



Efficacy testing of various categories of pesticides for aphid management in cauliflower crops



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Article Info

ABSTRACT

Accepted:
5 Dec. 2020

Keywords:

Aphids, Bio-pesticides, Cabbage Butterfly, Cauliflower, Snow Mystique

Aphids are the important insect pest of winter season vegetable crops such as cabbage, cauliflower, mustard in Nepal. Their damage in these crops not only reduces the potential yields but also affects the market quality of those crops. Pesticides management practices are the common to reduce their infestation and crop damage. Judicious use of soft chemicals not only improve the farmers' health but also protect pollinator and beneficial soil arthropods. Therefore, a field study was conducted to test the commonly used alternative safe measures (bio-pesticides, home-made and chemical) in RCBD in a four replicates design in cauliflower crop cv. Snow Mystique. These were Mahashakti (Bt.), Neemix (*Azadirachtin*), Spinosad (bacteria-based), Liquid manure (a mixture of succulent plants, cow urine, fresh cow dung and ash) and Cypermethrin-10 (Superkiller-10). The study suggested that Cypermethrin-10 treated plots followed by Liquid manure and Spinosad was more effective to keep the aphid population below the threshold level than the control. The highest cauliflower curd yield was recorded in Cypermethrin treated plot (42.3 mt ha⁻¹) followed by Spinosad. This study suggests that chemicals are superior in terms of population reduction and crop yield but these were not eco-friendly and sustainable. Hence, integrating these chemicals to other bio-pesticides could be an alternative to aphid as well as other pest management.

INTRODUCTION

Cauliflower is an important and the mostly grown winter vegetable crop in Nepal. Aphids are the important insect pest of winter season vegetable crops such as cabbage, cauliflower, mustard in Nepal. Aphids can attack cauliflower crops that result in the loss of yield and quality of cauliflower crop (Patel et al. 1997). Their damage in these crops not only reduce the potential yields but also effects on the market quality of those crops. Aphids are polyphagous agricultural pest which causes a major loss of crop yield due to its severe infestation (Farang and Gesraha 2007; Lu et al. 2008). This pest is mostly available on the

underside of the oldest leaves as well as on seedlings, young plants and lower leaves of the cauliflower plants. Wilting and curling of the leaves due to the removal of cell sap, toxic action of their salivary secretions causing galls on leaves, stems and roots, while honeydew excretion favors the secondary growth of fungus and moulds which further damages the growth of leaves and young shoots. It also acts as a virus vector and transmits many diseases to the plants (Tooper-Kaygin et al. 2008).

Chemical pesticides are the common pest management technique to reduce the pest level in agricultural production (Mehmood et al. 2001). These pesticides are useful in reducing the pest population and incidence but these pesticides causes a potential hazard to human health and environment (Sharma and Singhvi 2017). Furthermore, fossil-based pesticides are deleterious to human health, the environment and other non-traded ecosystem service providers. The commercial growers are not familiar with the harmful effects of pesticides, unaware on the type

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and dose of pesticides, as well as safe measures of pesticide use (Yassin et al. 2002). Hence, an integrated pest management has been suggested utilizing 'safer' chemicals at a last resort. There are various natures of pesticides available in the market some are harmful, and some are safe in nature. The safe pesticides available in the market called bio-pesticides which are derived from the natural products of living organisms such as microorganisms including bacteria, viruses, fungi and plants that are used to control the pest populations (Thakore 2017). In order to support the sustainable production of cauliflower with least environmental health hazards, these mild pesticides are used for testing their efficiency against aphids in cauliflower. Therefore, a field study was conducted to test the effectiveness of different pesticides and compared with chemical as well as home-made pesticides to control aphids in tropical climate in Chitwan, Nepal.

MATERIALS AND METHODS

An experiment was conducted to test the effectiveness of different safe, home-made and chemical pesticides to control aphids in a late season cauliflower variety "Snow Mystique" in Rampur, Chitwan during November 2017 to March 2018. This experiment site was situated at 27°37' North latitude and 84°25' East longitude with elevation of 256 meter above sea level which falls in inner Terai region of Nepal

Weather condition of the experimental area

Weather parameters such as temperature, rainfall and relative humidity (RH) was collected from the National Maize Research Program, Rampur Chitwan (www.narc.gov.np). The data was taken from crop sowing to harvesting of cauliflower during November 2017 to March 2018. The maximum temperature of 33°C was recorded in March 2018 while the minimum temperature of 9°C was observed in January 2018. Similarly, the maximum and minimum relative humidity of 96% and 71% were recorded during January and March, respectively. There was negligible rainfall for the whole experiment period at Rampur (Figure 1).

