Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(3): 1110-1115
© 2020 JEZS
Received: 16-03-2020
Accepted: 18-04-2020

Saayan Samanta
Ph.D. Research Scholar, Department of Agricultural Entomology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Rana Sen
Ph.D. Research Scholar, Department of Agricultural Entomology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Arunava Samanta
Associate Professor, Department of Agricultural Entomology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Corresponding Author:
Saayan Samanta
Ph.D. Research Scholar, Department of Agricultural Entomology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Bioefficacy of some bio-pesticides against major insect pests of cabbage

Saayan Samanta, Rana Sen and Arunava Samanta

Abstract
The experiment was conducted at Instructional farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, WB, during rabi season of 2017-18 for the management of major insect pests of cabbage. Pooled data of three applications of eight different insecticidal treatments *viz.*, Derisom (Karanjin 2%EC), Anosom (Annonin 1% EC), Margosom(Azadirachtin 0.15% EC), Lipel (*Bacillus thuringiensis var.* kurstaki), Biosar (*Verticillium lecanii*), Biocere (*Beauveria Bassiana*), Mahamaya (Novaluron@ 10% EC), Tracer (Spinosad 45% SC) and a natural control plot against DBM, shows that Novaluron @ 10% EC was most effective in reducing the larval population of DBM (67.9%) followed by Tracer @ 45% SC (54.5%) and *Bt. kurstaki* (53.3%). In case of aphid, Margosom @ 0.15% was best in reducing the population (72.9%) followed by *Verticillium lecani* (51.07%). The highest yield was recorded in the plot treated with novaluron i.e 416.67 q/ha as compare to the untreated plot produce 193.4q/ha cabbage.

Keywords: Cabbage, bio-efficacy, bio-pesticides, DBM, aphid

1. Introduction

Cabbage, *Brassica oleracea var capitata* is an important cruciferous vegetable crop, grown over an area of 407 thousand hectors with an annual production of 89.71 million tons in India [4]. West Bengal is the leading producer in India with a production of 22.71 million tons over an area of 79.13 thousand ha, which is 25% of total production of India [4]. It is not rich in nutrients but based on the volume consumed, it contributes a lot to the daily nutrient requirements of an average adult. Cabbage leaves are low in calories (27%), fat (0.1%) and carbohydrates (4.6%). It is good sources of protein (1.3%) which contains all essential amino acids, particularly sulphur containing amino acids. Cabbage is an excellent source of minerals such as calcium (39 mg), iron (0.8 mg), magnesium (10 mg), sodium (14.1 mg), potassium (114 mg) and phosphorus (44 mg). It has substantial amounts of β carotene pro-vitamin A), ascorbic acid, riboflavin, niacin and thiamine. Ascorbic acid content varies from 30-65 mg per 100 g fresh weight.

Cabbage is very popular in West Bengal and grown almost everywhere because of the favourable agro-climatic condition. However, one of the major constraints in the successful cultivation of cabbage is the pest menace. A wide range of arthropod pests feed on cabbage. They are Hemiptera (Cabbage aphid and bagrada bugs); Lepidoptera (moth, semi-looper and bollworms); Coleoptera (flea beetles) and many other pests that are not yet considered as serious pest. Among these insect pests DBM, Cabbage aphid and Head borer are most damaging [3, 6]. Farmers apply chemical insecticides repeatedly and rapidly to control insect pests, but this indiscriminate use leads to the development of resistance to most of the frequently used chemical, failure of proper control, affect non-target beneficial organisms, inflicts complex problems of biomagnifications and bio-accumulation and leave behind harmful residues in the environment and food chain.

Keeping the above point in view, present investigation was carried out to evaluate the bio efficacy of some bio-pesticides against DBM and aphid under field condition.

2. Materials and Methods

2.1 Treatments imposed

Nine treatments *viz.*, Derisom (Karanjin 2%EC), Anosom (Annonin 1% EC), Margosom (Azadirachtin 0.15% EC), Lipel (*Bacillus thuringiensis var.* kurstaki), Biosar (*Verticillium lecanii*), Biocere (*Beauveria Bassiana*), Mahamaya (Novaluron@ 10% EC), Tracer (Spinosad 45% SC) and untreated plot were imposed in all 3 replications randomly.

