Published with Open Access at Journal BiNET
Vol. 25, Issue 01: 2060-2068
Journal of Bioscience and Agriculture Research
Journal Home: www.journalbinet.com/jbar-journal.html

# Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals

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Article received: 22.06.2020; Revised: 09.07.2020; First published online: 01 August 2020.

### *ABSTRACT*

*The production of cabbage is highly influenced by the attack of insect pests and the infestation of insects is higher in the summer season. Among the insect pests, Lepidopterous insects play a vital role in the decreased production of cabbage. The response of major Lepidopterous insects to some commonly used botanicals was investigated under the present study on summer cabbage. Seven treatments, viz.* $T_1$ *(Mahogany seed kernel extract @ 3.0 ml/L of water);* $T_2$ *(Tobacco leaf extract @ 3.0 ml/L of water);* $T_3$ *(Garlic extract @ 3.0 ml/L of water);* $T_4$ *(Neem leaf extract @ 3.0 ml/L of water);* $T_5$ *(Neem seed kernel extract @ 3.0 ml/L of water);* $T_6$ *(Neem oil @ 3.0 ml/L of water) and* $T_7$ *(untreated control) were used and applied at seven days interval. Among the management practices, the lowest mean infestation of cabbage leaf by semi-looper (4.79 leaves/5 plants), cabbage caterpillar (6.25 leaves/5 plants) and diamondback moth larvae (4.39 leaves/5 plants) was found in* $T_6$ *that reduced highest leaf infestation over control (59.40%, 61.73%, and 68.03% respectively); whereas the highest mean infestation by semi-looper (11.80 leaves/5 plants), cabbage caterpillar (16.33 leaves/5 plants) and diamondback moth larvae (13.73 leaves/5 plants) was recorded in* $T_7$*. The highest diameter and height of cabbage head was found in* $T_6$ *(21.58 cm and 10.23 cm respectively); whereas the lowest was found in* $T_7$ *(14.87 cm and 7.10 cm respectively). The highest single head weight (1.46 kg) was found in* $T_6$ *that provided the highest total yield (36.50 t ha*$^{-1}$*). On the contrary, the lowest single head weight and total yield were recorded in* $T_7$ *(0.94 kg and 23.08 t ha*$^{-1}$ *respectively). So, Lepidopterous insects of summer cabbage could be managed by using botanicals judiciously that would be safe for the health concerns of farmers as well as the consumers.*

***Key Words***: *Biorational approach, Ecofriendly management, Food safety, Offseason cabbage and Organic vegetable*

**Cite Article:** Hossain, M. E., Rahman, M. M., Akter, S., Akhter, N. and Khan, M. S. I. (2020). Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals. Journal of Bioscience and Agriculture Research, 25(01), 2060-2068.
**Crossref:** https://doi.org/10.18801/jbar.250120.252





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## I. Introduction

There are many limiting factors of cabbage production and insect pests play a vital role to the decreased production of cabbage. Many insect pests damage the cabbage crop (*Brassica oleracea* var. *capitata* L.). Among them, Lepidopterous insects such as cabbage semi-looper (*Trichoplusia ni* Hub.), diamondback moth (*Plutella xylostella* L.), tobacco caterpillar/prodenia caterpillar (*Spodoptera litura* Fab.), are the most destructive insect pests of cabbage (Iqbal et al., 2015). Cabbage looper (*Trichoplusia ni* Hub.) is one of the most destructive pests, which destroys leaves of cabbage by voraciously feeding. They deposited eggs on the underside of leaves near the leaf edge. The caterpillars of semi-looper feed voraciously and cause large damage by making holes on the cabbage head (Natwick et al. 2017). Tobacco caterpillar (*Spodoptera litura* Fab.) is a polyphagous pest and cause considerable damage to vegetables (Srivastava et al., 2018). Reddy et al. (2017) reported that, tobacco caterpillar (*Spodoptera litura* Fab.) is one of the important insect pests of crops in the Asian tropics and the pest was found to occur in cabbage growing areas. It can reduce more than 50% yield in some cabbage genotypes (Bhat et al. 1994). In Bangladesh, Ahmed (2008) reported that cabbage caterpillar causes damage 3.99% to 13.44% on leaves and 23.33% to 58.33% on plants depending on the varieties.

