ECOFRIENDLY MANAGEMENT OF INSECT PESTS OF CAULIFLOWER (*Brassica oleracea var. botrytis)* VAR. MADHURI IN KAPURKOT, SALYAN

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ABSTRACT

A field experiment was conducted in Kapurkot rural municipality, Salyan from January to June 2020 to identify the safe and effective insecticide against aphid, cutworm and Diamondback Moth in Cauliflower production. Control, Botanical Extract Fermented with Cow Urine, Neemix (Azadirachtin), Spinosad 45% SC and Emamectin benzoate 5% SG are the five treatments of the experiment and each replicated four times in a Randomized Complete Block Design (RCBD). Two insecticides Spinosad (90.61% and 81.00%) and Emamectin benzoate (80.82% and 57.57%)gave highly significant reduction of aphid and DBM respectively followed by Neemix (57.21%and 40.00%) and BEFCU (53.37% and 34.80%). Similarly, Spinosad (80.14%) and Emamectin benzoate (67.30%) were highly effective against cutworm whereas Neemix (41.70%) and BEFCU (33.53%) failed significant control of cutworm population. The maximum curd yield was obtained from Spinosad (22.02 mt/ha) followed by Emamectin benzoate. Neemix and BEFCU gave the least curd yield and were nearly equal effective. The highest benefit-cost ratio was obtained with Spinosad (2.19) followed by Emamectin benzoate (2.06). These were followed by Neemix (1.54) and BEFCU (1.46). Spinosad and Emamectin benzoate were found highly effective against aphid, cutworm and Diamondback Moth to give superior yield as well as less hazardous compared to other treatments, thus could be potential option for management of insect of Cauliflower.

Keywords: Botanical Extract Fermented with Cow Urine (BEFCU), Spinosad, Emamectin Benzoate, Neemix

INTRODUCTION

- Cauliflower, (*Brassica oleracea* L. var. Botrytis, 2n=2x=18) is one of the important and major vegetable crops which has a large production and export potential and in the context of Nepal, it is grown as both seasonal and off-seasonal vegetables.
- It is cultivated in 35,383 hectares of land with an annual production of 5,35,008 mt (MOAD, 2017) and in the Salyan district, it is cultivated in 156 ha of the area with the production of 1,698 mt with a productivity of 11 mt/ha (AKC, Salyan, 2017).
- Cauliflower is attacked by various insect pests. The important insect pests of cauliflower are Diamondback Moth (*Plutella xylostella* L.), Aphids (*Brevicoryne brassicae* L.), Cutworm (*Agrotis ipsilon* L.), Tobacco caterpillar (*Spodoptera litura* L.), Semilooper (*Thysanplusia orichalcea* L.), Cabbage butterfly (*Pieris brassicae nepalensis* L.), etc. (Ministry of Agriculture and Co-operatives, 2012).
- Production of cauliflower is often hindered due to heavy infestation of major insect pests of Cole crops and the application of organic fertilizer is low and that of chemical fertilizer is high, inducing the outbreak of insects and diseases (AKC, 2017).
- Pesticides which are derived from biological agents like plant extracts, seed extracts, cow urine, different viruses, fungus, bacteria, etc. are commonly known as bio-pesticides.
- Bio-pesticides act as a major tool in eco-friendly management of insect pests and also provides nutrients to crop through their easy degradation.

RATIONALE

- The efficacy study aids farmers providing the knowledge about pests and enabled them to apply effective eco-friendly management practices that are less hazardous and economically viable.
- Increase in the productivity as well improve in the quality of the fruits, the income of the farmers can be increased and can better benefit from cauliflower cultivation.

OBJECTIVES

To develop an effective and safe practice for the management of major insect pests of cauliflower in the Mid hills.

HYPOTHESIS

Null Hypothesis (Ho): Effectiveness of different insect pest management practices against major insect pests of cauliflower is same.

Alternate Hypothesis (H1): Effectiveness of different insect pest management practices against major insect pests of cauliflower is different.

MATERIALS AND METHODS

EXPERIMENT LOCATION

- A field experiment was conducted in Kapurkot rural municipality-06, Sinbang, Salyan.
- The district experiences a hot climate with a maximum temperature of 38°C in the hottest month (May-June) and the minimum temperature of around 2°C in the coldest month (January-February).
- It receives an average of 1165 mm of precipitation per annum, of which around 80% occurs from June to August.