Total 27 plots of 3m x 2m size were sown with variety of cabbage, Green ball and spacing of 45 cm x 15 cm between rows and plants were maintained respectively. The experiment was laid out in Randomized block design with 9 treatments that were replicated thrice. The crop was raised under irrigated condition. All the recommended agronomic practices i.e., fertilizer application, intercultural operation, proper irrigation and weeding operations were practiced thoroughly.

2.2 Method of recording observation

When the population of insect pests was above the economic threshold level, the first application was given on 15th January, 2018. Similarly the second and third was given on 15 days interval i.e., on 1st February and 16th February, 2018 respectively. To evaluate the efficacy of different bio-pesticides, observations of DBM larvae and aphid were recorded from randomly selected five plants from each treatment before 24 hours and 3, 7, and 10 days after application. In case of DBM, larval population was counted per plant and in case of aphid; the population was counted with the help of hand lens per sq. inch of leaf.

3. Results and Discussion

Besides DBM and aphid, cabbage head borer (*Hellula undalis*) is a major pest of cabbage and need a huge monitory support for management [6, 10]. It did not cause any significant damage during the experiment as no such population was found. Therefore, the efficacy of above insecticides had been tested on the basis of mean pest population and their percentage reduction over control. Besides, the yield was also recorded to find out the influence of these insecticides on the yield of cabbage.

3.1 Efficacy of insecticides against DBM

3.1.1 First spray

It can be seen from (Table-1) that the pretreatment count of DBM larvae/plant before lst spray varied between 2.22-6.05. After first spray lowest mean population of DBM (2.2 dbm larvae /plant) was observed in Novaluron treated plots followed by Anosom (2.86 dbm larvae /plant) and tracer (2.93 dbm larvae /plant) respectively. Among the microbial pesticides, *Beauveria bassiana* and *B.t. var kurstaki* were effective with mean population of 2.92 and 2.72, dbm larvae /plant respectively. Whereas in untreated plot it was 5.87 larvae/plant. Highest percentage reduction of DBM population over control was also recorded in Novaluron treated plots (62.52%) followed by Anosom (51.27%) and tracer (50.08%). Among the microbials, *Bacillus thuringiensis* var *Kurstaki* (53.66%) and *Beauveria bassiana* (50.25) were effective in reducing the DBM population but these were superior over control. Derisom (14.65) and *V. lecani* (4.87) were not effective in reducing the DBM population.

3.1.2 Second spray

During second spray, pretreatment count of DBM larvae varied from 5.68-7. Results revealed that (Table-1) Novaluron recorded minimum population of DBM larvae (2.4 dbm larvae /plant) followed by Tracer (3.55 dbm larvae /plant) and Anosom (3.8 dbm larvae /plant). Margosom and Derisom were at par with 6.26 and 6.5 dbm larvae /plant. Among microbials, *Bacillus thuringiensis var Kurstaki* and *Beauveria bassiana were* most effective with the population of 3.7 and 3.8 dbm larvae/plant respectively. *Verticillium lecani* was less effective in reducing DBM population but were superior over control. Similar trend was observed in percent reduction of DBM population over control as in first spray. Highest percentage reduction of DBM population over control was also recorded in novaluron treated plots (69.07%) followed by tracer (54.25%) and anosom (51.03%). Among the microbials, *Bacillus thuringiensis var Kurstaki* (52.31%) and *Beauveria bassiana (*51.03%) were effective in reducing the DBM population but these were superior over control. Derisom (16.23%) and *V. lecani* (8.5%) were not effective in reducing the DBM population.

3.1.2 Third spray

During third spray (Table-1), pretreatment count of DBM larvae varied from 4.72 – 8.2/plant. Lowest mean population of DBM (2.44 dbm larvae/plant) was observed in Novaluron treated plots followed by tracer (3.52 dbm larvae/plant) and Anosom (3.57 dbm larvae/plant), respectively. Margosom and Derisom were *at par* with 6.74 and 6.89 dbm larvae /plant. Among microbials, *Bacillus thuringiensis var Kurstaki* and *Beauveria bassiana were* most effective with the population of 3.96 dbm larvae/plant each. *Verticillium lecani* was less effective in reducing DBM population but were superior over control. Similar trend was observed in per cent reduction of whitefly population over control as in first spray. Highest percentage reduction of DBM population over control was also recorded in Novaluron treated plots (72.09%) followed by tracer (59.06%) and anosom (58.48%). Among the microbials, *Bacillus thuringiensis var Kurstaki* (53.95%) and *Beauveria bassiana (*53.95%) were effective in reducing the DBM population but these were superior over control. Derisom (19.88%) and *V. lecani* (10.8%) were not effective in reducing the DBM population.