Diamondback moth (*Plutella xylostella* L.) is reported as a primary pest that causes heavy loss of the cabbage field by larval feeding (Parajuli and Paudel, 2019). The egg laying position of the adult moth is on the underside of the lower leaves and they lay eggs singly or in the cluster. Larvae feed on the whole plant parts but it mostly feeds around the bud of small transplants (Figure 03). The young larvae crawl and make mine between the lower and upper leaf areas and older larvae create irregular short mines while leaving the upper surface intact (Iqbal et al., 2015). The yield losses due to the infestation of diamondback moth (*Plutella xylostella* L.) was recorded up to 12.00 and 20.7ton $ha^{-1}$ in the first season and 27.00 and 48.7 ton $ha^{-1}$ respectively in the second season (Bhatia, 1994). The loss of yield up to 30% was considered tolerable as an alternative to severe pest damage, in situations where infestation levels are high. These insect pests cause more serious damage to cabbage in the summer season (Andrea, 2006).

Despite being mostly a winter vegetable, cabbage can be grown in summer also with necessary management (Smith et al., 1988). From Bangladesh's perspective, evidence was found that cabbage can be grown successfully in the summer season also. In 2011, farmers of Jibon Nagar Upazila in Chuadanga district produced a variety of summer cabbage (KKR) which was imported from Japan and the production was very satisfactory. Mukaiede Yoko, a vegetable specialist of the Taki and Company (Japan) suggested bringing the cabbage cultivation under eco friendly management instead of using synthetic chemical insecticides for the sake of safety to public health (Aman, 2011). However, there are many challenges in case of pest management from economic and ecological point of view due to human and environmental hazards and most of them are caused by synthetic chemical pesticides (Joshi et al., 2020). Indiscriminate use of chemical pesticides resulted in problems like the development of resistance to pesticides, secondary pest outbreak, pest resurgence, bioaccumulation of chemicals in the food chain, environmental pollution, human health hazards, and destruction of non-target organisms. The use of safer chemicals such as botanicals is drawing attention throughout the world as more compatible substitutes to the highly persistent synthetic pesticides. Hence, biorational approaches by utilizing botanical preparations and natural products are gaining significance as possible alternative measures for the eco-friendly management of insect-pests (Joshi et al., 2020). Therefore, an attempt was made to evaluate some botanicals against major lepidopterous insect pests of cabbage in the summer season as a way of their eco-friendly management.

## II. Materials and Methods

The location of the present experimental field was at the central Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from April to August 2018. The soil of the experimental plot was shallow red-brown terrace soil and little less than neutral (pH 5.8-6.5) in nature. Tropical-33 was used as the planting material of summer cabbage in this experiment. Seeds were collected from Advanced Chemical Industry (ACI) Limited and were sown on the seedbed on 18th April. Before seed sowing, the seedbed was prepared well and made suitable for seedling production. Seven treatments, viz. $T_1$ (Mahogany seed kernel extract); $T_2$ (Tobacco leaf extract); $T_3$



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(Garlic extract); $T_4$ (Neem leaf extract); $T_5$ (Neem seed kernel extract); $T_6$ (Neem oil) and $T_7$ (untreated control) were used. All the botanical treatments were applied @ 3ml $L^{-1}$ of water at seven days interval. We laid out the experiment in a Randomized Complete Block Design (RCBD) with three replications. The area of a single plot of the experiment was 4 $m^2$ (2.5 m ×1.6 m). Before seedling transplantation, the land was prepared well by deep ploughing followed by laddering. One-month-old seedlings were transplanted in the main field on 18th May at the rate of ten seedlings $plot^{-1}$. Application of manures and fertilizers was done according to the recommended fertilizer doses for cabbage production per hectare by (BARC, 2012).

Except for urea and MoP, all the manure fertilizers were applied at the time of final land preparation. The application of Urea and MoP was done following ring method in two equal installments at 15 and 35 days after transplanting (DAT) under moist soil condition and the fertilizers were mixed thoroughly with the soil as soon as possible for better utilization. Intercultural operations such as gap filling, weeding, earthing up, irrigation, etc. were done as and when required for ensuring and maintaining the normal growth of crops. Five plants were randomly selected from each unit plot for the recording of necessary data on different crop characters. Data collection was started at the vegetative stage at 20 DAT to cabbage head harvest. The data on crop characters like the number of infested leaves by cabbage semi-looper, cabbage caterpillar and diamondback moth larvae; the weight of individual head; height, and diameter of cabbage heads; yield (t $ha^{-1}$) were recorded. Only the fully compact and marketable heads were harvested at the time of harvesting. Collected data were analyzed following ANOVA techniques by using Statistix-10 computer package. The mean separation was done by the Least Significant Difference (LSD) test.

