EFFECT OF BIOPESTICIDES and PHEROMONE TRAPS ON MAJOR INSECT- PESTS AND THEIR , NATURAL ENEMIES OF CABBAGE AND YIELD OF CABBAGE

ABSTRACT

Aims: This study is aimed to know the effect of biopesticides on insect pests, predators and yield of cabbage.
Study Design: The experiment was laid out at a randomized complete block design with four replications.
Place and Duration of Study: Central farm of Sher-e-Bangla Agricultural University, Bangladesh during the period from October 2018 to March 2019.
Methodology: **The experiment were conducted with** Ssix treatments were used in this experiment which wereviz. T_1= Spinosad @, T_2= SNPV (*Spodoptera litura* nuclear polyhedrosis virus) @ , T_3= Spodolure trap, T_4 Spodolure trap + Spinosad spray, T_5= Spodolure trap + SNPV spray and T_6= untreated control.
Results: Results revealed that Tthe lowest number of infested leaves per five by flea beetle (0.33/ 5 plants), tobacco cutworm (0.33/ 5 plants), semi- looper (0.33/ 5 plants), diamondback moth (1.33/ 5 plants), aphid (7.50/ 5 plants), was found in T_4 treatment (Spodolure trap + Spinosad). In case of incidence ofof The population of natural enemies per plot was also recorded and , the highest number population of lady bird beetle (8.00/plot) and spider (8.60/plot) was also found observed from T_4 (Spodolure trap + Spinosad) treatment as compared to untreated control. The highest percentage of healthy plants (91.67%), highest maximum weight of healthy cabbge head plant^{-1} (1.20 kg), marketable cabbage head plot^{-1} (19.48 kg) and marketable yield of healthy cabbage head (45.08 t ha^{-1}) was found in $T_4$with (Spodolure trap + Spinosad) treatment.
Conclusion: It is concluded that Spodolure trap in combination with Spinosad spray may be effective practice for the management of cabbage insect pests.

Keywords: Cabbage; Predators ; Spodolure ; Spider; SNPV; Marketable yield.(please arrange as alphabetically)

1. INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.) is an important vegetable crop which is extensively cultivated because of it has high s economical and nutritional values from thefor producers and consumers ,point of view respectively [1]. In 2015-2016, 237, (very old please add latest data) thousand metric tons of cabbage was produced from an area with an average yield [2]. The yield produced by cabbage in Bangladesh is 75-100 ton/ha depending on selection of variety and season [[2, 3]. These The average yields of cabbage are is low comparing with other developing countries.due to Vvarious reasons are responsible for low yield of cabbagefactors. Among, biotic factors the insect-pests play major role in reduction quantity and quality of Insect pest infestation and lack of proper management of insect pest is one of the main reasons for low yield of cabbage.

Cabbage is prone to insect pest ravages from the time of sowing till the harvest. The crop is attacked by a number of insect pests, *viz.* tobacco caterpillar, *Spodoptera litura* (Fab.); diamond back moth, *Plutella xylostella* (L.); cabbage leaf webber, *Crocidolomia bionotalis* (Zell.); aphids, *Bravicornye brassicae* (L.) and *Lipaphis erysimi* (Kalt.); painted bug, *Bagrada cruciferarum* (Kirk.) and flea beetle, *Phyllotreta cruciferae* (Goeze.) etc. [4]. Among various insect pests attacking cabbage, some of them are very serious likethese diamond back moth, *P. xylostella* (L.) causes significant losses. Diamondback moth (*Plutella xylostella* L.) is reported as a primary pest that causes heavy loss of theto cabbage field by larval feeding [5]. Yield loss due to the attack of *P. xylostella* on cabbage was reported 44.6 and 53 percent % respectively [6] [7]. Tobacco caterpillar (*Spodoptera litura* Fab.) is also an one of the important insect pests of crops in the Asian tropics and the pest was found to occur in cabbagecrop growing areas [8] and . Iit can cause more than 50 %

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reduction e more than 50% in yield in some cabbage genotypes [9]. The caterpillars of semi-looper feed voraciously and cause large damage by making holes on the cabbage head [10]. They deposited eggs on the underside of leaves near the leaf edge. Flea beetle infestation leads to at least 25 % foliage damage characterized by "shot holes" on the foliage [11]. Pesticide consumtion in vegetable crops

Pesticide use for growing vegetables was six times higher (1.12 kg/ha) than the rice (1.12 kg/ha for vegetables, while it was only(0.20 kg/ha) in rice) [12]. Due to high pest stress, crop cultivation is mainly dependent on use of synthetic insecticides that causes serious health issues, environmental contamination, resurgence and resistance (Dutta 2015) Conventional insecticides continue to be one of the most powerful weapons available for the control of pests, but their wide scale and indiscriminate application creates problems like, development of resistance and resurgence of pests; besides, leaving excessive residue on edible portions [13] [14].

