed in variety Super tropic and trichoderma (V₂M₄) applied plots which was statistically similar to V₁M₃ (0.67) (Atlas-70 + vermicompost) applied plots. The highest number of infested heads per plot (4.00) was found in variety Super tropic and mustard oil cake (V₂M₂) applied plots followed by variety Atlas-70 and control plots (V₁M₀) (3.33) and variety Atlas-70 and mustard oil cake (V₁M₂) (2.67) applied plots. No

significant differences were observed among variety Atlas -70 and cowdung (V_1M_1) (2.33), variety Super tropic and control (V_2M_0) (2.00), variety Super tropic and cowdung (V_2M_1) (2.12) and variety supertropic and vermicompost (V_2M_3) (1.67) applied plots in respect of number of infested heads per plot. In case of percent head infestation by number, the lowest percent (1.65%) was recorded in variety Super tropic and trichoderma (V_2M_4) applied plots followed by V_1M_3 (3.35%) and V_1M_4 (6.65%) applied plots. The highest percent (20.00%) head infestation by number was recorded in variety Super tropic and mustard oil cake (V_2M_2) applied plots followed by variety Atlas-70 and control plots (V_1M_0) (16.65%). No significant difference was observed among variety Atlas -70 and cowdung (V_1M_1) (11.65%), variety Super tropic and cowdung (V_2M_1) (10.60%), variety Super tropic and control (V_2M_0) (10.00%) in respect of the percentage of infested heads by number (Table 3).

Table 3. Mean number of healthy and infested head plot⁻¹ and percent head infestation (by number) caused by *S. litura* and *P. brassicae* as influenced by treatment combinations

Treatment combinations	No. of healthy heads plot ⁻¹	No. of infested heads plot ⁻¹	Percent head infestation by number
V_1M_0	16.67e	3.33ab	16.65ab
V_1M_1	17.67cd	2.33cd	11.65cd
V_1M_2	17.33d	2.67bc	13.35bc
V_1M_3	19.33ab	0.67f	3.35fg
V_1M_4	18.67b	1.33e	6.65ef
V_2M_0	18.00bc	2.00cde	10.00cde
V_2M_1	17.88bd	2.12cde	10.60cd
V_2M_2	16.00e	4.00a	20.00a
V_2M_3	18.33bc	1.67de	8.35de
V_2M_4	19.67a	0.33f	1.65g
LSD	0.874	0.854	4.472

V_1 =var. Atlas-70; V_2 = Super tropic;

M_0 = control, M_1 = cowdung @ 6 kg plot⁻¹, M_2 = mustard oilcake @ 750g plot⁻¹, M_3 = Vermicompost @ 3 kg plot⁻¹ and M_4 = Trichoderma @ 3 kg plot⁻¹

Head yield of cabbage varied significantly among different treatment combinations applied in cabbage field under the present trial. The highest healthy head yield (71.47 ton ha⁻¹) was recorded in variety Super tropic and trichoderma (V_2M_4) applied plots which was statistically similar to V_1M_3 (69.23 ton ha⁻¹) applied plots but significantly different from all other treatment combinations

while the lowest head yield (50.40 ton ha⁻¹) was recorded in variety Super tropic and mustard oil cake (V₂M₂) treated plot. However, no significant difference was observed among variety Super tropic and untreated control (V₂M₀) (59.20 ton ha⁻¹) and variety Super tropic and cowdung (V₂M₁) (58.78 ton ha⁻¹) treated plots in respect of healthy head yield by weight (Table 4). In contrast, the highest infested head yield (8.11 ton ha⁻¹) was recorded in variety Super tropic plus mustard oil cake (V₂M₂) applied plots followed by variety Atlas-70 plus control plots (V₁M₀) (6.13 ton ha⁻¹). No significant differences were observed among variety Atlas -70 plus cowdung (V₁M₁) (4.22 ton ha⁻¹), variety Super tropic plus cowdung (V₂M₁) (4.21 ton ha⁻¹), variety super tropic plus control (V₂M₀) (4.10 ton ha⁻¹) and variety super tropic plus vermicompost (V₂M₃) applied plots in respect of infested head yield by weight.

Table 4. Mean healthy, infested and total yield of cabbage and percent head infestation (by weight) caused by *S. litura* and *P. brassicae* as influenced by treatment combinations

Treatment combinations	Head yield (t ha ⁻¹)			Percent head infestation by weight
	Healthy	Infested	Total	
V ₁ M ₀	53.65ef	6.13b	59.78ef	10.25b
V ₁ M ₁	57.60d	4.22cd	61.82def	6.83c
V ₁ M ₂	56.30de	4.37bc	60.67ef	7.20c
V ₁ M ₃	69.23a	1.30ef	70.53ab	1.84ef
V ₁ M ₄	64.63b	2.63cde	67.26bc	3.91de
V ₂ M ₀	59.20cd	4.10cd	63.30cde	6.48c
V ₂ M ₁	58.78cd	4.21cd	62.99de	6.68c
V ₂ M ₂	50.40f	8.11a	58.51f	13.86a
V ₂ M ₃	62.13bc	3.17cd	65.30cd	4.85cd
V ₂ M ₄	71.47a	0.67f	72.14a	0.93f
LSD	3.614	1.827	4.143	2.512

V₁=var. Atlas-70; V₂ = Super tropic;

M₀ = control, M₁ = cowdung @ 6 kg plot⁻¹, M₂ = mustard oilcake @ 750g plot⁻¹, M₃ = Vermicompost @ 3 kg plot⁻¹ and M₄ = Trichoderma @ 3 kg plot⁻¹

