ECOFRIENDLY MANAGEMENT OF CABBAGE APHID, *Brevicoryne brassicae* L. ON CABBAGE IN FARMER'S FIELD, DHADING, NEPAL

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ABSTRACT

Cabbage is important vegetable among crucifers, cabbage aphid (*Brevicoryne brassicae* L.) (Homoptera: Aphididae) on cabbage significantly reduces the yield in terms of quality and quantity. A field experiment was conducted using treatments namely, i) Spinosad @0.25ml/lit, ii) Spinosad @0.5 ml/lit, iii) Spinosad @0.725 ml/lit, iv) Margosom @2.50 ml/lit, v) Margosom @5ml/lit, vi) Margosom @7.5ml/lit, vii) *Beauveria bassiana* @1ml/lit, viii) *Beauveria bassiana* @2ml/lit, ix) *Beauveria bassiana* @3ml/lit and x) control. These treatments were replicated three times in completely randomized block design (RCBD) in the Baireni VDC, Dhading district. On mortality of cabbage aphid, highest average reduction of cabbage aphid population was found on Spinosad @0.725 ml/lit followed by *Beauveria* @3.0 ml/lit. Among three different dose of Spinosad, the highest efficacy on reduction of cabbage aphid was found in Spinosad @0.725 ml/lit (38.37%). Among *Beauveria*, *Beauveria bassiana* @3ml/lit (35.27%) gave the highest reduction of aphid population and among Margosom, Margosom @7.5 ml/lit (33.35%) resulted highest reduction of aphid population. Appearance of natural enemies population on cabbage field was observed the highest decrease in Margosom @7.5 ml/lit (35.08%) and the lowest decrease was found in Spinosad @0.25ml/lit (15.46%) treated plot. Biological and economic yield also differed significantly among the different treatments. Highest biological yield was found in Spinosad @0.725ml/lit and lowest was found in Spinosad @0.25ml/lit treated plot. Highest economic yield was found from *Beauveria* @3ml/lit (49.05 mt/ha) and lowest was from Spinosad @0.25ml/lit (37.97 mt/ha) treated plot. The highest Benefit: Cost ratio was found in *Beauveria* @3ml/lit (2.51) treated plot and the lowest in Spinosad @0.25 ml/lit (1.96) treated plots. Further field and laboratory study will be imperative for improving efficacy of ecofriendly pesticides.

INTRODUCTION

Nepal is landlocked country having agriculture based economy, a major source of livelihood for the 65.6% of the population of Nepal (National Population Census, 2011). Contribution of Agriculture and forestry to the national GDP is 28.79% (Agriculture Diary, 2016). On season and off season vegetable cultivation is emerging enterprise in nearby areas of large cities.

Vegetable cultivation contributes 9.71 % to the agriculture gross domestic product. Vegetable crops like the *Brassica*, tomato, eggplant, okra, *Capsicum*, garlic and onion are grown in several parts of the Nepal (MoAD, 2014). Recommended amount of daily consumption is higher i.e. 300 gm/person/day (AVRDC, 2000). The major factors responsible for expansion of fresh vegetable cultivation areas in and around the periphery of urban areas of the country are road accessibility, irrigation facility and good market prospect (Giri, Mainali, Aryal, Paneru, Bista, & Maharjan, 2004).

Cruciferae is the most important vegetable in Nepalese diet and play an important role in the economy of the farmers (Timila, Joshi, Khadgi, Baidhya, & Neupane 2007). The crucifer crops (*Brassica spp.*) also known as cole crops and consists of cabbage, cauliflower, broccoli, radish, turnip, carrot, brussels sprouts etc. which are of high economic and dietary value. These crops are mainly grown during winter season in the terai region and as off-season crop in hilly region of the country. Among the high yield rate vegetable cabbage also lies with the yield rate of 21,115 kg/ha along with ash gourd, yam and squash (CBS, 2010). Total vegetable production area of Nepal is 266937 ha with 3580085 mt production (Agriculture Diary, 2016). A national survey on vegetable by Central Bureau of Statistics has identified 55 types of vegetable grown for consumption (CBS, 2010). In Dhading district vegetable is cultivated in 5925 ha area and production is 75458 mt. In the district, cabbage is cultivated in 565 ha area and production was 8249 mt and productivity of 15 mt/ha which is lower than the national average (MoAD, 2014).