After all three consecutive sprays it was revealed that (Table-2) Novaluron provided best control with lowest mean population of DBM (2.34 DBM larvae/plant) followed by tracer (3.33 DBM larvae/plant) and Anosom (3.41 DBM larvae/plant). The study of [1, 8] reveals that novaluron is best in reducing the population and also increasing the yield. But the findings of [2, 7] said that the maximum reduction of DBM larval population was observed in Spinosad (58.82%). Among the microbials, *B. bassiana* and *B.t.* were effective in reducing population of 3.56 and 3.46 DBM larvae/plant, respectively. Highest percentage reduction of DBM population over control was also recorded in novaluron treated plots (67.9%) followed by tracer (54.5%) and lipel (53.3%). From the Table we can further reveal that the descending order of toxicity is as follows- Novaluron(67.9%) > Tracer (54.5%)> Lipel (53.3) > anosom (52.4%) > *Beauveria bassiana* (51.7%) > Margosom (20.9%) > Derisom (16.89%) > *Verticillium lecani* (8.1%).

3.2 Efficacy of insecticides against aphid

3.2.1 First spray

There was significant difference of aphid population among the treatments before spraying (Table-3). During first spray, pretreatment count of aphid was varies from 16.5-47.1/leaf. Margosom recorded lowest mean population (9.03 aphids/ leaf) followed by *V. lecanii* (14.2 aphids/15 leaves) and Derisom (14.67 aphids/leaf) per treated plots. Next best insecticide was Tracer (18.38 aphids/leaf). Novaluron and Lipel were at par with the mean population of 21.8 and 21.76, respectively. *B. bassiana* and Anosom were less than others in reducing aphids' population but were superior over untreated control plots. In untreated plots the population were

21.3aphids/leaf. Highest percentage reduction over control was also found in Margosom (68.5%) treated plots followed by *V. lecanii* (50.5%) and Deisom (48.9%) treated plots.

3.2.2 Second spray

During second spray (Table-3) pretreatment count of aphid varied from 24.6-37.5/leaf. After spray, Margosom again provided best control with lowest mean population of 11.23aphids/leaf followed by *V. lecanii* and Derisom, 20.4aphids/leaf, each per treated plots. Next best insecticide was tracer (25.78aphids/leaf). Novaluron and Lipel was at par with the mean population of 30.8 and 32.8 aphids/leaf, respectively. *B. bassiana* and Anosom were less than others in reducing aphids' population but were superior over untreated control plots. In untreated plots, it was 37.5 aphids/leaf. Highest percentage reduction over control was also found in Margosom (72.75%) treated plots followed by *V. lecanii* (50.49%) and Deisom (50.4%) treated plots.

3.2.3 Third spray

During third spray (Table-3), pretreatment count of aphid was varies from 19.26 – 47.48/leaf. After spray, Margosom again provided best control with lowest mean population of 11.8 aphids/ leaf followed by Derisom (24.52 aphids/leaf) and *V. lecanii* 25.06 aphids/leaf, each per treated plots. Next best insecticide was Tracer (30.32 aphids/leaf). Novaluron and Lipel were at par with the mean population of 30.8 and 21.76, respectively. *B. bassiana* and Anosom were less than others in reducing aphids' population but were superior over untreated control plots. In untreated plots it was 47.48 aphids/leaf. Highest percentage reduction over control was also found in Margosom (77.47%) treated plots followed by Deisom (53.27%) and *V. lecanii* (52.23%) treated plots.