## III. Results and Discussion

### Infestation by cabbage semi looper

The significant variations ($p>0.05$) were observed among different treatments in terms of leaf infestation by cabbage semi-looper at different days after transplanting (DAT). At 20 DAT, the highest leaf infestation was recorded in $T_7$ (10.67 leaves/5 plants) which was statistically different from all other treatments followed by $T_1$ (9.33 leaves/5 plants) and $T_3$ (8.33 leaves/5 plants). On the other hand, the lowest leaf infestation was recorded in $T_6$ (4.77 leaves/5 plants) which was significantly similar to $T_4$ (5.33 leaves /5 plants) followed by $T_5$ (6.67 leaves /5 plants) and $T_2$ (7.33 leaves /5 plants). More or less similar results of leaf infestation by number were also recorded at 30 DAT, 40 DAT, 50 DAT, and 60 DAT (Table 01). In the case of mean infestation, the highest number of leaf infestation was recorded in $T_7$ (11.80 leaves/5 plants) which was significantly different from all other treatments followed by $T_1$ (8.93 leaves/5 plants) and $T_3$ (7.90 leaves/5 plants). On the other hand, the lowest infestation was recorded in $T_6$ (4.79 leaves/5 plants) which was significantly different from all other treatments followed by $T_4$ (5.46 leaves/5 plants) and $T_5$ (6.17 leaves/5 plants) (Table 01).

**Table 01. Infestation of cabbage caused by semi-looper at different DAT**

| Treatments | Number of infested leaves per five plants | | | | | Mean | % Reduction over control |
|---|---|---|---|---|---|---|---|
| | 20 DAT | 30 DAT | 40 DAT | 50 DAT | 60 DAT | | |
| $T_1$ | 9.33 b | 10.33 a | 9.33 b | 8.33 b | 7.33 b | 8.93 b | 24.32 |
| $T_2$ | 7.33 d | 8.33 c | 7.33 d | 6.33 d | 5.50 d | 6.97 d | 40.93 |
| $T_3$ | 8.33 c | 9.33 b | 8.33 c | 7.33 c | 6.17 c | 7.90 c | 33.05 |
| $T_4$ | 5.33 e | 6.33 e | 5.67 ef | 5.17 e | 4.80 e | 5.46 f | 53.73 |
| $T_5$ | 6.67 d | 7.33 d | 6.33 e | 5.42 e | 5.10 de | 6.17 e | 47.71 |
| $T_6$ | 4.77 e | 5.50 e | 5.17 f | 4.67 e | 3.87 f | 4.79 g | 59.40 |
| $T_7$ | 10.67 a | 11.00 a | 11.67 a | 13.00 a | 12.67 a | 11.80 a | - |
| LSD (0.05) | 0.88 | 0.94 | 0.75 | 0.83 | 0.53 | 0.64 | - |
| CV (%) | 6.57 | 6.39 | 5.49 | 6.49 | 4.57 | 4.85 | - |

[DAT= Days after transplanting, in a column, the numeric value represents the mean of 3 replications; each replication is derived from 5 plants per treatment; in a column means having a similar letter(s) are statistically identical at 0.05 level of probability, $T_1$: Mahogany seed kernel extract; $T_2$: Tobacco leaf extract; $T_3$: Garlic extract; $T_4$: Neem leaf extract; $T_5$: Neem seed kernel extract; $T_6$: Neem oil; $T_7$: Untreated control].



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Considering the percent reduction of leaf infestation, the highest reduction over control was achieved in $T_6$ (59.40%) followed by $T_4$ (53.73%) and $T_5$ (47.71%). Nevertheless, the minimum reduction of leaf infestation over control was found in $T_1$ (24.32%) followed by $T_3$ (33.05%) (Table 01). More or less similar result was found by Iqbal et al. (2015). They obtained 64.62% infestation reduction over control by applying neem derivatives against cabbage semi-looper. (Joshy et al., 2020) reported that, botanicals including neem-based insecticides play important roles in crop protection having properties like repellent, feeding deterrent and growth regulators against several insect pests leading to their death.