Now the people have become more aware about health, which has opened doors for production of organic vegetable and use of green chemistry insecticides for pest management. Therefore, now the basis of vegetable production has shifted from quantity to quality and food safety. The increased demand of residue free vegetables will definitely motivate vegetable growers to use safe pesticides for pest management (Khosa ….) So, eco-friendly management using bio-pesticide can be an alternative to control insect pest of cabbage as well as to keep sound environment. It has been observed that effective management of *Spodoptera litura* can be ensured with the mass trapping of *Spodoptera litura* by pheromone traps along with 2-3application of SNPV [15]. In Bangladesh, scientists of different public research institutes and universities have already developed bio-pesticide based pest management packages against several destructive insect pests and diseases of different crops. Keeping this view in mind, the research was undertaken to test the efficacy of bio-pesticide (pheromone traps) for succession of insect pests and their natural enemies in cabbage ecosystem and management of major insect pest.

2. MATERIALS AND METHODS

2.1 Experimental site

The research work was conducted during the period of October 2018 to March 2019, at the central farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The location of the site is $23^0$74/N latitude and $90^0$35/E longitude with an elevation of 8.2 meter from sea level.

2.2 Climate and soil

The experimental site was subtropically characterized by high temperature, high humidity and heavy rainfall in Kharif season (April to September) and scanty of rainfall in Rabi season (October to March). The soil was having a texture of silty clay with pH and organic matter 5.8 and 1.16%, respectively. The results showed that the soil composed of 27% sand, 43% silt and 30% clay [16].

2.3 Experimental treatment and design

The seeds of CROP VARITY WAS BARI cabbage-2 (Agradut) were WAS RAISED WITHOUT ANY PLANT PROTECTION MEASURES used as the test crop. It is a high yielding variety with average yield 50-55 t/ha^{-1}. THE Nnine treatments, viz. T_1 (Spinosad @ 25 ml/ha at 7 days interval), T_2 (SNPV (Spodoptera litura nuclear polyhedrosis virus) @ 2.47/ha at 7days interval), T_3 (Spodolure @ 1/6 plot at 14 days interval), T_4 (Spodolure + Spinosad), T_5 (Spodolure + SNPV) and T_6 (Untreated Control) were used at seven days interval. We laid outT the experiment was laid in a Randomized Complete Block Design (RCBD) with four replications with .plot The area of a single plot of the experiment was 2.4 m × 1.8 m. The distance was maintained between two blocksreplications and and two plots were 1.0 m and 0.5 m, respectively.

2.4 Crop husbandry

The seeds were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. and were**The seed was** sown on the seedbed on October 20, 2018. Before seed sowing, the seedbed was prepared well and made suitable for seedling production. The main plot which select for conducting the experiment was opened in the last week of October, 2018 with a power tiller, and left exposed to the sun for a week. After one

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~~week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good puddle condition. Weeds and stubbles were removed accordingly. The experimental main plot was partitioned into unit plots in accordance with the experimental design.~~ The crop was raised with s~~S~~tandard dosages of cowdung and fertilizers ~~were applied~~ as recommended by BARC Fertilizer Recommendation Guide-~~2018~~ 2020[17]. Cowdung, urea, TSP and MoP were applied @ 10000, 370, 250 and 250 kg ha-1, respectively . The 28 days old seedlings were transplanted in the main field ~~on 22~~in third week of November~~, 2018~~. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings of the same source whenever required. ~~Intercultural operations such weeding, earthing up, irrigation, etc. were done as and when required for ensuring and maintaining the normal growth of crops.~~

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~~2.5 Data collection~~

Five plants were randomly selected from each unit plot for the recording of necessary data.The data of different parameters was collected as well as recorded twice in week starting from 10 days after transplanting ~~the seedlings from seedbed to the main field~~. The data on crop characters like the number of healthy and infested leaves and number ~~no.~~ of healthy and infested head, ~~Number of~~of the insect~~-~~-pest population plant^{-1}, 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~~ collected at the time of harvesting.