Crop	: Cauliflower
Variety	: Madhuri
Spacing	: 50(RR) × 50(PP) cm^2
Fertilizer dose	: 200:180:80 kg NPK/ha + Compost 20 ton/ha
Year	: 2020
Design	: Randomized Complete Block Design (RCBD)
Treatments	: 5
Replications	: 4
Total number of plots	: 20
Spacing between treatments	: 75 cm

EXPERIMENTAL DESIGN

The experiment was conducted in Randomized Complete Block Design (RCBD) in the experimental field with five treatments and four replications of each treatment.

TREATMENT DETAILS

Five treatments against the management of major insect pests (aphid, cut worm, and DBM) of cauliflower which were; control, BEFCU, Neemix, Spinosad, and Emamectin benzoate

Treatment	Common Name	Trade Name	Dose	Type
T1	BEFCU	-	1:5, BEFCU: water	Botanical extracts origin, systemic
T2	Neem oil (300 ppm)	Neemix	3ml/l	Neem plant origin, systemic
T3	Spinosad (45% SC)	Tracer	0.5ml/l	Bacterial origin, Contact, Ingestion, and Neurotoxicity
T4	Emamectin benzoate	Snake venom	0.6gm/l	Soil fungus origin - systemic and Neurotoxicity
T5	Control	-	-	-

DATA ANALYSIS

- Microsoft- Excel for data entry and calculations
- R-Studio for analysis of variance and statistical analysis of field experiment data
- Duncan's Multiple Range Test (DMRT) employed to find out the significant differences between the mean values at 5% level of significance
- Data transformation - SQRT Transformation (SQRT (X + 0.5) for insect counts

RESULTS

Table 1. Effect of different treatments against cauliflower aphid (*Brevicoryne brassicae* L.*)* population per plant after 1st, 2nd, and 3rd spray, Salyan, Nepal, 2020

Treatments	1st Spray			2nd Spray			3rd Spray		
	Pre-treatment	3 DASp	PROC	Pre-treatment	3 DASp	PROC	Pre-treatment	3 DASp	PROC
BEFCU @1:5	4.83	1.99^{b}	46.89%	5.00(2.34)	$2.62(1.76)^{b}$	53.37%	4.82(2.30)	$2.95(1.85)^{b}$	50.11%
Neemix @3ml/liter	4.83	1.95^{b}	47.96%	5.10(2.36)	$2.45(1.71)^{b}$	57.21%	4.95(2.33)	$2.83(1.82)^{b}$	53.51%
Spinosad @ 0.5 ml/liter	4.74	0.58^{d}	84.21%	4.83(2.30)	$0.83(1.15)^{d}$	84.73%	4.02(2.12)	$0.41(0.95)^{d}$	91.61%
Emamectin benzoate@ 0.6 gm/liter	4.93	1.21^{c}	68.55%	4.81(2.29)	$1.16(1.28)^{c}$	78.49%	3.00(1.86)	$0.71(1.09)^{c}$	80.82%
Control	4.97	3.87^{a}		4.00(2.16)	$4.50(2.23)^{a}$		5.10(2.36)	$6.27(2.60)^{a}$	
F-Test (α=0.05)	NS	***		**	***		***	***	
P-Value	0.884	<0.001		0.009	<0.001		<0.001	<0.001	
SEm (±)	-	0.170		0.032	0.033		0.021	0.031	
CV (%)	-	17.70%		2.81%	4.13%		1.98%	3.81%	
LSD-0.05	-	0.52		0.10	0.10		0.06	0.09	
Grand Mean	4.86	1.92		2.29	1.62		2.19	1.66	

PROC: Percentage Reduction Over Control; CV: Coefficient of Variance; DASp: Days After Spray; *, ** and *** represent significant at 5%, 1% and 0.1% level of significance respectively; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance, values with the same letters in a column are not significantly different at 5% and figure in parenthesis indicate $\sqrt{(x+0.5)}$transformation.