Experiment design and treatments

There were altogether six treatments viz. Mahashakti (Bt. based), Neemix (*Azadirachtin* based), Spinosad (bacterial based), Liquid manure (mixture of succulent plants parts, cow urine, cow dung and ash), Superkiller-10 (Cypermethrin based) and control (no use) which were arranged in a Randomized Complete Block Design (RCBD) with four replications. The area of individual plot was 7.5 m² (3 m x 2.5 m) with 25 plants. Row to row spacing was maintained at 60 cm and plant to plant 50 cm. The detail of treatments used in this experiment are listed in Table 1.

Table 1. List of treatments for the control of aphid populations in Rampur, Chitwan during November 2017 to March 2018

SN	Treatments
1	Mahashakti (B.t.) @ 2 ml /litter of wate
2	Spinosad 45 % EC @ 0.5 ml/liter of wate
3	Neemix @ 5 ml/liter of water
4	Liquid manure: 1 part liquid manure and 3 part water
5	Cypermethrin-10 @ 2 ml /liter of water
6	Control (Water)

Based on the recommended dose of 30 mt/ha FYM and 200:120:80 kg NPK/ha, total amount of 22.5 kg farmyard manure, 195 g di-ammonium phosphate, 152 g urea and 100 g murate of potash per plot was used as a basal dose and 98 gram urea was applied at 40 days after transplanting as a split dose. The seedlings were transplanted four weeks after seed sowing and regular water was supplied as per need by the crops. Number of aphid populations at 3, 6 and 9 days after spray was recorded from those randomly selected nine plants during first, second, third and fourth spray of pesticides. Number of infested plants and leaves were also recorded at final harvest in a randomly selected nine plants in each plot. Finally, curd yield was measured from a selected five plants in each plot.

Data were recorded and entered into MS-Excel 2016. The analysis of variance (ANOVA) was identified by using GenStat 18th edition. Data analysis was done using Duncan's Multiple Range Test (*DMRT*) using GenStat. The significant differences between varieties were determined using the least significant difference (LSD) test at 1% or 5% level of significance (Gomez and Gomez 1984; Shrestha 2019).

RESULTS AND DISCUSSION

Aphid population during second spray of pesticides

Population of aphids did not appear during first and fourth spray of pesticides due to slightly higher temperature at that time. Number of aphid populations were differed significantly at $p < 0.01$ among the treatments at three, six and nine days after spray during second spray of pesticides (Table 2). At three days after spray, significantly lower number of aphids were recorded in Cypermethrin treated plots which was statistically similar to liquid manure and significantly different from other treatments. At six days after spray, significantly lower number of aphids were found in Cypermethrin and liquid manure than other treatments. Significantly, lower number of aphids were recorded in Cypermethrin and liquid manure treated plots than other treatments at nine DAS.

Table 2. Effect of different treatments on aphid populations at second spray of pesticides in Rampur, Chitwan during November 2017 to March 2018

Treatments	Number of aphids during second spray			
	3 DAS	6 DAS	9 DAS	Mean
Mahashakti @ 2 ml/L	2.5 (1.7) ^c	1.7 (1.4) ^{bc}	6.5 (2.6) ^{bc}	3.5 (1.9) ^c
Spinosad @ 0.5 ml/L	2.5 (1.7) ^b	2.2 (1.6) ^b	4.2 (2.1) ^{cd}	3.0 (1.8) ^c
Neemix @ 5 ml/L	4.2 (2.1) ^b	3.0 (1.8) ^b	7.7 (2.8) ^{ab}	5.0 (2.3) ^b
Liquid manure	1.0 (1.1) ^d	1.0 (1.1) ^c	3.0 (1.8) ^d	1.6 (1.4) ^d
Cypermethrin-10 @ 2 ml/L	0.7 (1.0) ^d	1.0 (1.1) ^c	3.0 (1.7) ^d	1.5 (1.3) ^d
Control	9.5 (3.1) ^a	9.7 (3.1) ^a	10.7 (3.3) ^a	10.0 (3.2) ^a
Grand mean	1.83	1.75	2.44	2.01
SEM	0.20	0.20	0.27	0.13
F-test	**	**	**	**
LSD _{0.05}	0.43	0.44	0.58	0.29
CV %	15.7	16.7	15.9	9.6

Means with same letter in column are not significantly different at $p = 0.05$ by DMRT. *Significant at 5% ($P < 0.05$) and ** Significant at 1% ($P < 0.01$). NS = Non-significant different, SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variance and DAS = Day after spray. [Figure in the parenthesis indicate $\{SQR(x+0.5)\}$ transformation and mean value are placed inside the bracket]

Overall, lower number of aphid populations were recorded in Cypermethrin, which was also not significantly different from liquid manure. Maximum aphid population were recorded in control plot, which was significantly higher than aphids in other treatments.