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~~2.6 Statistical package~~

Collected data were analyzed following ANOVA techniques by using MSTAT computer package program. Mean values were ranked and compared by Duncan's Multiple Range Test (DMRT) at 5% level of significance [18].

~~3.~~ RESULTS AND DISCUSSION

~~3.1~~ Incidence of insect- pests ~~during cabbage cultivation~~

Five major insect~~-~~-pests named flea beetle (*Phyllotreta* spp.), aphid (*Brevicoryne brassicae*), semi-looper (*Trichoplusia* spp.), diamondback moth (*Plutella xylostella*) and tobacco cutworm (*Spodoptera litura*) were found in the cabbage field during the experimental period.

~~3.1.1~~Population ~~Incidence~~ of cabbage flea beetle

Among the identified insect pests, flea beetle is the only insect thats adult stage attacked cabbage leaves and caused damage by feeding leaf lamina in the form of small hole. Significant variation was observed on ~~cabbage~~ flea beetle ~~in number~~population among ~~the~~ differnt treatments (Fig. 1). ~~Results revealed that T~~the lowest ~~number of cabbage~~ flea beetle population (0.33) was found from T_4 (Spodolure + Spinosad) ~~treatment~~ whereas the highest number of cabbage flea beetle (5.28) was found from control ~~treatment T~~plots$_6$. Under treated plot, the highest number of cabbage flea beetle (3.00) was found from T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) which was statistically identical with T_1 (Spinosad). Islam et al. 2017 reprted more or less simiar result in the same ~~variety.~~crop

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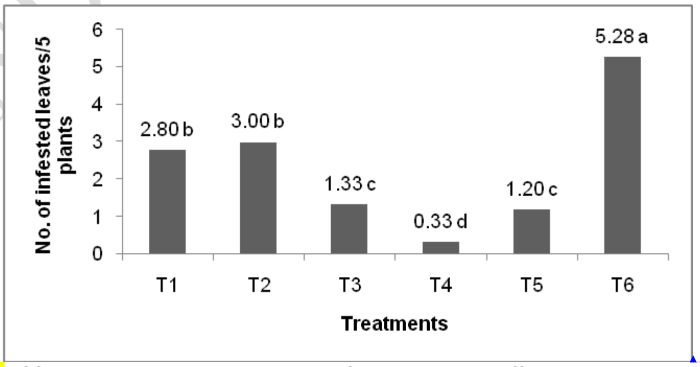

Fig.1. Incidence of flea beetle by number in cabbage field treated by different treatments

T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

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~~3.1.2 Incidence p~~Population of cabbage aphid

Aphid at its adult and nymphal stages attacked cabbage leaves and damage caused by sucking cell sap from the tender leaves resulting weaken of the plants. Significant variation was observed on Aphid incidence in number among the treatments (Fig. 2). Results revealed that the lowest number of Aphid (7.50) was found from T_4 (Spodolure + Spinosad) treatment whereas the highest number of Aphid (26.44) was found from control treatment T_6. Under treated plot, the highest number of Aphid (23.60) was found from T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) which was statistically identical with T_1 (Spinosad). Bhavani and Punnaiah (2006) also found the more or less similar result using some botanicals and biopesticides [20].

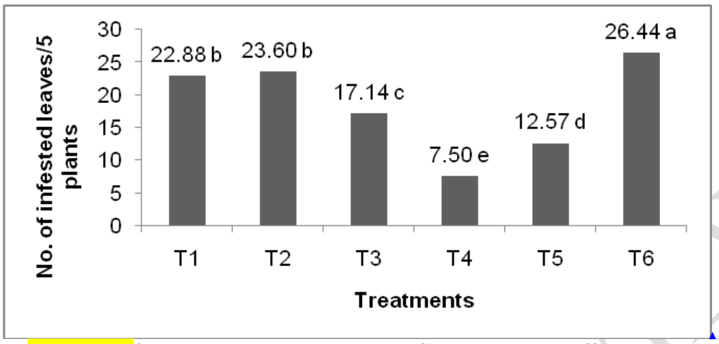

Fig. 2. Incidence of aphid by number in cabbage field treated by different treatments

T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

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3.1.3 Population Incidence of cabbage semi-looper

The semi-looper only at its larval stage attacked cabbage leaves and damage caused by feeding leaf lamina in the form of irregular hole. Significant variation was observed on Semisemi-looper in numberpopulation among the different treatments (Fig. 3). Results revealed that the lowest numberpopulation of Semisemi-looper (0.33) was found from T_4 (Spodolure + Spinosad) treatment whereas theaqnd highest number of Semi-looperpopulation (4.36) was found from in control treatment plots T_6. Under among treated plot, the highest numbermaximum population of Semi-looper (2.50) was found observed from T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) which was statistically identical with T_1 (Spinosad) and T_3 (Spodolure). This result was supported by Iqbal et al. 2015 [21].