After all three consecutive sprays (Table-4), treatment Margosom recorded lowest mean population of aphid (10.68 aphids/ leaf) followed by Derisom (19.86 aphids/ leaf) and *V. lecanii* (19.88 aphids/ leaf). The excellence performance of Neem in the present findings for the management of Cabbage aphid were similar with the findings of [5, 9]. Here also, highest percentage reduction of aphid occurred in margosom treated plots (72.9%) followed by *V. lecanii* (51.07%) and Derisom (50.85%). Annonin, *B.t.*, *B. bassiana*, Novaluron and Tracer were not effective in reducing population but were superior over untreated control plots. But the study of G. P. Singh Yadav *et al*. (2017) [11] says that spinosad is best in reducing the pest population. From the Table we can further reveal that the descending order of toxicity is as follows- Margosom (72.9%) > *Verticillium lecani* (51.07%) > Derisom (50.85) > Tracer (37.19%) > *Novaluron* (25.44%) > Lipel (20.93%) > Anosom (19.94%) > *Beauveria bassiana*(16.4%).

3. Results and Discussion

Table 1: Effects of all three sprays of insecticides on incidence of DBM in Cabbage at Jaguli farm, BCKV during experiment (2017-18)

Treatments	Dose (ml/L) Or (gm/L)	PCB 1st spray	Popl^n of DBM on diff. DAS			Mean popl^n of 1st spray	% ROC	PCB 2nd spray	Popl^n of DBM on diff. DAS			Mean popl^n of 2nd spray	% ROC	PCB 3rd spray	Popl^n of DBM on diff. DAS			Mean popl^n of 3rd spray	% ROC
			3DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS		
Derisome @2%EC	2 ml/l	2.22 (1.65)	4.3 (2.19)	5.23 (2.39)	5.5 (2.49)	5.01	14.65	6.07 (2.55)	6.2 (2.58)	6.5 (2.64)	6.82 (2.7)	6.5	16.23	6.73 (2.69)	6.6 (2.66)	6.83 (2.70)	7.3 (2.82)	6.89	19.88
Anosom @1%EC	2 ml/l	3.93 (2.1)	2.4 (1.56)	2.8 (1.81)	3.4 (1.97)	2.86	51.27	6.1 (2.56)	3.6 (2.02)	3.8 (2.07)	4 (2.12)	3.8	51.03	4.72 (2.28)	3.24 (1.93)	3.62 (2.02)	4.02 (2.12)	3.57	58.48
Margosom @0.15% EC	2 ml/l	4.95 (2.33)	4.26 (2.18)	4.11 (2.14)	5.44 (2.43)	4.6	21.63	5.68 (2.48)	5.9 (2.53)	6.3 (2.6)	6.61 (2.66)	6.26	19.32	6.94 (2.73)	6.23 (2.59)	6.8 (2.7)	7.2 (2.77)	6.74	21.62
Lipel (*B.t.*)	2 ml/l	3.53 (2)	2.38 (1.69)	2.8 (1.81)	3 (1.87)	2.72	53.66	6 (2.54)	3.25 (1.93)	3.8 (2.07)	4.05 (2.13)	3.7	52.31	5.28 (2.40)	3.34 (1.95)	3.9 (2.12)	4.56 (2.24)	3.96	53.95
Biosar (V. lecanii)	5gm/l	5.04 (2.35)	4.24 (2.17)	6.01 (2.55)	6.35 (2.61)	5.53	4.87	6.8 (2.7)	6.95 (2.72)	7.1 (2.75)	7.45 (2.81)	7.15	8.5	7.56 (2.84)	7.4 (2.81)	7.62 (2.84)	8 (2.92)	7.67	10.8
Biocere (B.bassiana)	5gm/l	4.57 (2.25)	2.75 (1.80)	2.9 (1.84)	3.12 (1.90)	2.92	50.25	6.42 (2.63)	3.5 (2)	3.72 (2.05)	4.2 (2.16)	3.8	51.03	5.8 (2.50)	3.2 (1.92)	3.8 (2.07)	4.56 (2.24)	3.96	53.95
Novaluron @10% EC	1.8ml/l	5.44 (2.43)	1.9 (1.54)	2.2 (1.64)	2.5 (1.73)	2.2	62.52	5.75 (2.5)	2 (1.58)	2.4 (1.70)	2.8 (1.81)	2.4	69.07	5.6 (2.46)	2.16 (1.63)	2.5 (1.73)	2.81 (1.82)	2.44	72.09
Spinosad	1ml/l	6.05 (2.56)	2.6 (1.76)	2.9 (1.84)	3.3 (1.94)	2.93	50.08	5.95 (2.53)	3.12 (1.9)	3.54 (2)	4 (2.12)	3.55	54.25	5 (2.34)	3.28 (1.94)	3.5 (2)	3.8 (2.07)	3.52	59.06
Untreated		4 (2.12)	4.76 (2.29)	6 (2.56)	6.8 (2.7)	5.87		7 (2.73)	7.2 (2.77)	7.64 (2.85)	8.16 (2.94)	7.76		8.2 (2.95)	8.42 (2.98)	8.8 (3.04)	9.2 (3.11)	8.6	
SE.m±		0.023	0.084	0.082	0.053			0.040	0.032	0.042	0.034			0.033	0.031	0.023	0.021		
CD		0.071	0.254	0.247	0.161			0.120						0.099	0.092	0.071	0.065		