Aphid populations during third spray of pesticides

Number of aphids were differed significantly at $p < 0.01$ among the treatments at three, six and nine days after spray during third spray of pesticides (Table 3). At three days after spray, significantly lower number of aphids were recorded in Cypermethrin which was statistically similar to liquid manure treated plots than other treatments. At six days after spray, the lowest number of aphids were recorded in Cypermethrin treated plots which was statistically similar to liquid manure treated plots. At nine days after spray, Cypermethrin was significantly similar to Spinosad, at which lower number of aphid populations were recorded in Cypermethrin than

other treatments. Overall, lower number of aphid population were recorded in Cypermethrin, which was also not significantly different with liquid manure. Maximum aphid population were recorded in control plot that was significantly differed with other treatments.

Few number of aphids were seen along with cabbage butterflies during the field experiment in Rampur, Chitwan. Overall, significantly lower number of aphid populations were recorded in Cypermethrin and liquid manure than Mahashakti, Spinosad and *Bacillus thuringiensis* (Bt.) after second and third spray of pesticides. Significantly, the highest number of aphid population was observed in control plots as compared to other treatments. Cypermethrin effects on blood-brain barrier and induces neurotoxicity to the majority of the insects. It is also strong insecticides having anti-feedant properties. Therefore, the aphid population was lowered after spray of Cypermethrin than other bio-pesticides while, similar findings was observed by Gogo et al. (2017) and Younas et al. (2004). Neem-based

Table 3. Effect of different treatments on population of adult aphids at third spray of pesticides in Rampur, Chitwan during November 2017 to March 2018

Treatments	Number of adult aphids during third spray			
	3 DAS	6 DAS	9 DAS	Mean
Mahashakti @ 2 ml/L	4.2 (2.1) ^b	3.0 (1.8) ^b	2.2 (1.5) ^{bc}	3.1 (1.8) ^c
Spinosad @ 0.5 ml/L	3.5 (1.9) ^b	2.7 (1.7) ^b	2.0 (1.5) ^{bc}	2.7 (1.7) ^c
Neemix @ 5 ml/L	4.7 (2.2) ^b	4.2 (2.1) ^b	3.2 (1.9) ^b	4.0 (2.1) ^b
Liquid manure	2.0 (1.5) ^c	1.5 (1.3) ^c	0.7 (1.0) ^d	1.4 (1.3) ^d
Cypermethrin-10 @ 2 ml/L	1.2 (1.2) ^c	1.0 (1.1) ^c	1.0 (1.1) ^d	1.0 (1.2) ^d
Control	8.2 (2.9) ^a	8.5 (2.9) ^a	7.0 (2.7) ^a	7.9 (2.8) ^a
Grand mean	2.04	1.89	1.67	1.86
SEM	0.19	0.20	0.21	0.10
F-test	**	**	**	**
LSD _{0.05}	0.41	0.43	0.46	0.22
CV %	13.5	15.1	18.4	8.0

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

Table 4. Effect of different treatments on aphids attacked plants and leaves in Rampur, Chitwan during November 2017 to March 2018

Treatments	Number of infested plants	Number of attacked leaves
Mahashakti @ 2 ml/L	3.0 ^c	2.2 ^c
Spinosad @ 0.5 ml/L	2.0 ^d	1.2 ^d
Neemix @ 5 ml/L	4.5 ^b	3.7 ^b
Liquid manure	4.0 ^b	3.0 ^{bc}
Cypermethrin-10 @ 2 ml/L	1.2 ^d	1.2 ^d
Control	9.5 ^a	7.2 ^a
Grand mean	4.04	3.12
SEM	0.43	0.45
F-test	**	**
LSD _{0.05}	0.92	0.95
CV %	15.2	20.2

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

products are used to enhance product toxicity resulting in mortality of serious pests of vegetable crops. Due to application of liquid manure with mixture of cow urine, lower number of aphids' population was observed with compare to Mahashakti, Bt. and Spinosad. Similar results was obtained by Bahar et al. (2007) and Gahukar (2013).

Effect of different treatments on plants and leaves of cauliflower

Infested plants and leaves of cauliflower from those randomly selected nine plants in each plot was differed significantly at ($p < 0.01$) among the treatments (Table 4). Significantly, few numbers of plants were infested in Cypermethrin treated crops compared with other pesticides; however, Cypermethrin effect was significantly similar to Spinosad. Considerably lower numbers of damaged leaves were recorded in Cypermethrin treated plots than other treatments that were also not significantly differed from Spinosad.

