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EFFICACY OF SELECTED BOTANICALS AND BIO-PESTICIDES AGAINST DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA* (LINN.) ON CABBAGE, *BRASSICA OLERACEA* VAR. *CAPITATA*

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ABSTRACT
In order to determine the selected botanicals and bio-pesticides**,** NSKE, neem leaf extract, *lantana camara* leaf extract and *Bacillus thurigeinsis* (Delfin). *Beauveria bassiana,* spinosad respectively with recommended insecticide Chlorpyriphos against diamondback moth, *Plutella xylostella* (L.). Field trial was conducted during *Rabi* season 2003-14 at Allahabad, U.P. The insecticides were used as per recommended dose along with an untreated control. Each insecticide was sprayed thrice at 15 days interval. The larval count per plant was taken day before and 3, 7 and 14 days after each spray. All the insecticides tested significantly reduced the pest population compared to control. Chlorpyriphos 20 EC 3ml/lit was the most effective on the basis of pest population per plant and increase of yield over untreated control. Chlorpyriphos recorded the highest yield (296.75 q/ha) followed by Spinosad (275.15 q/ha), Bacillus *thurigiensis* (Delfin) (200.13 q/ha), *Beauveria bassiana* (180.25 q/ha), NSKE 2% (138.15 q/ha), neem leaf extract 10% (130.15 q/ha) and *Lantana camara* leaf extract 10% (120.65 q/ha) and untreated control (70.32 q/ha).

KEY WORDS: botanicals, bio-pesticides Cabbage, *Brassica oleracea* var. *Capitata*, Diamondback moth, *Plutella xylostella*.

INTRODUCTION
Cabbage (*Brassica oleracea* L.) is an important leafy vegetable widely cultivated in many countries in grown for food and fodder. India is the second largest producer of cabbage in the world after China. Total area under cabbage crop in India producing 909.2 million tonnes (5.5 per-cent of total vegetable production) an area of 400.1 /ha (4.3 per-cent of total vegetable area) with a productivity of 22.6 Mt/ha. Highest production of cabbage in India is found in West Bengal. Highest Cabbage producing states of India, West Bengal, Orissa and Bihar, 2197.4, 1150.9 and 735.0 tonnes respectively, (Anonymous, 2014). It is a primary source of roughage in the diet of humans (Ensminger & Ensminger, 1986). However, cabbage is susceptible to insect pest infestation in the field, which causes great loss to the growers. These pests infest the plants at different stages of their growth and cause serious damage to the head of the crop as well as the wrapper leaves which reduces its marketability (Eigenbrode *et al.,* 1990). The most common pests of cabbage are the diamondback moth, *Plutella xylostella*, cabbage aphid, *Brevicoryne brassicae* (Norman, 1992). Even though many insect pests attack cabbage, the most destructive pest is *P. xylostella*. Generations of *P. xylostella* overlap throughout the warmer months of the year (Gullan & Crantson, 1994). Synthetic chemical insecticides have been used for many years in the control of these pests. The continuous and improper use of such chemical insecticides often results in the development of insect resistance to these insecticides, food and ground water contaminations. When insecticide resistance develops, management of the pest becomes even more difficult. As a result of the above problems there is the need to find alternative and suitable methods for the control of these pests to bring about increased crop production. The use of plant derivatives as an alternative to chemical insecticides has been studied throughout the world. Over 2000 plant species have been reported to possess pest control properties (Ahmed *et al*., 1984). Two of such plants are *Azadirachta indica* and *Lantana camara*. Many plant metabolites have been characterized as having defensive mechanisms against insect pests. These include azadirachtin from the neem plant and lantanine from *L. camara*. Extracts from the leaves of *L. camara* exhibit antimicrobial, fungicidal, insecticidal and nematicidal activities (Begum *et al*., 2000). The neem tree, *Azadirachta indica*, has been demonstrated to possess insecticidal properties. This is because several chemicals in its leaves and seeds have been shown to be effective against many agricultural insect pests (Schmutterer *et al.,* 1981). Azadirachtin is the major biologically active substance in the neem tree which interferes with the biology of a number of insects. Azadirachtin has an antifeedant, sterilizing and morphogenic effect on target pests' species. It is structurally similar to the insect hormone, ecdysone which controls the process of moulting. Azadirachtin appears to block the insect's ability to release this hormone (Gullan & Cranston, 1994). The process of moulting is therefore hindered, thus breaking the insect's life cycle (Schmutterer, 1998). The application of botanicals and bio-pesticides in the