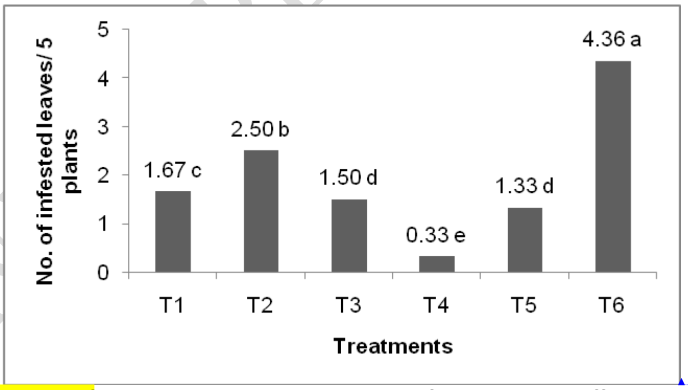

Fig.3. Incidence of semi-looper by number in cabbage field treated by different treatments

T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

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3.1.4 Incidence Number of cabbage diamondback moth

The diamond back moth only at its larval stage attacked cabbage leaves and damage caused by upper epidermis of leaf in the form of irregular hole and net like appearance. Significant variation was observed in larval population on of Diamondback dlarval population moth in number among the treatments (Fig. 4). Results revealed that the lowest number of Diamondback diamondback moth (1.33) was found from T_4 (Spodolure + Spinosad) treatment whereas the highest number of Diamondback moth (6.33) was found from control treatment T_6. Under treated plot, the highest number of Diamondback diamondback moth (4.00) was found from T_2

(SNPV; *Spodoptera litura* nuclear polyhedrosis virus). Goud *et al.* 2006 reported the similar result in diamondback moth ~~incidence~~ population ~~in 2006~~ [22].

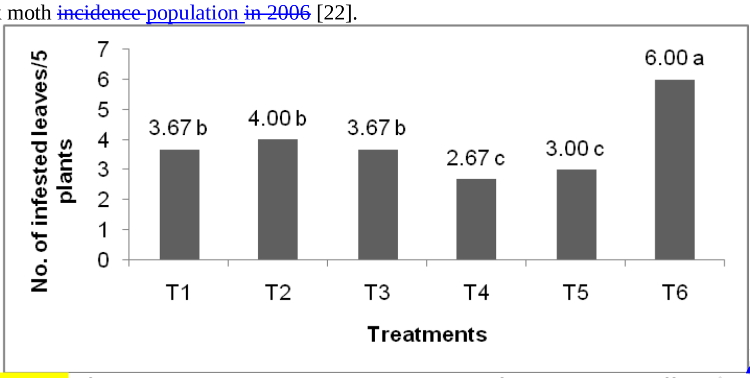

Fig.4. Incidence of diamondback moth by number in cabbage field treated by different treatments

T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

~~3.1.5 Incidence~~Population of cabbage tobacco caterpillar

~~The tobacco caterpillar only at its larval stage attacked cabbage leaves and head, and damage caused by voracious feeding of upper epidermis of leaf and head in the form of regular hole~~. Significant variation was also observed on ~~Tobacco~~ tobacco cutworm ~~in number~~popul;ation among ~~the~~ different treatments (Fig. 5). Results revealed that the lowest number of ~~Tobacco~~ tobacco cutworm (0.33) was found ~~from~~ in T_4 (Spodolure + Spinosad) ~~treatment~~ whereas the highest number ~~of Tobacco cutworm~~ (5.28) was found ~~from~~ in control ~~treatment T_6~~plots. ~~Under~~ Among different treatments ~~treated plot~~, the highest number of ~~Tobacco~~ tobacco cutworm (3.00) was found from T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) which was statistically identical with T_1 (Spinosad). More or less similar result was obtained by Reddy et al in 2017 [23].