Insect pest problems are abundant in cruciferous crops. Many types of insect pests like Cabbage Butterfly (*Pieris brassicae nepalensis* Doubleday), Diamond Back Moth (*Plutella xylostella* L.), Tobacco caterpillar (*Spodoptera litura* Fab.), Mustard aphid (Lipaphis *erysimi* Kalt) and Cabbage Aphid (*Brevicoryne brassicae* L.) attack these vegetable crops. Among them, Cabbage Aphid, *B. brassicae* L. is regarded as the most important pest of cabbage. Both nymph and adult aphids suck the cell sap from leaves, stems, cords and inflorescences which results in the deformed curly leaves, reduced fruit quality, unfilled pods, unhealthy seed (NARC, 2004). The Cabbage Aphid, (*Brevicoryne brassicae* L.) (Homoptera: Aphididae) reduces significantly the yield of cruciferous crop and also reduces its market values (Costello & Altieri, 1995). The ongoing control and management of aphids in cruciferous crop fields is based mainly on insecticides (Nunnenmacher and Goldbach, 1996). According to the report of Smith (1989), the trend of application of more insecticides in cabbage, lettuce and carrot has been growing in current time compared with other vegetables such as onions, peas, beans and leeks. The use of insecticides on vegetable crops has caused increasing concern among the growers, markets and consumers (Ellis, Oakley, Parker, & Raw, 1999).

2. MATERIALS AND METHODS

The experimental trial was carried out at the farmer's field of Dhading district. Which is located 30 minute moving up hill by foot from the Prithwi Highway from Galchhi of Baireni VDC.

Geographically Dhading district spreads from 27'40" E to 28'17" E and 80'17"N to 84'35"N and lies in mid hill region of central development region of Nepal. This trial was started from October 2015 to April 2016. Before the field experiment soil test was done at Central Soil Testing Laboratory, Harihar Bhawan, Lalitpur for analysis of NPK, PH and soil organic matter (SOM) content. An experimental setup was made on Randomized Complete Block Design (RCBD) comprising of ten treatments with three replications. Individual plot size comprised of 1.6m X 2m (3.2 m^2), row to row spacing of 40 cm and plant to plant spacing 40cm. After 35 days seedlings were transplanted on 10^{th} December. Seedlings were transplanted after application of fertilizer @ 12:9:4 NPK Kg/Ropani and FYM 1 mt/Ropani and remaining 6 Kg/ropani of Nitrogen was applied during two top dressings. On insect pest population aphid mortality yield was observed on selected plant.

Percentage population reduction over control (PROC) was calculated by using the modified Abbots formula given by Flemming and Retnakaran (1985) as follows:

Where,

PROC = The percentage of population reduction over control

Ta = Population in treatment after spray,

Tb = Population in treatment before spray,

Ca = Population in control after spray,

Cb = Population in control before spray.

Yield comparison between different treatments was done by using the increase in yield over control as follows.

Increase in yield over control (%) = [(T-C)/C] ×100

Where,

T = yield from treatment plot, and

C = yield from control plot

The data of insects were statistically analyzed by converting them into $(x+0.5)^{1/2}$ for field experiment as suggested by Gomez and Gomez (1984). Statistical analysis was done with statistical analysis was done by using R studio package. Means were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

3. RESULTS AND DISCUSSION

Spinosad is more toxic to DBM larvae with the increase in pesticide concentration. It acts as both contact and stomach poison, five to ten times greater mortality of DBM larvae than contact action (Bret *et al.*, 1997) but it is less efficient for sucking pests. Spinosad have found 43.14% control on cabbage aphid population on average with its highest dose i.e. @0.725ml/lit but a research from Pakistan in cauliflower, Spinosad was found less effective for aphid *Myzus persicae* (Sulzer), i.e. with only 15% reduction of aphid population (Akbar, Rana, & Perveen, 2014). Mortality of aphid was found different by using @0.25ml/lit and @0.5ml/lit dose of Spinosad was found 24.55% and 28.39% respectively on average reduction of aphid population over control. But in case of sucking pest, cotton aphid *Aphis gossipii* (Glover) even with the use of 45ml a.i/ha was found 41.03% control of cotton aphid over control (Shivanna, Gangadhara Naik, Nagaraja, Basavaraja, Kalleswara Swamy, and Karegowda, 2011) (Figure 1).

Samaneh, Seyed, and Yobert (2014) observed aphid mortality in laboratory for 14 days after treatment of *Beauveria bassiana* and found 54% at low concentration to 83% at the highest concentration. But here in farmers field condition there was only 4.02% to 32.97% reduction with the lowest dose @1ml/lit and 11.30% to 46.63% with the highest dose @3ml/lit during different spray periods. Similar result was found in *L. erysimi* by Rijal *et al.*, (2008), where highest reduction of aphid population ranges from 40.80% to 51.60%. The mortality in infected aphids with fungal isolate increased with increase in spore concentration of conidial suspensions and exposure time. Hence, the susceptibility of target insect to fungal infection is dose dependent (Liu *et al.*, 2002; Wright *et al.*, 2005). Maryam and Shirvani (2013) found that the certain strains of *Beauveria bassiana* were potentially effective for the IPM program for the control of *Aphis gossipii* (Glover) (Figure 2).