management of insect pests has received more attention because they offer a more environmentally friendly and sustainable alternative to synthetic insecticides. The study therefore assessed the effectiveness of extracts from NSKE, neem leaf extract and *L. camara* leaves in the management of some pests of cabbage.

MATERIALS & METHODS

A Field experiment was conducted at Central Research Farm, Department of Entomology, Sam Higginbottom Institute of Agriculture, Technology & Sciences, Naini, Allahabad, Uttar Pradesh during *Rabi* season 2013-2014. The research field is situated on the right side of Allahabad Rewa road at 25.57^{o} N latitude, 81.51^{o} E longitude and is about 98 m above sea level. The trial were laid out in a randomized block design having plot size of 2 x 2 m and spacing 45 x 45 cm with cabbage cv, Golden Acre. All the treatments were replicated thrice. All the recommended agronomical practices were followed from the package of practices of the zone of Uttar Pradesh except insecticidal sprays. The field efficacy of selected botanicals and bio-pesticides *viz*., NSKE, neem leaf extract, *lantana camara* leaf extract and *Bacillus thurigeinsis* (Delfin). *Beauveria bassiana,* spinosad respectively, was compared with untreated control and also with Chlorpyriphos, an old generation synthetic pesticide against diamondback moth. In order to maintain uniform plant stand in each treatment plot, gap filling was done by transplanting fresh healthy seedlings wherever the plants died after transplanting. There were four rows of four plants in each plot *i.e.,* 16 plants per plot. The transplanting was done on 10 December 2013. The dose used for different treatments are given in the Table 1. The first spray was applied as soon as the pest level crossed the ETL *i.e.,* 2-3 larvae per plant the second spray was given after 15 days respectively. All the respective spray fluids were sprayed thoroughly to cover each plant in every treatment. The spraying was done with the help of knap-sac sprayer. The population count of diamondback moth larvae was recorded five plants randomly selected each plots one day before every spray which served as pre-treatment observation and the subsequent counts were taken on 3rd 7th and 14th days after each spray (Post-treatment). Observation on the larval population will be recorded during morning hours.

The spray solution of a desired concentration will prepare by adopting the following formula.

$$V = \frac{C \times A}{\%\ a.i.}$$

Where,

V= Volume / weight of commercial insecticide ml or g.

C = Concentration required.

A = Volume of solution to be prepared.

% a.i. = Percentages of active ingredient in commercial formulation.

Preparation of neem leaf extract

Fresh leaf of neem was collected from central field of SHIATS in the morning. The collected leaves were washed under running water in the laboratory. Approximately 100 g fresh weight of leaf was blended in 1 liter tap water and filtered through muslin cloth. Spraying of fresh 10% neem leaf water extract to treated plot was carried out on the same day once or twice a week.

Preparation of *lantana camara* leaf extract

Fresh leaf of wild *Lantana camara* was collected from central field of SHIATS in the morning. The collected leaves were washed under running water in the laboratory. Approximately 100 g fresh weight of leaf was blended in 1 liter tap water and filtered through muslin cloth. Spraying of fresh 10% *Lantana camara* leaf water extract to treated plot was carried out on the same day once or twice a week (Nashriyah *et al.,* 2006).

The percent reduction in the population of this pest was worked out by using following formula:

$$P = \frac{T_a - T_b}{T_a} \times 100$$

Where,

P= Percent reduction in the population of pest.

Ta = Number of pest individuals before application (Pre-treatment count).

Tb = Number of surviving pest individuals on particular day after application.