PCB= Pretreatment count before, ROC= Reduction over control, Popl^n= Population, diff. = different
Figures in the parenthesis are square root transformed values, NS= Non significant.

Table 2: Mean of all insecticidal spray on incidence of DBM in Cabbage at Jaguli farm, BCKV during experiment (2017-18)

Treatment	Dose (ml/L or gm/L)	No. of DBM after each spray			Mean of three spray	% reduction over control at different spray			Overall reduction over control after all spray
		1ST	2ND	3RD		1ST	2ND	3RD	
Derisom @2% EC	2 ml/l	5.01	6.5	6.89	6.13	14.56	16.23	19.88	16.89
Anosom @1%EC	2 ml/l	2.86	3.8	3.57	3.41	51.27	51.03	54.88	52.4
Margosom @0.15% EC	2 ml/l	4.6	6.2	6.74	5.84	21.63	19.32	21.62	20.9
Lipel (*B.t.*)	2gm/l	2.72	3.7	3.96	3.46	53.66	52.31	53.95	53.3
Biosar (*V. lecanii*)	5gm/l	5.53	7.15	7.67	6.78	4.87	8.5	10.8	8.1
Biocere (*B. bassiana*)	5gm/l	2.92	3.8	3.96	3.56	50.25	51.03	53.95	51.7
Novaluron@10% EC	0.3 ml/l	2.2	2.4	2.44	2.34	62.52	69.07	72.09	67.9
Tracer @45% SC	1 ml/l	2.93	3.55	3.52	3.33	50.08	54.25	59.06	54.5
Natural control		5.87	7.76	8.6	7.41				

Table 3: Effects of all three sprays of insecticides on incidence of Aphid in Cabbage at Jaguli farm, BCKV during experiment (2017-18)