Population reduction of cabbage aphid was 29.00% to 37.55% on average with the use of lowest dose and highest dose, but it ranges from 3.73% to 49.08% control over control. But Rijal *et al.*, (2008), found the mortality of aphid ranging from 33.70% to 56.90% with the use of 2ml/lit Margosom. Kafle (2015) found that efficacy of Margosom @5ml/lit on reduction of Mustard aphid (*Lipaphis erysimi* Kalt.) was 38-64%. Efficacy of Margosom was found lower in case of cabbage aphid than that of mustard aphid. Locally extracted Neem pesticide was found control on aphid population up to 53.58% Abed and Simon, 2015.

The result from the field experiment in Dhading district reveals that all the treatments are useful for the aphid control but it depends on the concentration of the pesticide use. Among the tested treatments there is highest mortality of cabbage aphid was found in higher concentration of ecofriendly pesticides showed significant decrease in aphid population than their respective lower concentrations. However, it is important that adequate concentration of eco-friendly pesticide use is better for aphid population management with the least effect on its natural enemies. All the eco-friendly pesticides need favorable climatic condition for higher mortality and reduction of cabbage aphids but it was quite lower in field than in laboratory and green house conditions (Feng, Pu, Ying, & Wang, 2004) (Figure 3).

Figure 1. Variation of average aphid population before first spray and after first spray, Dhading, 2015/016

Figure 2. Variation on aphid population after second spray in Dhading, 2015/016

Figure 3. Variation on aphid population after third spray in Dhading, 2015/016

Among the various treatments tested, highest 54.47 mt/ha and 43.60 mt/ha with the use of Botanical and microbial pesticide was obtained as reported by Stoleru, Munteanu, Stoleru, and Rotaru, (2012). Here the yield was also found higher with the use of higher dose of pesticide but considering on the B:C ratio, effect on natural enemies and major pest recommendation on use of botanical and bio pesticide may be different than the treatment with highest yield. There were lower cost of cultivation and higher economic benefit (3.24 B:C ratio) in central region hills as reported vegetable crops survey 2009/10, but due to the increase in cost of cultivation of cabbage here B:C ratio in quite lower ranging from 1.81-2.51. Even there was higher production ranging from 3234-49.05 mt/ha than national average (21.12 mt/ha) B:C ratio was found lower (CBS, 2010). *Beauveria* @3ml/lit has got highest B:C ratio than any other treatment which may be the ecofriendly option for the cabbage aphid management (Table 1).

Table 1. Effect treatments on benefit cost ratio in cabbage production, Dhading, 2015/016

Treatments	Head weight (mt/ha)	Increase in yield over control (%)	Total return (Rs/ha)*	Cost of cultivation (Rs/ha)	Net profit (Rs/ha)	Benefit cost ratio (B:C)
Spinosad @ 0.25 ml/lit	37.97	17.42	379706.1	193888.9	185817.2	1.96
Spinosad @ 0.50 ml/lit	43.77	35.35	437725	194666.7	243058.3	2.25
Spinosad @ 0.725ml/lit	46.30	43.17	462960.4	195444.4	267516	2.37
Margosom @ 2.5 ml/lit	38.51	19.08	385063.1	194333.3	190729.7	1.98
Margosom @ 5 ml/lit	41.21	27.44	402100	195555.6	206544.4	2.06
Margosom @ 7 ml/lit	48.14	48.82	481422.9	196777.8	284645.1	2.45
Beauveria @ 1 ml/lit	40.97	26.70	409694.2	194000	215694.2	2.11
Beauveria @ 2 ml/lit	46.83	44.82	468293.1	194888.9	273404.2	2.40
Beauveria @ 3 ml/lit	49.05	51.68	490489.6	195777.8	294711.8	2.51
Control	32.34	0	323350	179111.1	144238.9	1.81

*Selling price in Nepalese rupees of cabbage head at farm gate was NRs. 10 per Kg in Dhading, April, 2016.

4. Conclusion

On reduction of cabbage aphid population with the use of Spinosad @0.725 ml/lit is at par with Margosom @7.5ml/lit and *Beauveria* @3ml/lit. Regarding on mortality of cabbage aphid, highest efficacy was found on Spinosad @0.725ml/lit treated plot among all treatments. Reduction on appearance of natural enemies found highest on Margosom @7.5ml/lit treated plot. Economic yield was obtained highest on *Beauveria* @3ml/lit treated plot and also highest B:C ratio was obtained from *Beauveria* @3ml/lit treated plot among all the treatments.

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