Bio-rational management of Major Insect Pests and their effect on yield of Cabbage crop under Manipur valley conditions

Abstract

To test certain bio-rational insecticides against the cabbage major insect pests, diamond back moth, *Plutellaxylostella*Linnaeus and cabbage butterfly, *Pieris brassicae* Linnaeus and their toxic effect on the population of lady bird beetle, *Coccinella septempunctata* Linnaeus population in the Manipur valley cabbage crop-ecosystem, a field trial was carried out during *Rabi*, 2022–23 at the Vegetable Research Farm of the College of Agriculture, Central Agricultural University, Imphal. The mean extent of damage caused by *P. xylostella* and *P. brassicae* was high which varied from 62.67 to 88.34% and 83.33 to 92.11%, respectively, over the investigation period. The effectiveness of bio-rational pesticides against *P. xylostella*and *P. brassicae*was determined by the results of the insecticidal treatments, which showed a considerable reduction in the incidence of these pests. Malathion 50 EC applied @ 500 ml/ha witnessed the most effective insecticide against the diamond back moth, *P. xylostella* with a record of minimum mean leaf damage of 19.36% as against 50.08% in untreated control, closely followed by Greenracer (*Beauveria bassiana*) @ 1000 ml/ha (20.37%), and Neemajal (Azadirachtin 1500 ppm) @ 1000 ml/ha (22.37%) but, differed significantly from each other except with green racer. Among the phytoproducts, the plots treated with Neemajal (Azadirachtin 1500 ppm) @1000 ml/ha recorded lowest DBM incidence (22.37% leaf damage) which was at par with Pestoneem (Azadirachtin 1500 ppm) @ 1000 ml/ha (24.57% leaf damage). Against *P. brassicae*also Malathion @ 500 ml/ha substantially recorded the lowest mean leaf damage of 22.67 vs 82.56% in the untreated check, followed by Greenracer with a record of 26.12% leaf damage, however there were significant differences between the two. Neemajal (Azadirachtin 1500 ppm) @1000 ml/ha demonstrated to be the most effective treatment in reducing the pest incidence with the lowest mean leaf damage of 28.67% of the botanical insecticides field tested against cabbage butterfly. The highest mean leaf damage incidence (37.11% LD) was noticed in the plots treated with Pacer (*Metarrhizumanisoplae*) @ 1000 ml/ha. The efficacy of Pestoneem (Azadirachtin 1500 ppm) @ 1000 ml/ha, Multineem (Azadirachtin 300ppm) @1500ml/ha and Neemta (Azadirachtin 300ppm) @1500ml/ha was at par from each other recording mean leaf damage of 34.78, 35.56 and 36.89% respectively.The highest mean cabbage yield (23.67 t/ha was harvested from the plots treated with Malathion @ 500 ml/ha with the maximum yield increase over control of 9.34 t/ha and 65.17% which showed non-significant difference with the plots of Green racer (22.67 t/ha), Neemajal (20.09 t/ha), Pestoneem (20.04 t/ha), Mutlineem (19.44 t/ha) and Neemta (19.32 t/ha) with their corresponding yield increase over control of 8.34 t/ ha, 5.76 t/ ha , 5.71 t/ha, 5.11 t/ha and 5.00 t/ha respectively, Whereas Pacer treated plots accrued significantly lowest cabbage yield of (18.43%) with a record of lowest yield increase over control of 4.1 t/ha and 28.61%. The avoidable yield loss was computed to be 40.82 per cent in the untreated control plots. Application of insecticides resulted in reduction of the mean avoidable yield loss, which ranges between 4.22 and 20.74 per cent in different insecticidal treatments, the lowest being in Greenracer (*Beauveria bassiana*) and highest in Pacer *(Metarrhizumanisoplae).* The net profit of the insecticidal treatments varied from Rs. 19595.60 (Pacer) to Rs. 35364.7 (Malathion 50 EC) with the cost: benefit ratios ranging between 1:11 to 1:46, the minimum and maximum being with Neemajal and Green racer, respectively.

The results on toxic effect of insecticides on the population of *C. septempunctata* indicated that the minimum mean population (0.52 beetles/plant) was recorded from Malathion 50 EC @ 500 ml/ha treated plots which was at par with Neemta (Azadirachtin 300ppm) (0.84 beetles/plant), Multineem (Azadirachtin 300ppm) (0.90 beetles/plant) and Pestoneem (Azadirachtin 1500ppm) (0.93 beetles/plant). However, maximum population of beetle (1.39 beetles /plant) was marked in the plots of Greenracer which did not differ significantly with the rest of insecticidal treatments.