Treatments	Dose (ml/L) Or (gm/L)	PCB 1st spray	Popl^{n} of aphid on diff. DAS			Mean popl^{n} of 1st spray	% ROC	PCB 2nd spray	Popl^{n} of aphid on diff. DAS			Mean popl^{n} of 2nd spray	% ROC	PCB 3rd spray	Popl^{n} of aphid on diff. DAS			Mean popl^{n} of 3rd spray	% ROC
			3DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS		
Derisome @2%EC	2 ml/l	22.3 (4.77)	12 (3.54)	14.5 (3.87)	17.47 (4.24)	14.67	48.9	24.6 (5.01)	15.56 (4.01)	20.4 (4.57)	25.3	20.4	50.4	28.2 (5.36)	20.49 (4.58)	24.6 (5.01)	28.46 (5.38)	24.52	53.27
Anosom @1%EC	2 ml/l	17.16 (4.2)	20.6 (4.59)	23.16 (4.86)	25.5 (5.1)	23.12	19.46	29 (5.43)	30.46 (5.56)	33 (5.79)	35.7 (6.02)	33.06	19.8	32.1 (5.71)	37.66 (6.18)	44 (6.67)	43.3 (6.62)	41.67	20.58
Margosom @0.15% EC	2 ml/l	31.3 (5.64)	6.58 (2.66)	8.26 (2.96)	12.26 (3.57)	9.03	68.5	35.13 (5.97)	8.69 (3.03)	10.66 (3.34)	14.33 (3.85)	11.23	72.75	19.26 (4.45)	8.26 (2.96)	11.6 (3.48)	15.56 (4.01)	11.8	77.47
Lipel (*B.t.*)	2 ml/l	16.5 (4.12)	18.76 (4.39)	21.5 (4.69)	25 (5.05)	21.76	24.18	29.7 (5.49)	31.68 (5.67)	31.83 (5.69)	34.96 (5.95)	32.8	20.4	39.6 (6.33)	42 (6.52)	41.4 (6.47)	45.3 (6.77)	42.9	18.21
Biosar (V. lecanii)	5gm/l	47.1 (6.9)	12 (3.54)	14.2 (3.83)	16.37 (4.11)	14.2	50.5	31 (5.61)	16.4 (4.11)	20.2 (4.55)	24.6 (5.01)	20.4	50.49	29.16 (5.45)	21.46 (4.69)	25.5 (5.1)	28.23 (5.36)	25.06	52.23
Biocere (B.bassiana)	5gm/l	19 (4.42)	20.5 (4.58)	22.7 (4.28)	26.5 (5.2)	23.25	19	29.5 (5.48)	32.86 (5.78)	35.6 (6.01)	38.5 (6.24)	35.66	13.5	39.8 (6.35)	43.1 (6.6)	43.2 (6.61)	45.56 (6.79)	43.95	16.24
Novaluron @10% EC	1.8ml/l	18 (4.3)	18.07 (4.31)	21.26 (4.66)	26.06 (5.15)	21.8	24.07	27.8 (5.32)	26.8 (5.22)	31.16 (5.63)	34.4 (5.91)	30.8	25.3	37.9 (6.2)	34 (5.87)	39.2 (6.3)	41.7 (6.5)	38.3	26.97
Spinosad	1ml/l	24.7 (5.02)	15 (3.94)	18 (4.3)	22.13 (4.76)	18.38	35.95	31.13 (5.62)	22.26 (4.77)	25.9 (5.08)	29.15 (5.45)	25.78	37.47	31.28 (5.64)	27 (5.24)	33.16 (5.8)	37.16 (6.14)	30.32	38.17
Untreated		21.3 (4.67)	25.6 (5.11)	28 (5.34)	32.3	28.7		37.5 (6.16)	39.26 (6.31)	40.8 (6.43)	43.6 (6.64)	41.23		47.48 (6.93)	51.6 (7.22)	54.36 (7.41)	51.5 (7.21)	52.48	
SE.m±		0.082	0.094	0.098	0.083			0.057	0.048	0.047	0.053			0.058	0.065	0.061	0.065		
CD		0.249	0.283	0.297	0.252			0.172	0.145	0.142	0.161			0.175	0.195	0.185	0.197		

PCB= Pretreatment count before, ROC= Reduction over control, Popl^{n}= Population, diff. = differ
Figures in the parenthesis are square root transformed values, NS= Non significant.

Table 4: Mean of all insecticidal spray on incidence of aphid in cabbage at Jaguli farm, BCKV during experiment (2017-18)

Treatment	Dose (ml/L or gm/L)	No. of aphid after each spray			Mean of three spray	% reduction over control at different spray			Overall reduction over control after all spray
		1ST	2ND	3RD		1ST	2ND	3RD	
Derisom @2% EC	2 ml/l	14.67	20.4	24.52	19.86	48.9	50.4	53.27	50.85
Anosom @1%EC	2 ml/l	23.12	33.06	41.67	32.6	19.46	19.8	20.58	19.94
Margosom @0.15% EC	2 ml/l	9.03	11.23	11.8	10.68	68.5	72.75	77.47	72.9
Lipel (B.t.)	2gm/l	21.76	32.8	42.9	32.48	24.18	20.4	18.21	20.93
Biosar (*V. lecanii*)	5gm/l	14.2	20.4	25.06	19.88	50.5	50.49	52.23	51.07
Biocere (*B. bassiana*)	5gm/l	23.25	35.66	43.95	34.28	19	13.5	16.24	16.24
Novaluron@10% EC	1.8ml/l	21.8	30.8	38.3	30.3	24.07	25.3	26.97	25.44
Tracer @45% SC	1 ml/l	18.38	25.78	30.32	24.8	35.95	37.47	38.17	37.19
Natural control		28.7	41.23	52.48	40.8				