The total head yield was the highest (72.14 ton ha⁻¹) in variety Super tropic and trichoderma (V₂M₄) applied plots which was statistically similar to V₁M₃ (70.53 ton ha⁻¹) applied plots but significantly higher from all other treatment combinations. On the other hand the lowest total head yield (58.51 ton ha⁻¹) was recorded in variety Super tropic and mustard oil cake (V₂M₂) applied plots followed by variety Atlas-70 plus control plots (V₁M₀) (59.78 ton/ha) which was

statistically similar to V_1M_2 ($60.67 \text{ ton ha}^{-1}$) treated plots. In terms of percent head infestation by weight, the lowest percent (0.93%) was recorded in variety Super tropic plus trichoderma (V_2M_4) applied plots followed by V_1M_3 (1.84%) treated plots. The highest percent (13.86%) head infestation by weight was recorded in variety Super tropic plus mustard oil cake (V_2M_2) applied plots followed by variety Atlas-70 plus control plots (V_1M_0) (10.25%). No significant difference was observed among variety Atlas-70 plus mustard oil cake (V_1M_2) (7.20%), variety Atlas -70 plus cowdung (V_1M_1) (6.83%), variety Super tropic plus cowdung (V_2M_1) (6.68%), variety Super tropic plus control (V_2M_0) (6.48%) in respect of percent infested heads by weight (Table 4).

From the results of Table 4, it is evident that the healthy head weight and total head yield of cabbage was increased in variety Super tropic plus trichoderma (V_2M_4), and variety Atlas-70 plus vermicompost (V_1M_3) treated cabbage plots compared to control group and remaining other treatment combinations.

There are many reports highlights the improvement of crop yield by applying vermicompost. Getnet and Raja (2013) observed significant differences in the growth and development of cabbage and pest infestation level between vermicompost applied and control plants. Uptake of soluble phenolic compounds from vermicompost, by the plant tissues makes them unpalatable there by affecting the rates of reproduction and survival of pest (Edwards *et al.*, 2010a; Edwards *et al.*, 2010b). The integration of vermicompost, chemical fertilizer and biofertilizer increased the rice yield by 15.9% over the use of chemical fertilizer alone (Jeyabal and Kuppasamy, 2001). The garden pea (*Pisum sativum*) grown by using vermicompost produce higher green pods, higher green grain weight plant⁻¹ (Meena *et al.*, 2007). In the present study the cabbage plant grown in vermicompost applied plot received all the essential nutrients there by cabbage head weight was increased significantly compared to untreated control. From the results of the present study, it is evident that the lowest number of infested plant plot⁻¹ and lowest percentage of infested leaves plant⁻¹ were found in variety Atlas-70 plus varmicompost (V_1M_3), and variety Super tropic plus trichoderma (V_2M_4) applied plots. Likewise, the lowest number of infested heads plot⁻¹ and lowest percentage of infested head by number and weight, respectively were recorded for variety Super tropic plus trichoderma (V_2M_4), and variety Atlas-70 plus vermicompost (V_1M_3) applied plots. On the other hand, the highest number of healthy heads plot⁻¹, highest yield of healthy head were obtained from variety Super tropic plus trichoderma (V_2M_4) applied plots followed by variety Atlas-70 plus vermicompost (V_1M_3) applied plots. It is assumed that both varieties have the ability to withstand the infestation caused by *S. litura* and *P. brassicae* caterpillars. On the other hand, the levels of the infestation on cabbage and the yield of cabbage were also influenced by the application of organic fertilizers. Khan (2007) reported that the variety Atlas-70 showed higher susceptibility to common cutworm in respect of head infestation, it gave higher yield. Khan (2006) reported that the weight of infested and healthy heads varied

insignificantly by the combined effect of variety and nitrogen fertilizer level. He obtained the highest yield from the treatment combination V_1N_1 (V_1 = Variety Atlas-70; $N_1 = 260\text{kg N ha}^{-1}$). This might be due to addition of organic amendments that helped in suppressing various insect pests such as European corn borer (Phelan *et al.*, 1996), other corn insect pests (Birader *et al.*, 1998), aphids and scale insects (Huelsman *et al.*, 2000) and brinjal shoot and fruit borer (Sudhakar *et al.*, 1998). Several authors reported that the addition of vermicompost decreased the incidence of *S. litura*, *Helicoverpa armigera*, leaf miner (*Apoaerema modicella*), jassids (*Empoasca kerri*), aphids (*Aphis craccivora*) and spider mites on groundnuts (Rao *et al.*, 2001; Rao, 2002; 2003). Significantly resulted lower number of leaf hoppers and thrips in chilli (Ramesh, 2000) and their damage in field crops. Vermicompost substitution to soil reduced the damage to cabbage seedlings by *Myzus persicae* and cabbage white caterpillars (*P. brassicae*) (Arancon *et al.* 2005). Plant grown in inorganic fertilizers is more prone to pest attack than those grown on organic fertilizers (Yardim and Edwards, 2003). Phelan (2004) reported that plant grown with organic fertilizers usually attacked by fewer arthropod pests and can resist pest attack much better than plants received inorganic fertilizers.

Variety Super tropic of cabbage grown in trichoderma (V_2M_4), and var. Atlas-70 plus vermicompost (V_1M_3) applied plots were found to be less infested by *S. litura* and *P. brassicae* in respect of number of infested plants plot^{-1} , number and percent of infested leaves plant^{-1} on different dates of observation. The highest healthy heads (by number), healthy head yield (by weight) and total head yield were obtained from combined effect of variety Super tropic plus trichoderma (V_2M_4) as well as variety Atlas-70 plus vermicompost (V_1M_3) applied plots while the lowest healthy heads (by number), healthy head yield (by weight) and total head yield were found from variety Super tropic plus mustard oil cake (V_2M_2) applied plots as well as variety Atlas-70 plus control plots (V_1M_0).

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