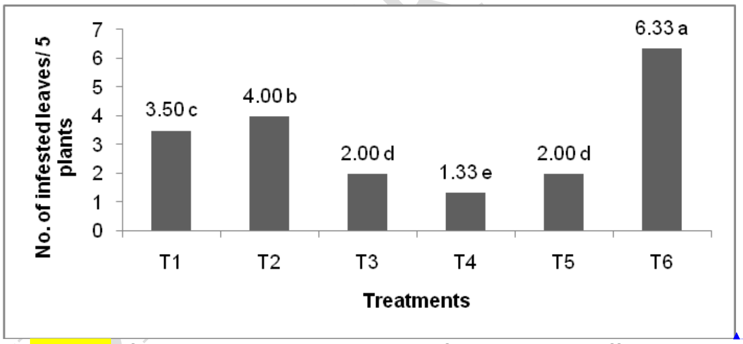

Fig.5. Incidence of cutworm by number in cabbage field treated by different treatments

T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

Effects on ~~3.2 Incidence~~ of natural enemies

~~3.2.1 Incidence~~Population of lady bird beetle:

Significant variation was observed on lady bird beetle in number among ~~the~~ treatments (Fig. 6). Results revealed that the highest (8.00) and lowest and lowest (6.50) number of lady bird beetle ~~(8.00)~~ was found from T_4 (Spodolure + Spinosad) and untreated control plots, respectively. ~~treatment whereas the lowest number of lady bird beetle (6.50) was found from control treatment T_6. Under the~~Among different treatments ~~treated plot,~~ the lowest ~~number of~~ lady bird beetle (6.75) was found from T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) which was statistically identical with T_1 (Spinosad), what a dose

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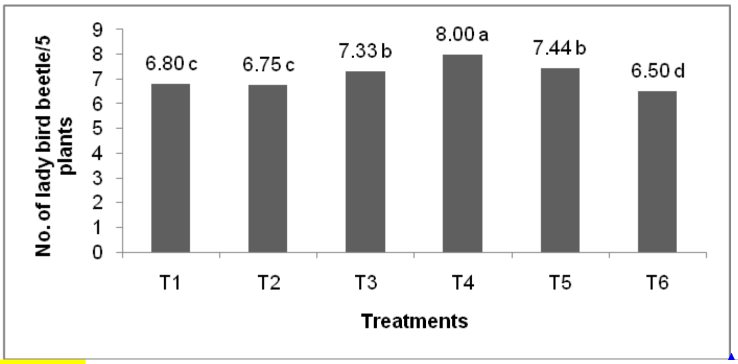

Fig.6. Incidence of lady bird beetle per plant in cabbage field treated by different treatments

T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

~~3.2.2 Incidence~~Poulation of spiders: ~~of spider~~

The spider population has ~~S~~significant variation ~~was observed on spider in number among the~~with different treatments (Fig. 7). ~~Results~~ The ~~revealed that the~~ highest (8.60) and lowest (6.80) number of spider ~~(8.60)~~ was found from T_4 (Spodolure + Spinosad) ~~treatment whereas the~~ and ~~lowest number of spider (6.80) was found from~~ control ~~treatment T_6~~plots, respectively. ~~Under treated plot, the lowest~~Among treatments the minimum ~~number of~~ spider (7.48) was found from T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) ~~which was~~ and it was statistically identical with T_1 (Spinosad what a dose).

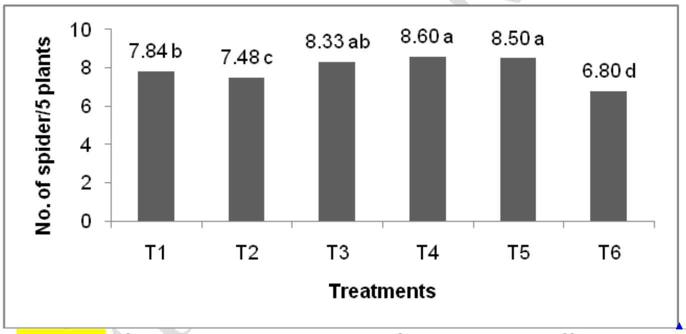

Fig. 7. Incidence of spider per plant in cabbage field treated by different treatments