3.1 Yield of fruits

Table-5 also revealed that there were significant variations of yield among the treatments ranging from 193.4 q/ha to 416.67 q/ha. Highest yield of cabbage (416.67 q/ha) was recorded in Novaluron treated plots followed by Tracer (375.6 q/ha), Lipel (361.43 q/ha), Anosom (340.2 q/ha) and *B. bassiana* (321.5) respectively. Novaluron showed highest percentage increase of yield over control with 115.44% increasement followed by Tracer (94.24%) and Lipel (86.88%). Whereas, the yield obtained from untreated control plots was 193.4 q/ha. These may be due to high occurrence of pest complex of cabbage which includes aphid with mean population of 40.8 aphid/leaf and DBM with mean population of 7.41/ leaf.

Table 5: Mean effect of three sprays of the said pesticides on incidence of sucking pests in Cabbage and on yield at Jaguli Instructional Farm, BCKV, Mohanpur, Nadia, West Bengal (2017-18)

Treatment	Dose (ml/L or gm/L)	Mean scoring of DBM	Mean scoring of cabbage aphid	Yield (q/ha)	% increase of yield over control
Derisom @2% EC	2 ml/l	6.13 (2.57)	19.86 (4.51)	271.6	40.46
Anosom @1%EC	2 ml/l	3.14 (1.9)	32.6 (5.75)	340.67	76.14
Margosom @0.15%EC	2 ml/l	5.84 (2.51)	10.68 (3.34)	296	53.05
Lipel (B.t.)	2gm/l	3.46 (1.98)	32.48 (5.74)	361.4	86.88
Biosar(*V. lecanii*)	5gm/l	6.78 (2.69)	19.88 (4.51)	233.3	20.64

Biocere (*B. bassiana*)	5gm/l	3.56 (2.01)	34.28 (5.89)	321.6	66.32
Novaluron@10%EC	1.8 ml/l	2.34 (1.68)	30.3 (5.54)	416.6	115.44
Tracer @45% SC	1 ml/l	3.33 (1.95)	24.8 (5.02)	375.6	94.24
Natural control		7.41 (2.81)	40.8 (6.42)	193.4	
CD at 5%					

Figures in the parenthesis are square root transformed values, NS = Non significant

