Research Article

EFFICACY TESTING OF 'SOFT' PESTICIDES FOR CABBAGE BUTTERFLY (*PIERIS BRASSICAE NEPALENSIS* DOUBLEDAY) IN CAULIFLOWER AT RAMPUR, CHITWAN

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ABSTRACT

Cabbage butterfly (*Pieris brassicae nepalensis*) is an important pest of cabbage, cauliflower, and many other crucifers. Pesticide use is a popular method of pest management in small and large-scale vegetable farming in Nepal. These practices are directly linked to human health, biodiversity, and the environment. There are various categories of pesticides available in market, some are toxic, and some are 'soft' in nature. Chemical action of pesticides to the insect pest has been recommended by efficacy testing. Accordingly this research was done to evaluate the effectiveness of 'soft' chemicals against cabbage butterfly management. Cauliflower cultivar 'Snow Mystique' was used for the field experiment established at Agriculture and Forestry University (AFU), Rampur Chitwan during November 2017 to March 2018. Six common pesticides such as Mahashakti (Bt. based), Neemix (*Azadirachtin* based), Spinosad (bacteria based), Liquid manure (mixture of botanical, cow urine and other ingredients), Superkiller-10 (Cypermethrin based), and control (no use) were used in Randomized Complete Block Design (RCBD), each with four replication. The study findings revealed that the highest number of larval populations of cabbage butterfly as well as damaged plants, leaves, curds, and holes were recorded in control plot, and the lowest larval population and damages were recorded in Cypermethrin and Spinosad treated plots. On the other hand, curd height was significantly higher (13.9 cm) in liquid manure treated plot that was similar with Spinosad treated plots. There was no significant difference in curd diameter (23.1 cm) and biological yield (79.6 t/ha) in Spinosad and Cypermethrin treated plots. It is thus suggested that biological pesticide, such as Spinosad are superior in controlling pests of cauliflower than other tested pesticides. These pesticides along with other soft pesticide are potentially safer for vegetable production. This information is important to develop IPM protocol for cabbage butterfly management in crucifers.

Key words: Bio-pesticides, cabbage butterfly, cauliflower, Snow Mystique

INTRODUCTION

Cauliflower shared the highest percentage (14.6%) of total vegetable production, equal to 491,834 mt. followed by cabbage, i.e. 448,980 t. This crop has covered a significant area (3298,816 ha) of vegetable production, equal to 13% of the total vegetable cultivated area (MoAD, 2012). Edible part of the cauliflower is tender, is rich source of vitamins and minerals. This vegetable crops can be used by cooking and making a various vegetable dishes such as curry, soup, pickles, salad and also preparing many other delicious food items in restaurants (Ashraf et al., 2017).

This crop has been affected by many insect pests such as cabbage butterfly (*Pieris brassicae nepalensis* Doubleday), diamondback moth (*Plutella xylostella*), cabbage aphid (*Brevicoryne brassicae*), white grubs (*Phyllophaga* sps.), cabbage semilooper (*Trichoplusia* sps.) and many more. Among them, cabbage butterfly (*P. b. nepalensis*) (Lepidoperta: Pieridae) is considered as a major pest in late season cauliflower and cabbage crops in Nepal (Joshi, 1994). There are various species of cabbage butterfly found in cabbage and cauliflower crops, some of them are cabbage butterfly, *P. b. nepalensis, P. candida* L. and *P. rapae* L. (Thapa, 1987). The larva of cabbage butterfly can damage crucifer crops gregariously and also bore in to the curds (Ali & Rizvi, 2007).This pest can also skeletonized the host leaf in severe situation, that can lead up to 100% crop failure (USDA, 1984). Nepalese farmers normally considered pesticide as a weapon of pest management (Yassin et al., 2002).

The current use of chemical pesticides causes various harmful effects to human beings and the environment (Thapa, 2003). The long-term effect of chemical pesticides has also been observed in soil, environment, human health, ground water contamination, pesticides resistance, pest resurgence and other ecological effects (Thapa & GC, 2000). Similarly, input cost for vegetable production can be increased while purchasing the chemical pesticides that causes pesticide consumptions increased by10-20% every year (Jasmine et al., 2008). Apart from, there are various natures of pesticides available in the market some are harmful, and some are safe in nature. Nowadays, local made botanical pesticide (*Jholmol*) has been used to control pest and diseases in Nepal. All soft nature of pesticides is called bio-pesticides. Bio-pesticides are derived from the natural products of living organisms such as microorganisms including bacteria, viruses, fungi and also plants that are used to control the pest populations (Thakore, 2017). The details of these pesticides as well as their efficacy are not tested yet. Hence, this study focused to evaluate the market available 'soft' chemicals against cabbage butterfly management.