Yield

In order to evaluate the effect of the treatments on the yield, the weight of cabbage head in a net plot was recorded. The cabbage head were plucked after attaining a desirable size. A plucking of cabbage heads was done. The weights of harvested heads in such a net plot of each treatment were summed-up to the total yield and computed on hectare basis by using hectare factor.

$$B{:}C = \frac{\text{Net return}}{\text{Cost of return}} \times 100$$

Statistical analysis

The data obtained from the different treatments were computed to determine the mean values. The mean values after suitable transformation were subjected to statistical analysis to test significance as per (Gomez and Gomez, 1984) for interpretation of the results.

RESULTS & DISCUSSION

The data on population reduction of diamondback moth before spraying Table 1 revealed that the results were statistically non significant. The result of pooled data of the year, 2013-14 are shown in Table 1. All the treatments significantly differed from the untreated control after first spray and reduction in the larval population of *P. xylostella* was observed in the all insecticidal treatments. At 3 DAS, the maximum percentage of larval reduction was observed in Chlorpyriphos (61.78%) followed by Spinosad (57.41%) whereas, *Bacillus thuringiensis* (37.80%), showed least effectiveness. Similar trend was observed after 7 and 14 days after first spray. Maximum of 75.86 per cent of larval reduction was observed in Chlorpyriphos treated plot 14 days after first spray.

TABLE 1. Efficacy of selected botanical and bio-pesticides against diamondback moth, *Plutella xylostella* (L.), in cabbage during *Rabi* season 2013-14

Treatments	Percentage reduction in larval population of diamondback moth after 1st and 2nd spray										
	First Spray					Second Spray					Overall mean% reduction after two sprays
	1DBS*	3DAS**	7DAS	14DAS	Mean	1DBS	3DAS	7DAS	14DAS	Mean	
T_1 *Bacillus thuringiensis*	5.25 (13.24)***	37.80 (37.93)	46.43 (42.95)	59.22 (50.31)	47.82 (43.75)	2.76 (9.56)	42.34 (40.59)	56.10 (48.50)	68.50 (55.85)	55.65 (48.24)	51.7
T_2 *Beauveria bassiana*	5.65 (13.75)	18.91 (25.77)	38.72 (38.48)	53.16 (46.81)	36.93 (37.42)	2.16 (8.45)	22.82 (28.53)	52.29 (46.31)	64.67 (53.53)	46.59 (43.04)	41.8
T_3 Spinosad	4.80 (12.65)	57.41 (49.26)	66.33 (54.53)	73.41 (58.95)	65.72 (54.16)	2.24 (8.60)	66.59 (54.68)	79.87 (63.34)	80.94 (64.11)	75.80 (60.53)	70.8
T_4 NSKE	6.10 (14.29)	16.54 (23.99)	24.49 (29.66)	29.34 (32.79)	23.46 (28.97)	4.12 (11.71)	19.92 (26.50)	34.18 (35.77)	37.84 (37.96)	30.65 (33.61)	27.0
T_5 Neem leaf extract	5.40 (13.43)	18.50 (25.47)	26.40 (30.91)	30.00 (33.21)	24.97 (29.98)	3.02 (10.00)	19.92 (26.50)	31.07 (33.87)	42.83 (40.87)	31.27 (34.00)	28.1
T_6 Lentana leaf extract	5.97 (14.14)	16.40 (23.88)	20.98 (27.26)	23.21 (28.80)	20.20 (26.70)	3.14 (10.20)	18.09 (25.17)	26.65 (31.08)	36.17 (36.97)	26.97 (31.28)	23.6
T_7 Chloropyriphos	6.13 (14.33)	61.78 (51.81)	73.06 (58.73)	75.86 (60.57)	70.23 (56.93)	1.92 (7.96)	72.78 (58.55)	81.15 (64.26)	84.96 (67.18)	79.63 (63.17)	74.9
T_0 Control	4.20 (11.82)	12.22 (20.46)	15.21 (22.95)	18.15 (25.21)	15.19 (22.93)	6.70 (15.00)	11.30 (19.64)	16.13 (23.68)	18.44 (25.43)	15.29 (23.01)	15.2
Overall Mean	**5.44**	**29.95**	**38.95**	**45.29**	**……..**	**3.26**	**34.22**	**47.18**	**54.29**	**………**	**……….**
F-Test	NS	S	S	S	....	NS	S	S	S	……….	....
S.Ed (±)	6.286	0.917	0.912	1.006	……..	5.451	0.928	0.757	0.672	……….	……….
C.D. (P= 0.05)	13.326	1.943	1.934	2.132	……..	11.556	1.967	1.604	1.425	……….	………..