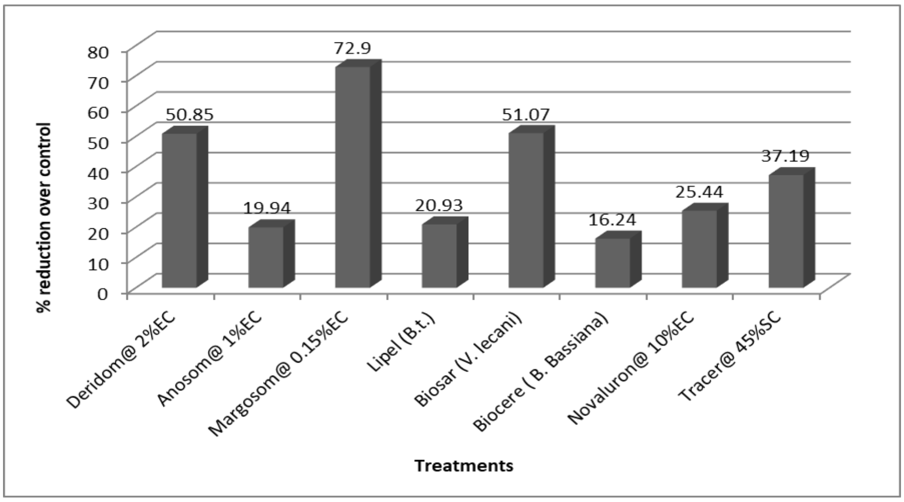

Fig 1: Overall percentage reduction of aphids over control

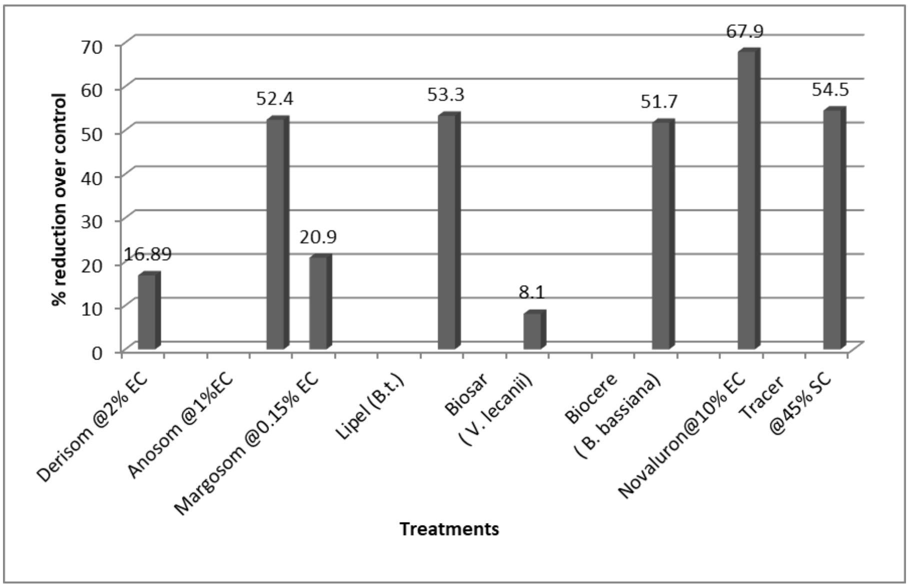

Fig 2: Overall percentage reduction of DBM over control

4. Conclusion

The eight bio pesticides were evaluated against pest revealed that in the field, overall best performance was found in case of Novaluron in reducing the larval population of DBM followed by Spinosad, and *Verticillium lecani* were found to be less effective in this respect. In case of controlling aphid (*Brevicoryne brassicae)*, margosom was best followed by *Verticillium lecani* and Novaluron were found to be less effective in this respect. The highest yield of cabbage was obtained in the novaluron treated plot followed by Spinosad.

5. Acknowledgement

The authors are thankful to the Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal for providing field facility and also offer our sincere gratitude to M/S.Bejo Sheetal Pvt. Ltd. for providing quality crop seed.

6. References

1. Ayalew G. Effect of the insect growth regulator novaluron on DBM (*Plutella xylostella*) and its indigenous parasitoid. Crop Protection. 2011; 30(80):1087-1090.
2. Debbarma A, Singh KI, Gupta MK, Devi Ph. Sobita. Bio-rational management of major lepidopteran pests and their influence on yield of cabbage inder Manipur Valley. Journal of Entomology and Zoology Studies. 2017; 5(5):1546-1551.

3. Harcourt DG. Biology of diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) in Eastern Ontario and Life-history, behaviour and host relationship. The Canadian Entomologist. 1957; 89:554-564.
4. National Horticulture Board of India, Horticulture at a glance-2016-17.
5. Nahusenay DG, Abatre GA. Evaluation of selected botanical aqueous extracts against cabbage aphid (*Brevvicoryne brassicae*) on cabbage under field condition in kobo district, Journal of Horticulture and Forestry. 2018; 10(50):69-78.
6. Rai S, Srivastava KM, Saxena JD, Sinha SR. Distribution Pattern of diamondback moth, *Plutella xylostella* (L.) on cabbage and cauliflower. Indian Journal of Entomology. 1992; 54(3):262-265.
7. Reddy MSS *et al*. Bio-efficacy of different noval insecticides and their interaction between numbers of sprays against DBM (*Plutella xylostella*) infesting cabbage. Journal of Entomological Research. 2018; 42(1):51.
8. Seal DR. Effectiveness of novaluron in controlling Diamind black moth in cabbage. Arthopod management tests. 2004; 29(1).
9. Singh KI, Devi P Sanatombi, Gupta MK, Devi Ph Sobita, Singh NG. Evaluation of plant extracts against insect pests of cabbage. Indian Journal of Entomology. 2015; 77(2):109-114
10. Talekar NS, Shelton AM. Biology, ecology and management of diamond back moth. Annual Review of Entomology. 1993; 38:275-301.
11. Yadav GP Singh *et al*. Study of eco-friendly insecticidal management of major insect pests of cabbage under agro-climatic condition of Imphal, Nepal. Indian Journal of Pure & Applied Bioscience. 2017; 5(6):273-277.