MATERIAL AND METHODS

Experiment was conducted using 'Snow Mystique' cultivar of cauliflower at AFU, Rampur Chitwan from November 2017 to April 2018. Research field was prepared by using tractor and added well decomposed FYM and recommended dose of chemical fertilizer. There were a total of six treatments, allocated in Randomized Complete Block Design (RCBD), each with four replicates. The area of individual plot was 7.5 m^2 (3 m × 2.5 m) with 25 plants in each plot. Row to row distance was 60 cm and plant to plant distance was 50 cm. There were total 600 plants including the boarder plants in each plot. Net experimental plot was 180 m^2 while gross plot area for experimental plot was 262.5 m^2. The space between blocks and plots was 1.0 meter and 0.5 meter respectively. The details of treatments used in this experiment are listed in Table (1).

Table 1. Details on different treatments against cabbage butterfly at Rampur, Chitwan in 2017/018

Trade name	Ingredients name	Recommendation dose	Target pests
Mahashakti	*Bacillus thuringiensis*	2 ml/liter water	Cabbage butterfly & and aphids
Spinosad	*Saccharopolyspora spinosa*	0.5 ml/liter water	Cabbage butterfly and aphids
Neemix	*Azadirachtin*	5 ml/liter water	Cabbage butterfly and aphids
Liquid manure	-	1:3 parts liquid manure and water	Cabbage butterfly and aphids
Superkiller	Cypermethrin 10 % EC	2 ml/liter water	Cabbage butterfly and aphids
-10			

The seedlings were transplanted four weeks after seed sowing and water was sprayed as per the need of the crop. Fertilizes were used at the rate of 30 t FYM, and 200:120:80 kg NPK per hectare that was 22.5 kg of FYM, 195 g of DAP, 152 g of urea, 100 g of MoP, and 10 g of Borax per plot as a basal dose and 98 g urea was applied 40 days after transplanting as a split dose. Number of larvae population of cabbage butterfly at 3, 6 and 9 days after spray (DAS) during first, second, third, and fourth spray of pesticides were recorded from the randomly selected nine plants. Number of infested plants, leaves, curds and number of holes in each leave was recorded at final harvest in a randomly selected nine plants in each plot. Finally, total leaf weight; stem weight, total number of leaves, curd height, curd diameter, biological yield and curd yield was measured in each plot. Data was calculated by using Microsoft Excel and Genstat. Analysis of Variance (ANOVA) of variables was used for the data analysis, and means were compared by using the Duncan's Multiple Range Test (DMRT) at 0.05 and 0.01 level of significance. Data were also transformed by using square root transformation [SQR(x+0.5)] as and when required (Gomez & Gomez, 1984).

Agro-meteorological features of the experiment area

Weather parameters such as temperature, rainfall and relative humidity (RH) were collected from the National Maize Research Program (NMRP), Rampur Chitwan (www.narc.gov.np) and was taken from crop sowing to harvesting. The temperatures range was 9- 33ºC and relative humidity range was 71% - 96% with no rainfall during experimental period.

RESULTS AND DISCUSSION

Effect of different treatments against cabbage butterfly (*Pieris brassicae nepalensis*) during third spray of pesticides

Larvae population of cabbage butterfly did not appear during first and second spray of pesticides. But the larval population differed significantly among the treatments at 3 days after spray (DAS), 6 DAS and 9 DAS ($p<0.01$) (Table 2). At 3 DAS, Cypermethrin was significantly similar to Spinosad, at which the lowest number of larva population was recorded. At 6 DAS, lower larva population was counted in Cypermethrin that was also significantly similar to the Spinosad and differs with other treatments. At 9 DAS, lowest larva population was counted in Cypermethrin than other pesticides. Overall, the lowest number of larva population was recorded in Cypermethrin followed by Spinosad, both are significantly differed. Control plot demonstrated maximum larval population which was significantly different to all other treatments.

Table 2. Effect of different treatments on population of cabbage butterfly at different intervals during third spray of pesticides at Rampur, Chitwan in 2017/018

Treatments	Number of cabbage butterfly during third spray			
	3 DAS	6 DAS	9 DAS	Mean
Mahashakti (Bt.)	2.5 (1.7)^{b}	2.2 (1.6)^{bc}	3.0 (1.8)^{bc}	2.5 (1.7)^{b}
Spinosad	1.0 (1.1)^{c}	1.2 (1.2)^{cd}	2.0 (1.5)^{c}	1.4 (1.3)^{c}
Neemix	2.7 (1.7)^{b}	3.0 (1.8)^{b}	3.5 (1.9)^{b}	3.0 (1.8)^{b}
Liquid manure	2.0 (1.5)^{b}	2.5 (1.7)^{b}	3.2 (1.9)^{bc}	2.5 (1.7)^{b}
Cypermethrin	0.5 (0.9)^{c}	0.5 (0.9)^{d}	1.0 (1.1)^{d}	0.6 (1.0)^{d}
Control	4.7 (2.2)^{a}	6.0 (2.5)^{a}	7.0 (2.7)^{a}	5.9 (2.5)^{a}
SEM	0.13	0.19	0.17	0.12
$LSD_{0.05}$	0.28	0.41	0.37	0.25
F-test	**	**	**	**