**Infestation by cabbage caterpillar**

Leaf infestation by cabbage caterpillar was significantly influenced by botanicals at different days after transplanting (DAT). At 20 DAT, the highest leaf infestation was recorded in $T_7$ (14.33 leaves/5 plants) which was statistically different from all other treatments followed by $T_1$ (11.67 leaves/5 plants) and $T_3$ (11.33 leaves/5 plants). On the other hand, the lowest leaf infestation was recorded in $T_6$ (7.33 leaves/5 plants) which was statistically different from all other treatments followed by $T_4$ (9.33 leaves /5 plants), $T_5$ (10.33 leaves /5 plants) and $T_2$ (10.67 leaves /5 plants). More or less similar results of leaf infestation by number were also recorded at 30 DAT, 40 DAT, 50 DAT, and 60 DAT (Table 02).

In the case of mean infestation, the highest number of leaf infestation was recorded in $T_7$ (16.33 leaves/5 plants) which was significantly different from all other treatments followed by $T_1$ (11.27 leaves/5 plants) and $T_3$ (10.80 leaves/5 plants). On the other hand, the lowest infestation was recorded in $T_6$ (6.25 leaves/5 plants) which was statistically different from all other treatments followed by $T_4$ (8.07 leaves/5 plants), $T_5$ (9.13 leaves/5 plants) and $T_2$ (9.80 leaves/5 plants) (Table 02).

Considering the percent reduction of leaf infestation over control, the highest 61.73% reduction over control was achieved in $T_6$ followed by $T_4$ (50.58%) and $T_5$ (44.09%). On the other hand, the minimum reduction of leaf infestation over control was found in $T_1$ (30.99%) which was very close to $T_3$ (33.86%) (Table 02). This result was supported by Reddy et al. (2017) where they found 45.04% and 68.00% infestation reduction of tobacco caterpillar (*Spodoptera litura* Fab.) by applying azadirachtin (0.03%) at 7 DAS (Days after spraying) and 10 DAS respectively. Neem derived compounds act as inhibitors of digestive alpha amylase in insect pests and cause digestive problems of insects leading to their death (Amtul, 2014).

**Table 02. Infestation of cabbage caused by tobacco caterpillar at different DAT**

| Treatments | Number of infested leaves per five plants | | | | | Mean | % Reduction over control |
|---|---|---|---|---|---|---|---|
| | 20 DAT | 30 DAT | 40 DAT | 50 DAT | 60 DAT | | |
| $T_1$ | 11.67 b | 11.33 b | 12.33 b | 11.00 b | 10.00 b | 11.27 b | 30.99 |
| $T_2$ | 10.67 cd | 10.00 cd | 10.67 cd | 9.33 c | 8.33 c | 9.80 c | 39.99 |
| $T_3$ | 11.33 bc | 10.67 bc | 11.67 bc | 10.67 b | 9.67 b | 10.80 b | 33.86 |
| $T_4$ | 9.33 e | 8.33 e | 8.67 e | 7.67 d | 6.33 d | 8.07 d | 50.58 |
| $T_5$ | 10.33 d | 9.33 de | 9.67 de | 8.67 c | 7.67 c | 9.13 c | 44.09 |
| $T_6$ | 7.33 f | 6.33 f | 6.67 f | 5.67 e | 5.27 d | 6.25 e | 61.73 |
| $T_7$ | 14.33 a | 15.33 a | 16.00 a | 17.00 a | 19.00 a | 16.33 a | - |
| LSD (0.05) | 0.96 | 1.19 | 1.15 | 0.98 | 1.33 | 0.73 | - |
| CV (%) | 5.06 | 6.54 | 6.00 | 5.49 | 7.87 | 4.02 | - |

[DAT= Days after transplanting, in a column, the numeric value represents the mean of 3 replications; each replication is derived from 5 plants per treatment; in a column means having a similar letter(s) are statistically identical at 0.05 level of probability, $T_1$: Mahogany seed kernel extract; $T_2$: Tobacco leaf extract; $T_3$: Garlic extract; $T_4$: Neem leaf extract; $T_5$: Neem seed kernel extract; $T_6$: Neem oil; $T_7$: Untreated control].