T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

~~3.3 Performance~~ Effect of of management practices

~~3.3.1 Performance regarding h~~Healthy plants ~~number~~: The data on per cent

~~Different treatments on percent (%)~~ number of healthy plants ~~showed~~ has significant variation at different days of crop duration (Table 1). Results indicated that the highest ~~percent (%)~~ number of healthy plants (100, 97.22, 94.44, 93.06 and 91.67 % at 30, 50, 70, 90 DAT (write full) and at harvesting, respectively) was found in T_4 (Spodolure + Spinosad) ~~treatment~~ the lowest ~~percent (%)~~ number of healthy plants (90.28, 79.17, 69.44, 59.72 and 52.78% at 30, 50, 70, 90 DAT and at harvesting, respectively) was found in control ~~treatment T_6~~plots. ~~But under treated plants~~Among different treatments the lowest ~~percent (%)~~ number of healthy plants (91.67, 84.72, 77.7, 73.61 and 70.83% at 30, 50, 70, 90 DAT and at harvesting, respectively) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) ~~treatment~~ which was statistically identical with T_1 (Spinosad what a dose) at the time of harvesting.

Table 1. Effect of bio-pesticides/pheromones on ~~percent (%)~~ number of healthy plants of cabbage plot^{-1} in ~~cabbage field~~ at different DAT

Treatments	~~Percent (%) N~~number of healthy plants(%)				
	30 DAT	50 DAT	70 DAT	90 DAT	At harvest

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T_1	93.06 bc	86.11 c	79.17 c	76.39 cd	73.61 d
T_2	91.67 c	84.72 c	77.78 c	73.61 d	70.83 d
T_3	94.44 bc	87.50 bc	81.94 c	79.17 c	77.78 c
T_4	100.00 a	97.22 a	94.44 a	93.06 a	91.67 a
T_5	97.22 ab	90.28 b	87.50 b	86.11 b	81.94 b
T_6	90.28 c	79.17 d	69.44 d	59.72 e	52.78 e
LSD	0.76	0.73	0.79	0.63	0.72
CV(%)	4.97	7.07	6.52	9.57	8.98

In a column, means followed by same latter(s) do not differ significantly at 5% level by LSD DAT= Days After Transplanting, T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

~~3.3.2 Performance regarding~~ Iinfested plants ~~number~~ ; The data on
~~Different treatments on percent (%) number of infested plants~~ showed significant variation at different days of crop duration (Table 2). Results indicated that the lowest ~~percent (%)~~ number of infested plants (0, 2.78, 5.56, 6.94 and 8.33 % at 30, 50, 70, 90 DAT and at harvesting, respectively) was found in T_4 (Spodolure + Spinosad) treatment the highest percent (%) number of infested plants (9.72, 20.83, 30.56, 40.28 and 47.22% at 30, 50, 70, 90 DAT and at harvest, respectively) was found in control ~~treatment T_6~~plots. ~~Under~~ Among treatments ~~treated plants the highest percent (%)~~the number of infested plants (8.33, 15.28, 22.22, 26.39 and 29.17% at 30, 50, 70, 90 DAT and at harvesting, respectively) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment which was statistically identical with T_1 (Spinosad) at the time of harvest.

Table 2. Effect of bio-pesticides/pheromones ~~on percent (%)~~ number of infested plants of cabbage plot^{-1} ~~in cabbage field~~ at different DAT

Treatments	~~Percent (%)~~ Nnumber of infested plants (%)				
	30 DAT	50 DAT	70 DAT	90 DAT	At harvest
T_1	6.94 bc	13.89 b	20.83 b	23.61 bc	26.39 b
T_2	8.33 ab	15.28 b	22.22 b	26.39 b	29.17 b
T_3	5.56 c	12.50 bc	18.06 b	20.83 c	22.22 c
T_4	0.00 e	2.78 d	5.56 d	6.94 e	8.33 e
T_5	2.78 d	9.72 c	12.50 c	13.89d	18.06 d
T_6	9.72 a	20.83 a	30.56 a	40.28 a	47.22 a
LSD	0.36	0.73	0.79	0.63	0.72
CV(%)	8.55	6.47	9.93	10.57	7.37

In a column, means followed by same latter(s) do not differ significantly at 5% level by LSD DAT= Days After Transplanting T_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

~~3.3.3 Performance regarding~~ Hhealthy leaves ~~plant^{-1}~~ :