Table 2. Effect of different treatments against cutworm (*Agrotis ipsilon* L.*)* population per plant after 1st, 2nd and 3rd spray, Salyan, Nepal, 2020

Treatments	1st Spray			2nd Spray			3rd Spray		
	Pre-treatment	3 DASp	PROC	Pre-treatment	3 DASp	PROC	Pre-treatment	3 DASp	PROC
BEFCU @1:5	0.75	1.12^{b}	38.52%	1.32	1.00^{b}	25.00%	1.80	1.21^{a}	33.53%
Neemix @3ml/liter	0.71	1.00^{b}	42.21%	1.00	0.87^{b}	13.30%	1.98	1.16^{a}	41.70%
Spinosad @ 0.5 ml/liter	0.83	0.41^{c}	79.56%	0.50	0.16^{c}	67.7%	0.20	0.04^{b}	80.14%
Emamectin benzoate@ 0.6 gm/liter	0.66	0.54^{c}	66.87%	0.60	0.20^{c}	66.00%	0.50	0.16^{b}	67.30%
Control	0.66	1.62^{a}		1.60	1.61^{a}		1.61	1.63^{a}	
F-Test (α=0.05)	NS	***		***	***		***	***	
P-Value	0.990	<0.001		<0.001	<0.001		<0.001	<0.001	
SEm (±)	-	0.057		0.093	0.061		0.060	0.145	
CV (%)	-	12.19%		17.76%	16.05%		9.93%	34.58%	
LSD-0.05	-	0.17		0.27	0.19		0.18	0.44	
Grand Mean	0.72	0.94		1.00	0.77		1.21	0.84	

PROC: Percentage Reduction Over Control; CV: Coefficient of Variance; DASp: Days After Spray; *, ** and *** represent significant at 5%, 1% and 0.1% level of significance respectively; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance, values with the same letters in a column are not significantly different at 5% and figure in parenthesis indicate $\sqrt{(x+0.5)}$transformation.

Table 3. Effect of different treatments against DBM (*Plutella xylostella* L.*)* population per plant after 1st, 2nd and 3rd spray, Salyan, Nepal, 2020

Treatments	1st Spray			2nd Spray			3rd Spray		
	Pre-treatment	3 DASp	PROC	Pre-treatment	3 DASp	PROC	Pre-treatment	3 DASp	PROC
BEFCU @1:5	2.04	1.75^{b}	34.90%	1.92	$1.83(1.52)^{b}$	16.73%	2.72	2.45^{b}	21.58%
Neemix @3ml/liter	2.21	1.91^{b}	34.30%	2.00	$1.37(1.36)^{b}$	40.00%	2.65	2.33^{b}	19.36%
Spinosad @ 0.5 ml/liter	1.82	0.45^{d}	81.00%	0.45	$0.24(0.84)^{d}$	51.90%	0.55	0.37^{d}	40.85%
Emamectin benzoate@ 0.6 gm/liter	2.01	1.12^{c}	57.57%	1.12	$0.71(1.03)^{c}$	45.00%	0.85	0.71^{c}	27.62%
Control	2.21	2.92^{a}		2.91	$3.33(1.95)^{a}$		3.33	3.83^{a}	
F-Test (α=0.05)	NS	***		***	***		***	***	
P-Value	0.369	<0.001		<0.001	<0.001		<0.001	<0.001	
SEm (±)	-	0.142		0.053	0.053		0.080	0.104	
CV (%)	-	17.46%		6.34%	8.00%		7.99%	10.58%	
LSD-0.05	-	0.43		0.16	0.16		0.25	0.32	
Grand Mean	2.06	1.63		1.68	1.34		2.02	1.98	

PROC: Percentage Reduction Over Control; CV: Coefficient of Variance; DASp: Days After Spray; *, ** and *** represent significant at 5%, 1% and 0.1% level of significance respectively; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance, values with the same letters in a column are not significantly different at 5% and figure in parenthesis indicate $\sqrt{(x+0.5)}$transformation.

Table 4 . Effect of different treatments on Cauliflower curd yield, curd diameter and curd height, Salyan, Nepal, 2020

Treatments	Yield (mt/ha)	Increase in yield over control	Curd diameter (cm)	Curd height (cm)
BEFCU @1:5	16.04^{bc}	16.57%	14.49^{b}	$12.54(3.60)^{c}$
Neemix @3ml/liter	16.19^{bc}	17.66%	14.17^{b}	$13.30(3.71)^{b}$
Spinosad @ 0.5 ml/liter	22.02^{a}	60.03%	16.10^{a}	$13.97(3.80)^{a}$
Emamectin benzoate@ 0.6 gm/liter	19.29^{ab}	40.19%	14.77^{b}	$13.30(3.71)^{b}$
Control	13.76^{c}		13.37^{c}	$11.02(3.39)^{d}$
F-Test (α=0.05)	**		***	***
P-Value	0.0011		<0.001	<0.001
SEm (±)	1.057		0.230	0.027
CV (%)	12.10%		3.16%	1.49%
LSD-0.05	3.25		0.71	0.08
Grand Mean	17.46		14.58	12.82

CV: Coefficient of Variance; *, ** and *** represent significant at 5%, 1% and 0.1% level of significance respectively; SEm: Standard error of mean; LSD-0.05: Least Significant Difference at 5% level of significance, values with the same letters in a column are not significantly different at 5% and figure in parenthesis indicate $\sqrt{(x+0.5)}$transformation.