Less damages of plants and leaves were recorded in Cypermethrin treated plants than other pesticides; however, Cypermethrin effect was significantly similar to Spinosad. However, the

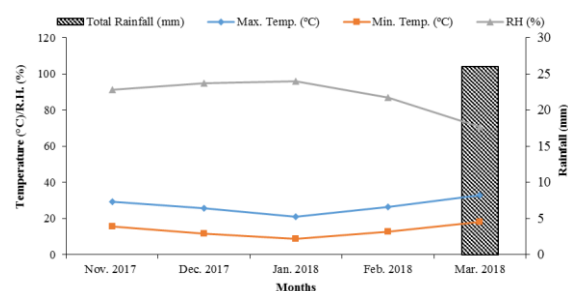


Figure 1. Weather condition during cauliflower growing period from November 2017 to March 2018 in Rampur, Chitwan

highest number of plants and leaves were found in control plots than other treatments. Aphids freely sucks the plant sap mainly winter vegetable crops including Cruciferae (Feltwell, 2012) and cause destruction to their all stages of growth (seedlings, vegetative, curding and flowering). Significantly, lower population of the aphids were recorded in Spinosad and Cypermethrin after second and third spray of pesticides, as a result, the lowest number of damaged plants, leaves, curds and leaf holes were recorded in Cypermethrin and Spinosad treated plots.

Effect of different treatments on curd yield of cauliflower

Curd yield of cauliflower differed significantly at $p < 0.01$ among the treatments (Figure 2). Significantly, higher curd yield of 42.3 mt/ha was recorded in Cypermethrin treated plots followed by Spinosad treated plots than other treatments. Significantly higher curd yield of cauliflower was recorded in Cypermethrin than other treatments, as Cypermethrin was statistically similar to Spinosad. Aphids can cause damage on crop and significantly reduce the yield (Cartea et al. 2009). Kumar et al. (2012) also reported efficiency of the Cypermethrin

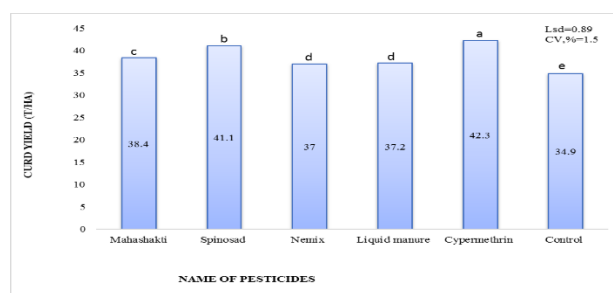


Figure 2. Curd yield of cauliflower against aphids by using different pesticide in Rampur, Chitwan

in vegetable crops. Spinosad one of the very effective treatments to control aphids, resulted highest crop yield as similar result was found by Singh (2015). Significant effectiveness of the Spinosad was also supported by Wanner et al. (2000) and Watson and Salgado (2001).

CONCLUSIONS

Insect pest are the common crop limiting factors of crop production in many vegetable crops. Some insect pest can directly reduce the crop yields, but some can reduce the yield and market quality together. Pesticides are the common and popular pest management tactics in a farming community in Nepal. Higher pest control efficiency, easily accessible and quick knockdown effect are the main cause of pesticide popularity in Nepal. However, these pesticides are harmful to the human health and environment. Among the tested materials, maximum pest reduction efficiency was achieved in Cypermethrin tested field followed by Spinosad. Significantly, maximum curd yield was found in Cypermethrin and Spinosad treated field followed by Liquid manure, Neemix and Mahashakti treated plots. The study suggests that chemical pesticides are more efficient and quick knockdown effect than home-made and bio-pesticides. However these were not sustainable and eco-friendly practices. Therefore, bio-pesticide, like Spinosad and home-made pesticides are suitable pest management tools at small scale before adopting chemical management practices. Safer pesticides such as Cypermethrin in right dose can be suggested to immediate suppression if the pest cross of the threshold level.

ACKNOWLEDGMENTS

This work was supported by the USAID and the Future Innovation Lab for the IPM, through a grant awarded for the "Participatory Biodiversity and Climate Change Assessment for IPM in Nepal (Cooperative Agreement No: AID-DAA-15-00001)". This article is a part of Ph.D. research of Hom Nath Giri. We are thankful to Dr. Rangaswamy Muniappen from Virginia Tech, USA and Prof. N. R. Devkota, former Director of DOREX, AFU, Rampur. We are also thankful to Dr. Sundar Tiwari, Head of Department, Department of Entomology under Faculty of Agriculture, AFU for his assistance during preparation of research plan.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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