**Infestation by Diamondback moth larvae**

Botanicals had a significant effect on the leaf infestation by diamondback moth larvae at different days after transplanting (DAT). At 20 DAT, the highest leaf infestation was recorded in $T_7$ (10.67 leaves/5 plants) which was statistically different from all other treatments followed by $T_1$ (9.67 leaves/5 plants) and $T_3$ (8.67 leaves/5 plants). On the other hand, the lowest leaf infestation was recorded in $T_6$ (4.43 leaves/5 plants) which was statistically different from all other treatments followed by $T_4$ (5.50 leaves /5 plants), $T_5$ (6.67 leaves /5 plants) and $T_2$ (7.67 leaves /5 plants) (Table 03). More or less



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similar results of leaf infestation by number were also recorded at 30 DAT, 40 DAT, 50 DAT, and 60 DAT (Table 03).

In the case of mean infestation, the highest number of leaf infestation was recorded in $T_7$ (13.73 leaves/5 plants) which was significantly different from all other treatments followed by $T_1$(9.07 leaves/5 plants) and $T_3$ (8.27 leaves/5 plants). On the other hand, the lowest infestation was recorded in $T_6$ (4.39 leaves/5 plants) which was statistically similar with $T_4$ (5.07 leaves /5 plants) but different from all other treatments and followed by $T_5$ (5.77 leaves /5 plants) and $T_2$ (7.03 leaves /5 plants). Considering the percent reduction of leaf infestation over control, the highest reduction over control was achieved in $T_6$ (68.03%) followed by $T_4$ (63.07%) and $T_5$ (57.98%). On the other hand, the minimum reduction of leaf infestation over control was found in $T_1$ (33.94%) followed by $T_3$ (39.77%) (Table 03). This result agreed with Dey at el. (2017). They reported that (70-74) % larval mortality of diamondback moth can be obtained by applying neem-based insecticides. There are so many properties of botanicals reported by Mochiah et al. (2011) such as feeding deterrent, repellency, quick knockdown that ultimately cause the death of diamondback moth larvae.

**Table 03. Infestation of cabbage caused by diamondback moth larvae at different DAT**

| Treatments | Number of infested leaves per five plants | | | | | Mean | % Reduction over control |
|---|---|---|---|---|---|---|---|
| | 20 DAT | 30 DAT | 40 DAT | 50 DAT | 60 DAT | | |
| $T_1$ | 9.67 b | 10.67 b | 9.33 b | 8.33 b | 7.33 b | 9.07 b | 33.94 |
| $T_2$ | 7.67 d | 8.33 c | 7.33 c | 6.33 c | 5.50 c | 7.03 d | 48.79 |
| $T_3$ | 8.67 c | 9.67 b | 8.67 b | 7.67 b | 6.67 b | 8.27 c | 39.77 |
| $T_4$ | 5.50 f | 5.50 de | 5.27 de | 4.83 de | 4.27 de | 5.07 ef | 63.07 |
| $T_5$ | 6.67 e | 6.33 d | 5.87 d | 5.27 d | 4.73 cd | 5.77 e | 57.98 |
| $T_6$ | 4.43 g | 4.83 e | 4.60 e | 4.30 e | 3.80 e | 4.39 f | 68.03 |
| $T_7$ | 10.67 a | 13.00 a | 14.00 a | 15.33 a | 15.67 a | 13.73 a | - |
| LSD (0.05) | 0.77 | 1.17 | 1.15 | 0.86 | 0.83 | 0.78 | - |
| CV (%) | 5.7 | 7.88 | 8.24 | 6.51 | 6.81 | 5.74 | - |

[DAT= Days after transplanting, in a column, the numeric value represents the mean of 3 replications; each replication is derived from 5 plants per treatment; in a column means having a similar letter(s) are statistically identical at 0.05 level of probability, $T_1$: Mahogany seed kernel extract; $T_2$: Tobacco leaf extract; $T_3$: Garlic extract; $T_4$: Neem leaf extract; $T_5$: Neem seed kernel extract; $T_6$: Neem oil; $T_7$: Untreated control].