*DBS = Days before spraying **DAS = Days after spraying ***Angular transformed values

TABLE 2. Cost benefit ratio of selected botanical and bio-pesticides against diamondback moth, *Plutella xylostella* (L.), in cabbage during *Rabi* season 2013-14

Treatments	Yield (q/ha)	Increased yield over control (q/ha)	Value of yield (q/ha)	Total value of yield (Rs.)	Common cost (Rs.)	Treatment cost (Rs.)	Total cost (Rs.)	Net returns/ha (Rs.)	C:B ratio
T_1 *Bacillus thuringiensis*	200.13	129.81	700	140091	21670	800	22470	117621	1:5.23
T_2 *Beauveria bassiana*	180.25	109.93	700	126175	21670	1032	22702	103473	1:4.55
T_3 Spinosad	275.15	204.83	700	192605	21670	1300	22970	165055	1:5.99
T_4 NSKE	138.15	67.83	700	96705	21670	1300	22970	73735	1:3.21
T_5 Neem leaf extract	130.65	60.33	700	91105	21670	1400	23070	68035	1:2.94
T_6 Lentana leaf extract	120.15	49.83	700	8855	21670	1400	23070	61385	1:2.66
T_7 Chloropyriphos	296.75	226.43	700	207725	21670	5880	27550	184335	1:7.88
T_0 Control	70.32	……	700	49224	21670	…….	21670	27554	1:1.27