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *Significant at 5% (P< 0.05), ** Significant at 1% (P< 0.01) and NS: not significantly different at 5% (P >0.05). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variance, DAS = Day after spraying and figure in the parenthesis indicate [SQR(x+0.5)] transformation value

Population of cabbage butterfly (*P. b. nepalensis*) during fourth spray of pesticides

At 3 DAS, significantly lower number of larva population was recorded in Cypermethrin and Spinosad treated plot, both were not significantly differed. At 6 DAS, lowest number of larva population was observed in Cypermethrin that was not significantly different with Spinosad and Mahashakti. At 9 DAS, Cypermethrin was statistically similar (p>0.05) to Spinosad. Overall, the lowest number of larva population was recorded in Cypermethrin which was not significantly different (p>0.05) with Spinosad. Maximum larval population was recorded in control plot which was significantly different (p<0.05) to other treatments (Table 3). Spinosad has a unique mode of action, involving nicotinic acetylcholine (Perry et al., 2011) and highly toxic to Lepidoptera (Watson & Salgado, 2001). Similarly, Cypermethrin is both contact and stomach poison (Tomlin, 1994). Deposition of Cypermethrin on surface of leaf also causes egg mortality. The field experiment for management of cabbage butterfly at Rampur, Chitwan revealed that two insecticides, such as Cypermethrin and Spinosad provided effective protection of cauliflower from cabbage butterfly, so they were superior to Neemix, Mahashakti and Liquid manure at 3 DAS, 6 DAS and 9 DAS at third and fourth sprays of pesticides. The findings of this experiment is similar to those reported by Legwaila et al., (2014); Khan & Kumar (2017), Dhawan et al., (2010) & Tomlin (1994) that Cypermethrin and Spinosad were more effective compared to other soft chemicals.

Table 3. Effect of different treatments on population of cabbage butterfly at different intervals during fourth spray of pesticides at Rampur, Chitwan in 2017/018

Treatments	Number of cabbage butterfly during fourth spray			
	3 DAS	6 DAS	9 DAS	Mean
Mahashakti (Bt.)	1.5 (1.4)^{b}	1.0 (1.1)^{bc}	1.2 (1.2)^{bcd}	1.2 (1.3)^{bc}
Spinosad	0.5 (0.9)^{cd}	0.7 (1.0)^{bc}	0.5 (1.0)^{d}	0.5 (0.9)^{cd}
Neemix	1.7 (1.4)^{b}	1.7 (1.4)^{b}	2.2 (1.6)^{b}	1.9 (1.5)^{b}
Liquid manure	1.0 (1.2)^{bc}	1.2 (1.3)^{b}	1.5 (1.4)^{bc}	1.2 (1.3)^{bc}
Cypermethrin	0.2 (0.8)^{d}	0.2 (0.8)^{c}	0.5 (0.9)^{d}	0.3 (0.8)^{d}
Control	4.2 (2.1)^{a}	5.0 (2.3)^{a}	5.5 (2.4)^{a}	4.9 (2.3)^{a}
SEM	0.14	0.21	0.18	0.15
$LSD_{0.05}$	0.31	0.44	0.38	0.32
F-test	**	**	**	**

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *Significant at 5% (P< 0.05), ** Significant at 1% (P< 0.01) and NS: not significantly different at 5% (P >0.05). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variance, DAS = Day after spraying and figure in the parenthesis indicate [SQR(x+0.5)] transformation

Effect of different treatments on leaves, curds and holes on leaves

Infested plants, leaves, curds, and holes on leaves of cauliflower from those randomly selected nine plants in each plot was differed significantly (p<0.01) (Table 4). Few damages were recorded in Cypermethrin treated crops compared with other pesticides; however, Cypermethrin effect was significantly similar to Spinosad. The lowest number of damaged leaves was observed in Cypermethrin treated crops as compared to other treatments that are also not significantly different to Spinosad. Significantly few numbers of holes on leaves was recorded in Cypermethrin treated plots as compared to other treatments. Finally, significantly lower number of damaged curd was recorded in Cypermethrin than other bio-pesticides, as Cypermethrin was statistically similar to Spinosad. Cabbage butterfly (*P. b. nepalensis*) freely feeds on five main plant families including Cruciferae (Feltwell, 2012) and cause massive destruction to their all growing stages (seedlings, vegetative, curding and flowering). Cabbage butterfly also causes a lot of damage to the host plants by eating rigorously and destroying the host plants (Asher et al., 2001). Significantly, lower larval population of the cabbage butterfly were recorded in Spinosad and Cypermethrin after third and fourth spray of bio-pesticides, as a result, the lowest number of damaged plants, leaves, curds and leaf holes were recorded in Cypermethrin and Spinosad treated plots.