### Diameter and height of cabbage head

In the case of the diameter and height of the cabbage head, significant variations were observed among the different treatments due to the attack of different insect pests at the time of harvesting. The highest diameter of the head (21.58 cm) was recorded in $T_6$ which was statistically different from all other treatments followed by $T_4$ (20.41 cm) and $T_5$ (19.37 cm). On the other hand, the lowest head diameter (14.87 cm) was found in $T_7$ which was significantly different from all other treatments. But among the treated plots, the lowest head diameter (16.36 cm) was found in $T_1$ which was followed by $T_3$ (17.97 cm) and $T_2$ (18.23 cm). In terms of percent (%) increase over control, the highest increase over control on head diameter was observed with the treatment of $T_6$ (45.12%) where the lowest was achieved from $T_1$ (10.02%).

The highest height of the head (10.23 cm) was recorded in $T_6$ which was statistically similar to $T_4$ (9.79 cm). On the other hand, the lowest height of the head (7.10 cm) was found in $T_7$ which was significantly different from all other treatments. But among the treated plots, the lowest height of the head (8.17 cm) was found in $T_1$ which was followed by $T_3$ (8.20 cm), $T_2$ (8.92 cm), and $T_5$ (9.25 cm). In terms of percent increase over control, the highest increase over control on the height of cabbage head was observed with the treatment of $T_6$ (44.05%) followed by $T_4$ (37.89%) where the lowest was achieved from $T_1$ (15.07%) which was very close to $T_3$ (15.49%) (Figure 01).