At 30 DAT, no significant variation was found on number of healthy leaves plant^{-1} (Table 3). But at 50, 70, 90 DAT and at harvesting time, significant variation was found due to different management practices against insect--pests of cabbage (Table 4). Results revealed that the highest number of healthy leaves plant^{-1} (14.36, 18.99, 20.70, 19.88 and 17.35 at 30, 50, 70, 90 DAT and at harvesting, respectively) was found in T_4 (Spodolure + Spinosad) treatment. The lowest number of healthy leaves plant^{-1} (13.48, 14.90, 15.40, 14.63 and 12.68 at 30, 50, 70, 90 DAT and at harvest, respectively) was found in control ~~treatment T_6~~plots But under treated plants the lowest number of healthy leaves plant^{-1} (13.85, 16.05, 16.85, 16.13 and 14.23 at 30, 50, 70, 90 DAT and at harvest, respectively) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment.

Table 3. Effect of bio-pesticides/pheromones on ~~number of~~ healthy leaves plant^{-1} of cabbage f~~ield~~ at different DAT

Treatments	Number of healthy leaves plant^{-1}				
	30 DAT	50 DAT	70 DAT	90 DAT	At harvest
T_1	13.73	16.48 d	17.58 d	17.04 d	14.98 c
T_2	13.85	16.05 d	16.85 e	16.13 e	14.23 d
T_3	13.55	17.17 c	18.35 c	17.92 c	15.43 c
T_4	14.36	18.99 a	20.70 a	19.88 a	17.35 a
T_5	14.25	18.10 b	19.33 b	18.90 b	16.27 b
T_6	13.48	14.90 e	15.40 f	14.63 f	12.68 e
LSD	1.72^{NS}	0.63	0.53	0.57	0.58
CV(%)	3.98	8.45	6.93	7.18	9.54

In a column, means followed by same latter(s) do not differ significantly at 5% level by LSD DAT= Days After TransplantingT_1 = Spinosad, T_2 = SNPV (Spodoptera litura nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

3.3.4 Performance regardingI infested leaves plant^{-1}: The data on infested leave at

At 30, 50, 70, 90 DAT and at harvest, has significant variation was foundon number of infested leaves plant^{-1} due to different management practices against insect- pests of cabbage (Table 4). Results showed that the lowest number of infested leaves plant^{-1} (0.88, 1.05, 1.70, 2.18 and 2.63 at 30, 50, 70, 90 DAT and at harvesting, respectively) was found in T_4 (Spodolure + Spinosad) treatment. the highest number of infested leaves plant^{-1} (3.43, 4.10, 4.63, 5.38 and 6.38 at 30, 50, 70, 90 DAT and at harvest, respectively) was found in control treatment T_6plots. But under treated plants the highest number of infested leaves plant^{-1} (2.80, 3.25, 3.50, 4.25 and 4.75 at 30, 50, 70, 90 DAT and at harvest, respectively) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment.

Table 4. Management of major insect pestEffects of by bio-pesticides/pheromone traps on number of infested leaves plant^{-1} of cabbage

Treatments	Number of Iinfested leaves plant^{-1}				
	30 DAT	50 DAT	70 DAT	90 DAT	At harvest
T_1	2.40 bc	2.75 bc	3.05 bc	3.50 c	3.88 c
T_2	2.80 ab	3.25 b	3.50 b	4.25 b	4.75 b
T_3	1.80 cd	2.43 cd	2.87 cd	3.25 cd	3.63 cd
T_4	0.88 e	1.05 e	1.70 e	2.18 e	2.63 e
T_5	1.55 de	2.03 d	2.38 d	2.75 d	3.25 d
T_6	3.43 a	4.10 a	4.63 a	5.38 a	6.38 a
LSD	0.75	0.62	0.61	0.56	0.46
CV(%)	4.41	7.84	8.25	10.48	7.53

In a column, means followed by same latter(s) do not differ significantly at 5% level by LSD DAT= Days After Transplanting
T_1 = Spinosad, T_2 = SNPV (*Spodoptera litura* nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

3.4 Management of major insect regardingEffect of management practices on yield performance

3.4.1 Weight of healthy cabbage head plant^{-1}

Different treatments has significant variation on weight of healthy cabbage head plant^{-1} showed significant variation (Table 5). Results indicated that tThe highest healthy (1.20 kg) and lowest (0.88 kg) cabbage head plant^{-1} (1.20 kg) was found in T_4 (Spodolure + Spinosad) treatment. the lowest healthy cabbage head plant^{-1} (0.88 kg) was found in control treatment T_6plots, respectively But under treated plants the lowest healthy cabbage head plant^{-1} (0.97 kg) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment which was statistically similar at par with T_1 (Spinosad).
In terms of % increase of healthy head weight plant^{-1} over control, the highest % increase (36.36%) was found in T_4 (Spodolure + Spinosad) whereas the lowest % increase (10.23%) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment. This result was supported by Dey et al. [24].