Table 5. Benefit-Cost ratio of different treatments for the management of insects on cauliflower, Salyan, Nepal, 2020

Treatments	Curd yield (mt/ha)	Yield Gain over control (mt/ha)	Cost of Production (NRs/ha)	Total Return (NRs/ha)	Benefit-Cost Ratio
BEFCU @1:5	16.04	2.28	1,30,300	3,20,800	1.46
Neemix @3ml/liter	16.19	2.43	1,27,300	3,23,800	1.54
Spinosad @ 0.5 ml/liter	22.02	8.26	1,37,800	4,40,400	2.19
Emamectin benzoate@ 0.6 gm/liter	19.29	5.53	1,26,000	3,85,800	2.06
Control	13.76		1,20,000	2,75,200	1.29

DISCUSSION

Efficacy of different treatments against major insects of cauliflower

Efficacy of different treatments against aphid (*Brevicoryne brassicae* L.)

The results obtained from the experiment for the management of cauliflower aphid in the field condition of Sinbang, Kapurkot, Salyan showed that the two insecticides (Spinosad and Emamectin benzoate) gave highly significant protection of cauliflower from aphids over control in all the three sprays. Spinosad was observed to be superior to other treatments against cauliflower aphid due to maximum reduction of aphid population over control in all the three sprays. Maximum PROC (91.61%) due to Spinosad was obtained three days after the third spray. This effectiveness of Spinosad is supported by Bret (1997).Emamectin benzoate, another promising insecticide was found nearly as effective as Spinosad in reducing the aphid population. Maximum PROC (80.82%) was obtained three day after third spray. Neemix also gave effective performance against aphids but the effectiveness was lower compared to Spinosad and Emamectin benzoate. Least effective performance of neem-based insecticides was also reported by Temurde et al., (1992).BEFCU was found least effective among all the treatments.

Efficacy of different treatments against cutworm *(Agrotis ipsilon* L.*)*

Spinosad and Emamectin benzoate gave highly significant and nearly equal reduction of the cutworm, *Agrotis ipsilon* L. population after all three sprays with maximum effectiveness and consistency. Neemix and BEFCU were nearly as same as in effectiveness in controlling cutworm population after all three sprays. Maximum PROC (80.14%) due to Spinosad was obtained three days after the third spray. This effectiveness of Spinosad against cutworms is supported by Gosselin et al., (2009), where they concluded that Spinosad is a promising tool for controlling black cutworm larvae alone or in combination with other products. Emamectin benzoate, was also found nearly as effective as Spinosad in reducing the cutworm population. Maximum PROC (67.30%) was obtained three day after third spray. Excellent efficacy of Emamectin benzoate at low use rates has been demonstrated against numerous lepidopteran pests in a variety of crops (Jasson & Lecrone, 1991; Jasson & Dybas, 1996).Neemix gave little poor performance compared to other pesticides giving maximum PROC of 42.21%, three days after the first spray of treatments. Poor performance of neem-based pesticides was reported by Temurade et al.,(1992). BEFCU was found least effective to reduce cutworm population three days after the first and third spray and was more effective than Neemix three days after the second spray. Though it was least effective, it gave significant reduction over control.

Efficacy of different treatments against DBM *(Plutella xylostella* L.*)*

Spinosad and Emamectin benzoate gave highly significant protection of DBM over control in all the three sprays. The treatments Neemix and BEFCU also gave significant reduction over DBM population in all sprays and both of them were statistically indifferent in effectiveness. Maximum PROC (81.00%) due to Spinosad was obtained three days after the first spray. This effectiveness of Spinosad against DBM is supported by Muthukumar et al.,(2007) , where they found Spinosad highly effective with a maximum PROC of 76.40% against DBM and highest PROC against cabbage butterfly in their study. Emamectin benzoate also found highly significant to control DBM population next to Spinosad. Maximum reduction of 57.57% was obtained after three days of first spray. The effectiveness of Emamectin benzoate was also reported by Ronald et al., (1997).Neemix, with azadirachtin as its main constituent, was least effective compared to Spinosad and Emamectin benzoate with a maximum PROC of 40% three days after second spray. The results obtained were supported by Laxman et al., (2019)where they recorded up to 63.45% PROC and by Nayak (2013), where they recorded 50.1% to 80.5% PROC of azadirachtin against DBM.BEFCU gave Maximum PROC of 34.90% three days after the first spray and was almost as effective as Neemix to control DBM population. The effectiveness of BEFCU is supported by Thapa et al., (2019).