### Single head weight (kg) and yield (t $ha^{-1}$) of cabbage

At the time of harvesting, significant variations were observed among different treatments in terms of single head weight (kg) and yield of cabbage (t $ha^{-1}$). The highest single head weight (1.46 kg) was recorded in $T_6$ which was statistically different from all other treatments and followed by $T_4$ (1.27 kg) and $T_5$ (1.23 kg). On the other hand, the lowest single head weight (0.94 kg) was found in $T_7$ which was significantly different from all other treatments. In terms of percent increase over control, the highest



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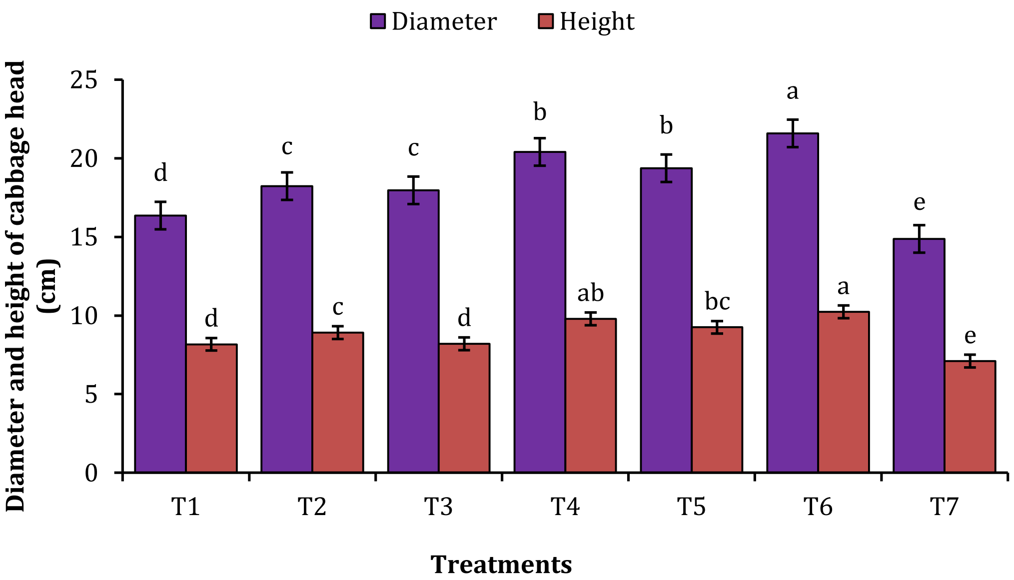
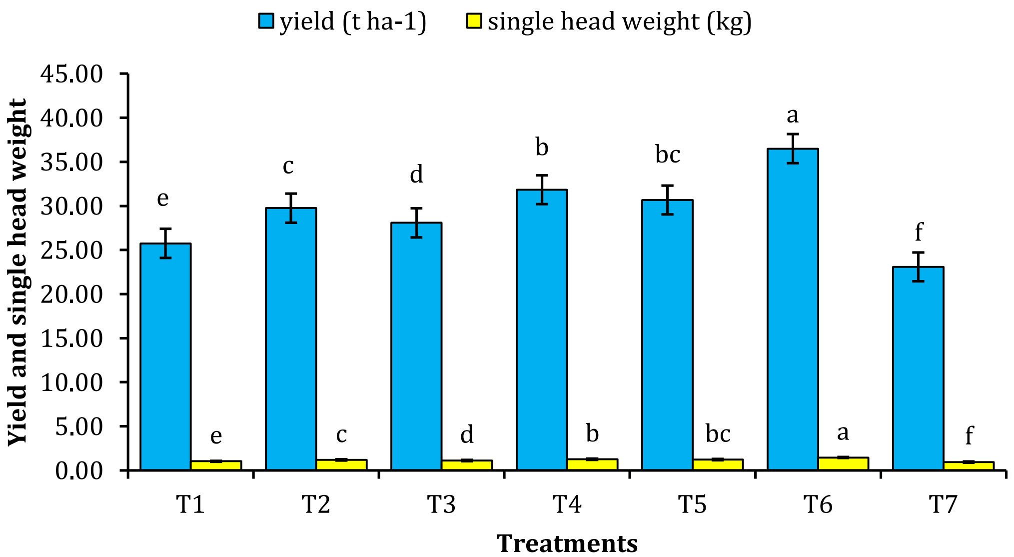
increase over control on single head weight was observed with the treatment of $T_6$ (55.32%) where the lowest was achieved from $T_1$ (9.57%) (Figure 02). The highest total yield (36.50 t $ha^{-1}$) was recorded in $T_6$ which was statistically different from all other treatments followed by $T_4$ (31.83 t/ha) and $T_5$ (30.67 t $ha^{-1}$). The lowest total yield (23.08 t $ha^{-1}$) was found in $T_7$ which was significantly different from all other treatments. But in the treated plots, the lowest total yield (25.75 t $ha^{-1}$) was found in $T_1$ which was followed by $T_3$ (28.08 t $ha^{-1}$) and $T_2$ (29.75 t $ha^{-1}$). This result was supported by Dey at el. (2017) where they obtained an average yield of (27.58-39.1) t $ha^{-1}$ by applying different botanical insecticides. In terms of percent increase over control, the highest increase over control on total yield (t $ha^{-1}$) was observed in $T_6$ (58.15%) which was followed by $T_4$ (37.91%) and $T_5$ (32.89%) whereas the lowest was achieved from $T_1$ (11.57%) followed by $T_3$ (21.66%) (Figure 02).