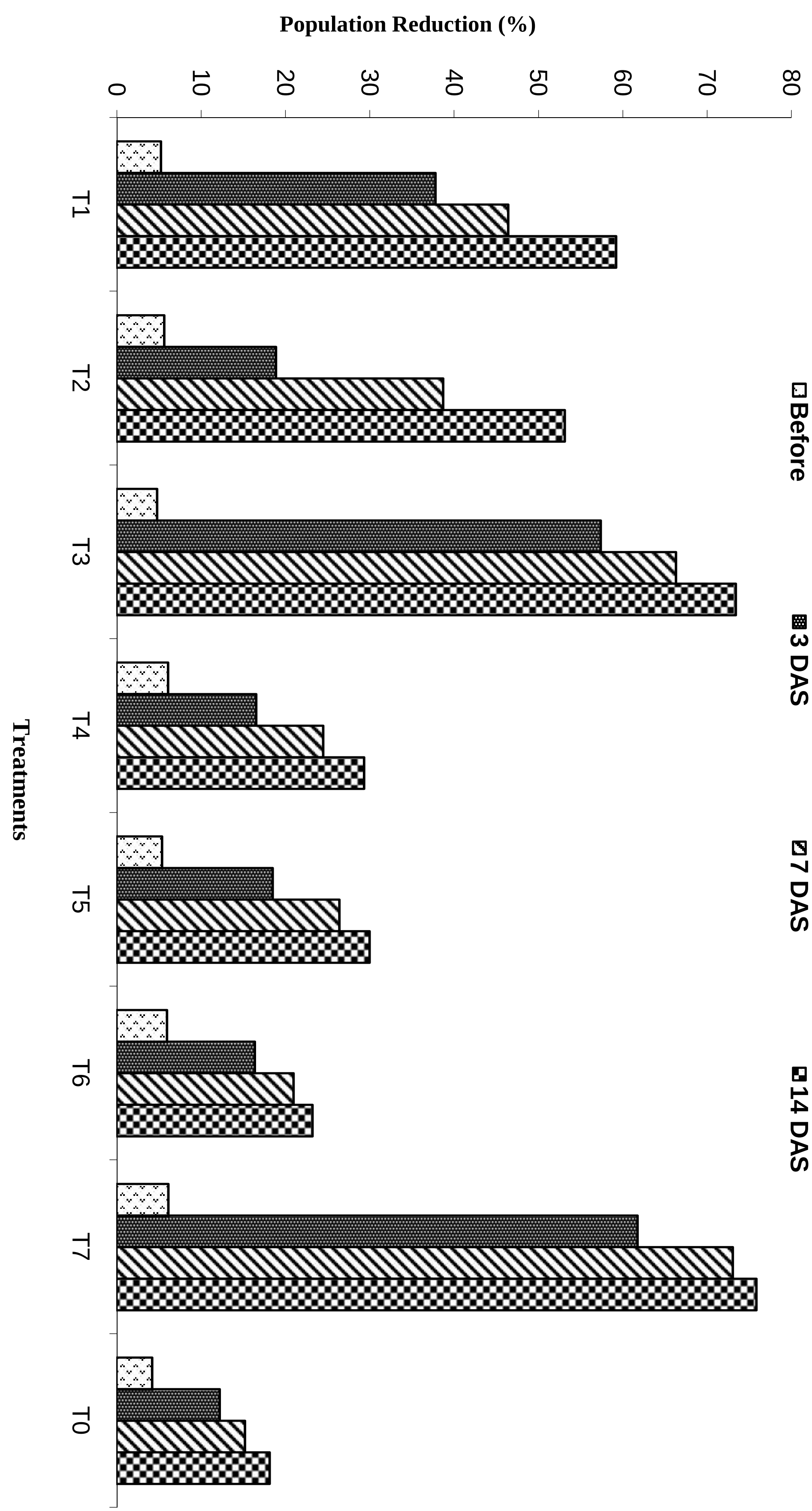

FIGURE 1. Efficacy of selected botanical and bio-pesticides against diamondback moth, *Plutella xylostella* (L.) in cabbage before and after of 1[st] spray during *Rabi* season 2013-14