Effect of different treatments on curd yield, curd diameter and curd height

Statistically, the curd yield obtained from Spinosad and Emamectin benzoate were significantly higher than that of control but the curd yield obtained from Neemix and BEFCU were statistically at par with control treated plots. Maximum curd yield of 22.02 mt/ha was obtained from Spinosad which was 63.03 percent more in curd yield compared to control (13.76 mt/ha) followed by Emamectin benzoate. The higher yields in case of Spinosad and Emamectin Benzoate have also been showed by Gautam (2015) and also by Pareet and Basavanagoud (2012).

Economies of different treatments

The highest benefit-cost ratio was obtained from Spinosad with 2.19 followed by Emamectin benzoate with 2.06 benefit-cost ratio. These were followed by Neemix with 1.54 and BEFCU with 1.46 benefit-cost ratio. Sharma and Tayde(2017) reported lower B:C ratio of Neemix. However, higher B:C ratio were reported when botanicals were used against major sucking pests in vegetables over chemical pesticides (Thapa, et al., 2019).

CONCLUSION

It was observed that the maximum reduction of all the studied pests' (aphids, cutworm and DBM) population over control as well as maximum increase in curd yield was found in Spinosad treated plots in farmers' field condition. Emamectin benzoate was effective next to Spinosad for both pest control and yield increment. Neemix and BEFCU were significant in reducing pest population so can be recommended as effective biological pesticides at higher frequency of application. Spinosad proved to be most cost effective with high B:C ratio followed Emamectin benzoate, Neemix and BEFCU respectively. Pesticides such as Spinosad and Emamectin benzoate were found to give superior yield and control over pests, aphids, cutworms and DBM, thus are recommended to be used for their management.

REFERENCES

Agriculture Knowledge Center. (2017). Statistical Information of agriculture in Salyan. Rukum: Agriculture Knowledge Center.

Ahmada, K., Thapa, R., Thapa, R. B., Regmi , R., & Gautam, B. (2020). Efficacy and profitability of using different IPM (Integrated Pest Management) measure for the control of cauliflower aphids *(Brevicoryne brassicae Linn*) in different genotypes of cauliflower in Chitwan district, Nepal. Sustainability in Food and Agriculture*, 1*(2), 42-49.

Bret, B. (1997). Biological properties of Spinosad. Down to Earth*, 52*, 6-13.

Gautam, B. (2015). Efficacy of Insecticides Against *Pieris brassicae nepalensis* on Cabbage in Chitwan, Nepal. Agriculture and Forestry University.

Jasson, R., & Dybas, R. (1996). Avermectins: biochemical mode of action, biological activity, and agricultural importance. Insecticides with Novel Modes of Action, 152-170.

Jasson, R., & Lecrone, S. (1991). Efficacy of non conventional insecticides for control of diamondback moth, *Plutella xylostella*. Proceedings of the Florida State Horticultural Society, 279-284.

Laxman, G., Sharma, R., & Sinha, S. (2019). Field efficacy of biopesticides against Diamondback Moth and Aphids on Cabbage. Pesticide Research Journal*, 31*(1), 54-59.

Ministry of Agriculture and Co-operatives. (2012). Vegetable Farming Technology. Singhadurbar, Kathmandu, Nepal: Agribusiness Promotion and Statistics Division.

Muthukumar, M., Sharma, R., & Sinha, S. (2007). Field efficacy of biopesticides and new insecticides against major insect pests and their effect on natural enemies in Cauliflower. *Pesticide Research Journal, 19*, 190-196.

Nayak, S. C. (2013). Efficacy of some bio-pesticides against the pests of cabbage at Bhuwaneshwar. Orissa University of Agriculture.

Temurade, A., Deshmukh, S., Nemade, S., & Khiratkar, S. (1992). Efficacy of neemark and its combination with other groups of insecticides against the shoot and fruit borer of Brinjal. Journal of Soils and Crops, 29-31.

Thapa, R. (2003). Pesticide Pollution and Integrated Pest Management. Proceedings of National Seminar on Integrated Pest Management in Nepal, (pp. 25-26).

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