[Means ±SD are calculated from three replications where each replication is derived from 5 plants per treatment; bars having a similar letter(s) are statistically identical according to Least Significant Difference (LSD) test at p ≤ 0.05, $T_1$: Mahogany seed kernel extract; $T_2$: Tobacco leaf extract; $T_3$: Garlic extract; $T_4$: Neem leaf extract; $T_5$: Neem seed kernel extract; $T_6$: Neem oil; $T_7$: Untreated control]

**Figure 01. Effect of different treatments on diameter and height of cabbage head**




[Means ±SD are calculated from three replications where each replication is derived from 5 plants per treatment; bars having a similar letter(s) are statistically identical according to Least Significant Difference (LSD) test at p ≤ 0.05, $T_1$: Mahogany seed kernel extract; $T_2$: Tobacco leaf extract; $T_3$: Garlic extract; $T_4$: Neem leaf extract; $T_5$: Neem seed kernel extract; $T_6$: Neem oil; $T_7$: Untreated control]

**Figure 02. Individual head weight (kg) and total yield (ton $ha^{-1}$) of cabbage in different treatments during harvesting**



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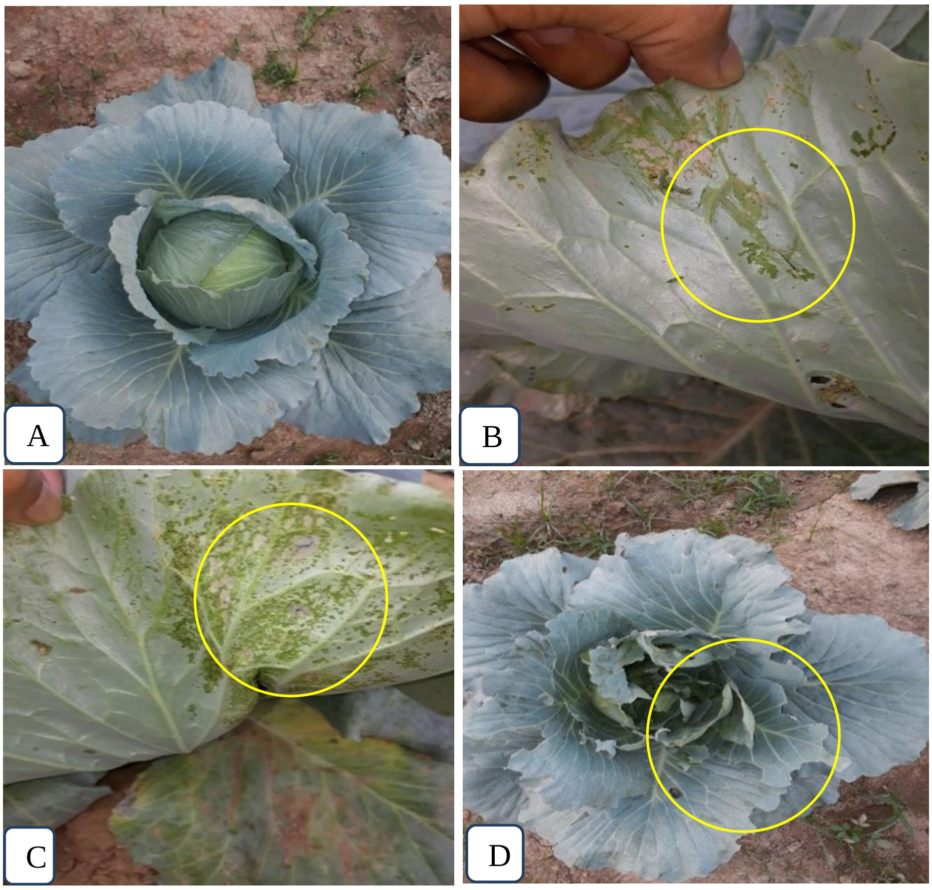


**Figure 03. A) Healthy cabbage head, B) Infested by semi looper, C) Infested by Tobacco caterpillar, D) Infested by diamondback moth larvae**

## IV. Conclusion

From the present study, we observed that the use of botanicals performed as an effective way of managing insect pests of summer cabbage. Results revealed that all botanical extracts performed well against the insect pests of summer cabbage. The treatment $T_6$ comprised of Neem oil @ 3.0 ml/L of water at 7 days interval gave the highest performance compared to all other treatments used under the present study where the lowest performance was obtained by control treatment. However, the lowest performance among the treated plots was achieved by $T_1$ (Mahogany seed kernel extract @ 3.0 ml/L of water at 7 days interval). Adoption of biorational approaches should be emphasized for healthy and ecofriendly management of insect pests so that the next generation has to suffer less by its impact. Hence, botanicals especially the neem derivatives could be an alternative way to manage lepidopterous insect pests of summer cabbage.

## Acknowledgement

This work was supported by the National Science and Technology (NST) Fellowship, Ministry of Science and Technology, Government of the People's Republic of Bangladesh. The authors are grateful for financial support.

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**HOW TO CITE THIS ARTICLE?**

**Crossref:** https://doi.org/10.18801/jbar.250120.252

**MLA**

Hossain, M. E. et al. "Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals". Journal of Bioscience and Agriculture Research, 25(01), (2020): 2060-2068.

**APA**

Hossain, M. E., Rahman, M. M., Akter, S., Akhter, N. and Khan, M. S. I. (2020). Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals. *Journal of Bioscience and Agriculture Research*, 25(01), 2060-2068.



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Hossain, M. E., Rahman, M. M., Akter, S., Akhter, N. and Khan, M. S. I. “Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals”. Journal of Bioscience and Agriculture Research, 25(01), (2020): 2060-2068.

**Harvard**

Hossain, M. E., Rahman, M. M., Akter, S., Akhter, N. and Khan, M. S. I. 2020. Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals. Journal of Bioscience and Agriculture Research, 25(01), pp. 2060-2068.

**Vancouver**

Hossain, ME, Rahman, MM, Akter, S, Akhter, N and Khan, MSI. Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals. Journal of Bioscience and Agriculture Research, 2020 August 25(01): 2060-2068.





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EISSN: 2312-7945, 