Table 4. Effect of different treatments on number of infested plants, leaves, curds and holes on leaves at Rampur, Chitwan in 2017/018

Treatments	Number of infested plants	Number of damaged leaves	Number of holes on leaves	Number of damaged curds
Mahashakti (Bt.)	3.0[c]	2.2[c]	4.0[c]	1.2 (1.3)[c]
Spinosad	2.0[d]	1.2[d]	2.5[d]	0.2 (0.8)[d]
Neemix	4.5[b]	3.7[b]	5.2[b]	3.2 (1.9)[b]
Liquid manure	4.0[b]	3.0[bc]	4.7[bc]	3.0 (1.8)[b]
Cypermethrin	1.2[d]	1.2[d]	1.5[e]	0.2 (0.8)[d]
Control	9.5[a]	7.2[a]	11.7[a]	6.2 (2.5)[a]
SEM	0.43	0.45	0.41	0.15
$LSD_{0.05}$	0.92	0.95	0.88	0.33
F-test	**	**	**	**

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *Significant at 5% (P< 0.05), ** Significant at 1% (P< 0.01) and NS: not significantly different at 5% (P >0.05). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variance and figure in the parenthesis indicate [SQR(x+0.5)] transformation

Effect of different treatments on biomass and curd yield of cauliflower

Curd height, diameter, biological yield and yield of cauliflower differed significantly among the treatments (p<0.01) (Table 5). Significantly, highest curd height (13.9 cm) was recorded in liquid manure treated plots that was significantly similar to Spinosad. The biggest curd diameter was recorded in Spinosad treated plot which was statistically similar to Cypermethrin. Highest biological yield (79.6 t/ha) was recorded in Cypermethrin treated plots that was significantly similar to Spinosad but differ with other treated plots. Cabbage butterfly can cause damage on crop and significantly reduces the yield (Cartea et al., 2009). Larval damage may lead up to 100% crop failure in severe situation (Feltwell, 2012). Spinosad, one of the very effective treatments to control cabbage butterfly, resulted highest crop yield in the experiment (Singh, 2015).

Table 5. Effect of different treatments on curd height, curd diameter, biological yield and curd yield of cauliflower at Rampur, Chitwan in 2017/018

Treatments	Curd height (cm)	Curd diameter (cm)	Biological yield (t/ha)	Curd yield (t/ha)
Mahashakti (Bt.)	13.3[ab]	21.3[c]	73.9[b]	38.4[c]
Spinosad	13.8[a]	23.1[a]	79.3[a]	41.1[b]
Neemix	12.5[b]	21.8[bc]	73.2[b]	37.0[d]
Liquid manure	13.9[a]	21.0[c]	72.5[b]	37.2[d]
Cypermethrin	13.5[ab]	22.6[ab]	79.6[a]	42.3[a]
Control	12.0[c]	19.2[d]	69.0[c]	34.9[e]
SEM	0.48	0.51	0.64	0.42
$LSD_{0.05}$	1.03	1.09	1.36	0.89
F-test	*	**	**	**

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *Significant at 5% (P< 0.05), ** Significant at 1% (P< 0.01) and NS: not significantly different at 5% (P >0.05). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variance

CONCLUSION

Cabbage butterfly is one of the most important pests of cabbage and cauliflower in winter season in Nepal. This pest causes significant crop loss in almost all crucifers. Pesticide is the pest management culture in Nepal. In this study, soft and popular pesticides were tested to evaluate their efficacy for the cabbage butterfly management in Chitwan Nepal. Parameters taken were larval population, curd height, curd diameter, biological and curd yield. Larval population was significantly lower in Cypermethrin and Spinosad treated plots. The maximum biological and curd yield was found in Cypermethrin and Spinosad treated plot compared to the Neemix, Mahashakti and Liquid manure treated plots. Similarly, lesser number of infested plants, leaves, curds and holes on leaves by larvae of cabbage butterflies were recorded in Cypermethrin and Spinosad than other treatments. All these information are important to develop IPM protocol of cabbage butterfly and reduce pesticide amount in crop fields.

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