3.4.2 Weight of infested cabbage head plant^{-1} (no need to give this data)

Different treatments on weight of infested cabbage head plant^{-1} showed significant influence (Table 5). Results indicated that the lowest infested cabbage head plant^{-1} (0.52 kg) was found in T_4 (Spodolure + Spinosad) treatment which was significantly different from other treatment. The highest infested cabbage head plant^{-1} (0.92 kg) was found in control treatment T_6 whereas under treated plants the highest infested cabbage head plant^{-1} (0.66 kg) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment.
In terms of % decrease of infested head weight plant^{-1} over control, the highest % decrease (43.48%) was found in T_4 (Spodolure + Spinosad) followed by T_5 (Spodolure + SNPV) whereas the lowest % decrease (28.26) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment.

3.4.3 Marketable cabbage head: plot^{-1}

Different treatments on marketable cabbage head plot^{-1} (kg) showed significant variation (Table 5). Results indicated that the highest marketable (Table 5). cabbage head plot^{-1} (19.48 kg) was found in T_4 (Spodolure + Spinosad) treatment and lowest . The lowest marketable cabbage head plot^{-1} (8.30 kg) was found in control

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treatment T_6. ~~but~~ But under treated ~~plants~~ plots the lowest marketable cabbage head plot^{-1} (12.34 kg) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment.

~~3.4.4 Marketable cabbage head ha^{-1}~~

Different treatments on marketable cabbage head ha^{-1} (kg) showed significant variation (Table 5). Results indicated that the highest marketable cabbage head ha^{-1} (45.08 t) was found in T_4 (Spodolure + Spinosad) treatment whereas the lowest ~~marketable cabbage head ha^{-1}~~ (19.24 t) was found in control ~~treatment T_6~~. ~~but~~ But under treated plants the lowest marketable cabbage head ha^{-1} (28.57 t) was found in T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus) treatment. Simiar trend of yield was found by other authors using chemical insecticides [25]. As using biopesticides/pheromones is better and safer than chemical insecticides, then is wise to use the biopesticides.

Table 5. Effect of bio-pesticides on yield and yield contributing characters of cabbage

~~Treatments~~a	Yield parameters					
	Wt.of healthy cabbage head plant^{-1} (kg)	**% increase of healthy head plant^{-1} over control**	**Wt. of infested cabbage head plant^{-1} (kg)**	**% decrease of infested head plant^{-1} over control**	**Cabbage yield plot^{-1} (Marketabl) (kg)**	**Cabbage yield ha^{-1} (Marketabl) (t)**
T_1	1.03 bc	17.05	0.80 b	13.04	13.68 d	31.65 d
T_2	0.97 cd	10.23	0.66 c	28.26	12.34 e	28.57 e
T_3	1.10 ab	25.00	0.60 d	34.78	15.35 c	35.54 c
T_4	1.20 a	36.36	0.52 e	43.48	19.48 a	45.09 a
T_5	1.18 a	17.05	0.55 e	40.22	17.38 b	40.23 b
T_6	0.88 d	--	0.92 a	--	8.31 f	19.24 f
LSD	0.12	--	0.05	--	1.29	2.99
CV(%)	7.49	--	8.94	--	5.94	6.94

In a column, means followed by same latter(s) do not differ significantly at 5% level by LSD, T_1 = Spinosad, T_2 = SNPV (*Spodoptera litura* nuclear polyhedrosis virus), T_3 = Spodolure, T_4 = Spodolure + Spinosad, T_5 = Spodolure + SNPV, T_6 = Control

CONCLUSION: It was foind that

~~The result of the current analysis suggests that among the different treatments~~ T_4 comprised of Spodolure trap along with Spinosad spray ~~gave the highest performance where the lowest performance was obtained by control treatment. On the other hand, the lowest performance among the treated plots was achieved by T_2 (SNPV; *Spodoptera litura* nuclear polyhedrosis virus)~~ found most effective against insect-pests f cabage crop .

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