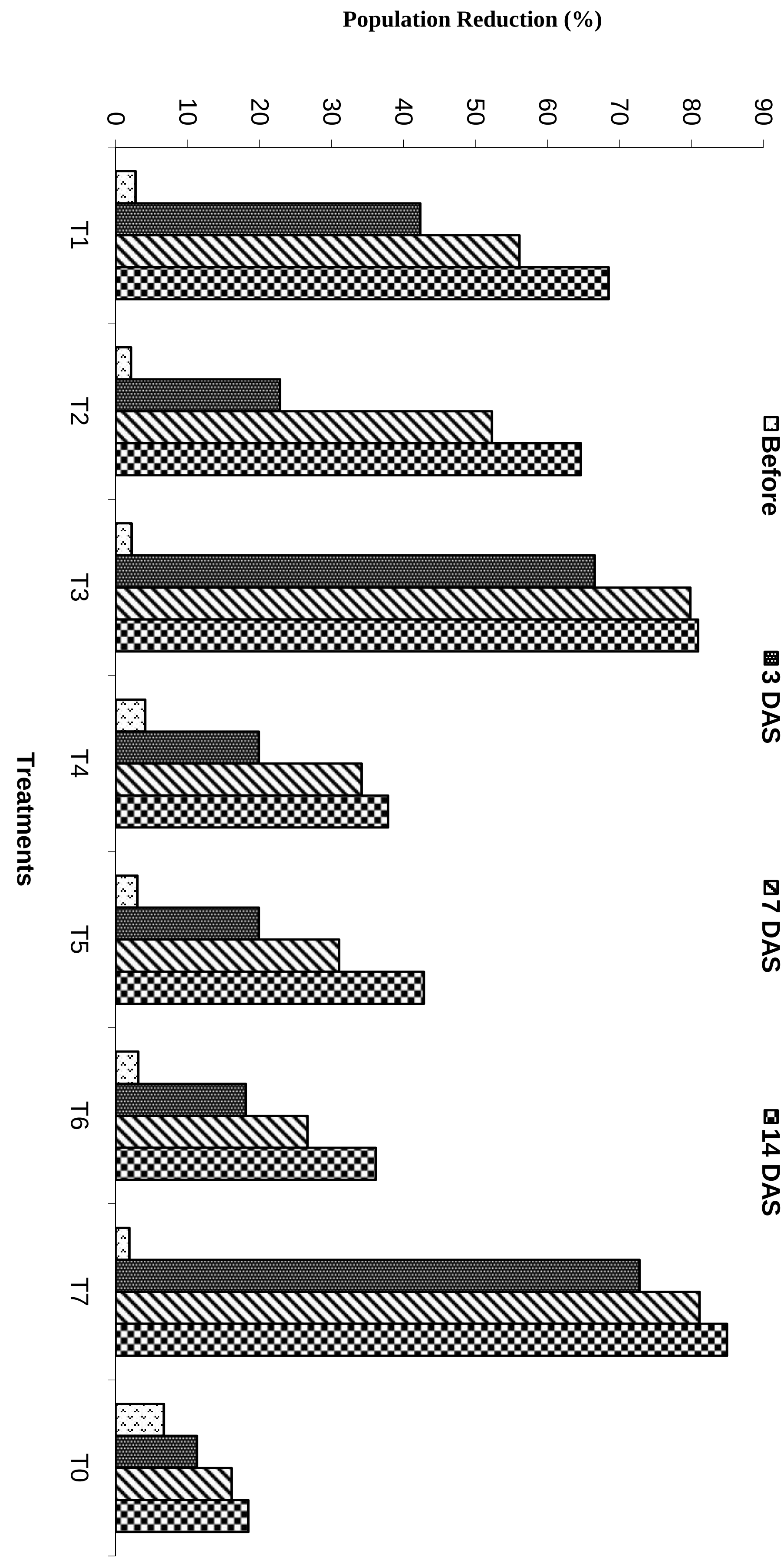

FIGURE 2. Efficacy of selected botanical and bio-pesticides against diamondback moth, *Plutella xylostella* (L.) in cabbage before and after of 2nd spray during *Rabi* season 2013-14

Similarly, after second spray the highest percentage reduction in larval population of *P. xylostella* was noted in Chlorpyriphos (72.78%) followed by Spinosad (66.59%) when compared to *Bacillus thuringiensis* (42.34%) treated plot. The same trend was observed after 7 and 14 days after second spray when compared to untreated control. The overall highest mean per cent reduction of *P. xylostella* in cabbage was noted in insecticide molecules, Chlorpyriphos (74.9%), Spinosad (70.8%) and *Bacillus thuringiensis* (51.7%).

All the treatments showed significant increase in yield over untreated control Table 2. Highest mean yield of cabbage was recorded in Chlorpyriphos (296.75 q/ha) followed by Spinosad (275.15 q/ha) and *Bacillus thuringiensis* (200.13 q/ha). The mean yield of 180.25 and 138.15 q/ha recorded in *Beauveria bassiana* and NSKE treated plots, respectively whereas the lowest yield was observed in untreated control (70.32 q/ha). The increase yield more than in Chlorpyriphos and Spinosad treated plots. The highest (Table 2) cost benefit ratio was noticed in Chlorpyriphos (1:7.88) and Spinosad (1:5.99) treatments followed by *Bacillus thuringiensis* (1:5.23), *Beauveria bassiana* (1:4.55), NSKE (1:3.21), Neem leaf extract (1:2.94) and *Lantana camara* leaf extract (1:2.66).

CONCLUSION

The use of plant extracts with insecticidal properties has the potential of reducing the effects of insect pests of agricultural crops. These can be of importance to the resource-poor farmers in many areas of the developing world. The significant reduction in pests' numbers on the treated plants was an indication that they can be used as alternatives to chemical insecticides. Even though various pest species attacked the cabbage plants, *P. xylostella* caused the most serious damage. It was the main cause of reduction in weight of cabbage heads.

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