Keywords: Bio-rational, phytoproducts, Malathion, crop-ecosystem, *Beauveria bassiana.*

Introduction

Cabbage (*Brassicae oleracea* var. *capitata* Linn.) is one of the most significant and widely produced vegetable crops because of its nutritional and economic benefits for both producers and consumers. It is a significant leafy vegetable crop that can be eaten raw or cooked as a salad. In addition to these purposes, cabbage leaves are also used to produce compost, a type of bio-fertilizer that is safe for humans and other beneficial wildlife to consume. It is primarily cultivated for its edible, expanded terminal buds, or "head," which contains high levels of the vitamins A (2000 IU), B1 (50 1.U), and C (124 mg/100 g), as well as minerals like phosphorus, potassium, sodium, calcium, and iron.

Cabbage is prone to infestation by a number of insect pests consisting of sucking and defoliating insects starting from germination to harvesting stage of the crop. In India, a total of 37 (thirtyseven) insect pests have been reported to feed on cabbage, of which the diamond back moth, *Plutellaxylostella*Linneaus and cabbage butterfly,*Pieris brassicae*Linneaus are the major constraints for profitable cultivation of the crop (Sachan &Gangwar 1980 and Lal, 1975). The effect of synthetic chemicals on agriculture has been so dramatic that conventional agriculture now means using chemicals. However, only 0.1% of the agro-chemicals used in pest control reach the target pests leaving the remaining 99.9% to enter the environment to cause hazards to non-target organisms (Verma, 2002). Alternative forms of crop protection have entitled interest for decades.

In order to counteract the problems caused by conventional synthetic insecticides, the bio-rational materials like neem products and microbial insecticides have been found promising in tackling the pest problem (Singh et al., 1987, Osman, 1993, Asokan et al., 1996 and Gopalkrishnan, 2001). Although from other parts of the country, a number of workers had reported in the management of cabbage pests on these aspects, limited attempt had been made in the North-east region.

Materials and Methods

A field experiment was carried out in randomized block design (RBD) with 8 treatment including control during *Rabi*, 2022-23 at the College of Agriculture, Central Agricultural University, Iroisemba, Imphal, in cabbage crop variety “Rare ball”. The seed bed was prepared well and the seeds are sown in the beds followed by light irrigation to facilitate better germination. The experimental field was thoroughly ploughed with the help of tractor followed by three cross ploughed by power tiller and the soil was pulverized and leveled properly to ensure better growth. The thirty days old seedlings were transplanted in the main field with a spacing of 45 × 45 cm followed by lifesaving irrigations to ensure better establishment of seedlings and to maintain good crop stand. After transplanting, the field was irrigated at weekly intervals to facilitate proper vegetative growth of the seedlings and thus enlarged the head of cabbage. The NPK was applied @ 100: 80: 60 Kg/ha. The field was kept weed free with two handweedings at 30 and 60 days after transplanting. The experiment was carried out at latitude of 24^0 45’N and 93^0 56’ E with an elevation of 790 m above Mean Sea Level, where the soil was clay loam and shows acidic 5.5 reaction.

Percent leaf damaged was calculated by using the following formulae

Leaf damage percent=$\frac{\text{No.of infested leaves/5plants}}{\text{Total No.of leaves/5plants}}$ x100

Percent yield increased over control was calculated by using the following formulae

Percent yield increase over control= $\frac{T-C}{C}$x 100

Where, T= Yield in respected treatment

C= Yield in control

Results and Discussions

Effectof bio-rational insecticides against *Plutellaxylostella* Linnaeus

The results of the bio-rational insecticides against diamond back moth, *Plutellaxylostella*is presented in (Table 1). From the pooled mean leaf damage data of three sprays over the three post applications periods of observations, it is amply clear that all the insecticidal treatments were superior in controlling the damage caused by *P. xylostella*in comparison to untreated control. Malathion 50 EC @ 500 ml/ha treated plots harbouring the lowest leaf damage of 19.00% as against 49.31% in untreated control (Tables 2). Malathion 50 EC was closely followed by Green Racer (*Beauveria bassiana*) @ 1000 ml/ha (20.89%) and Neemajal (Azadirachtin 1500ppm) @ 1000 ml/ha (22.37%) but differed significantly from each other except between Malathion 50 EC and Green Racer (*Beauveria bassiana*). These insecticidal treatments performed significantly better than rest of the treatments. Pacer (*Metarhizium anisoplae*) @ 1000 ml/ha was found to be least effective treatment against *P. xylostella* with a record of maximum leaf damage incidence of (32.46%). The effectiveness of Pestoneem (Azadirachtin 1500ppm) @ 1000 ml/ha (25.00% LD), Multineem (Azadirachtin 300ppm) @ 1500 ml/ha (27.78% LD) and Neemta (Azadirachtin 300 ppm) @ 1500 ml/ha showed insignificant difference from one another. The order of efficacy of each of treatments along with the test of significance is depicted below:

Mean of three sprays based on 3, 5 and 7 DAA

Malathion 50 EC > Green Racer (*Beauveria bassiana*)>Neemajal (Azadirachtin 1500ppm) >Pestoneem (Azadirachtin 1500ppm) >Multineem (Azadirachtin 300ppm) >Neemta (Azadirachtin 300 ppm) > Pacer (*Metarhizium anisoplae*) > Untreated control.

Effect of bio-rational insecticides against *Pieris brassicae* Linnaeus

The results of the bio-rational insecticides against cabbage butterfly, *Pieris brassicae*is presented in (Table 2).From the pooled mean leaf damage data of three sprays over the three post applications periods of observations, it is clearly indicated that Malathion 50 EC applied @ 500 ml/ha performed significantly better than rest of the insecticidal treatments with a record of lowest mean leaf damage

incidence of 22.67% as against 82.56% in untreated check, followed by Green Racer (*Beauveria bassiana*) @ 1000 ml/ha (26.12%) and Neemajal (Azadirachtin 1500ppm) @ 1000 ml/ha (28.67%) differed significantly from each other. The treatments with Pestoneem (Azadirachtin 1500ppm) @ 1000 ml/ha and Multineem (Azadirachtin 300ppm) @ 1500 ml/ha were also recorded comparatively lower mean leaf damage of (34.78%) and (35.56%), respectively which showed non-significant difference between them. The mean per cent leaf damage recorded in the plots treated with Neemta (Azadirachtin 300 ppm) @ 1500 ml/ha was (36.89% LD). However, all the insecticidal treatments were effective in restricting the infestation due to *P. brassicae* when compared with untreated control. The followings are the descending order of mean efficacy of the different treatments against the cabbage butterfly, *P. brassicae.*

Mean of three sprays based on 3,5 and 7 DAA

Malathion 50 EC > Green Racer (*Beauveria bassiana*)>Neemajal (Azadirachtin 1500ppm) >Pestoneem (Azadirachtin 1500ppm) >Multineem (Azadirachtin 300ppm) >Neemta (Azadirachtin 300 ppm) > Pacer (*Metarhizium anisoplae*) > Untreated control.

Effect of bio-rational insecticides on the yield of cabbage crop

Yield of a crop is the interaction product of Genetic potential of the variety, effect of prevailing environment and crop management practices including pest management system adopted. It is expected that the treatment providing good protection of pests will give higher yield under uniform ecological and crop management system. In present investigation, there was clear evidence that all the bio-rational insecticidal treatments registered significant reduction of *Plutellaxylostella* and *Pieris brassicae* incidence which results in significantly higher yield in comparison to untreated control. The mean data on cabbage var. **"Rare ball"** yield presented in Table 3 indicated that the minimum yield (14.33 t/ha) was obtained from untreated control plot, which was significantly lower than the yields harvested from the insecticidal treated plots (18.47 to 23.67 t/ha), the highest being recorded in Malathion 50 EC treatment with maximum yield increase over control of 9.34 t/ha and 65.17%, and lowest in Pacer (*Metarrhizumanisoplae*) treatment with minimum yield increase of 4.14 t/ha and 28.61%.The yield of Malathion 50 EC was followed by Green Racer (*Beauveria bassiana*) (22.67 t/ha) exhibiting yield increase over control of 8.34 t/ha and 58.19% which had non-significant difference between them. The mean cabbage yield harvested from the plots of Neemajal (Azadirachtin 1500ppm) (20.09 t/ha) with yield increase over control of 5.76 t/ha & 40.19%) Pestoneem (Azadirachtin 1500ppm) (20.04 t/ha, increase yield of 5.71t/ha & 39.84%), Multineem (Azadirachtin 300 ppm) (19.44 t/ha, yield increase of 5.11t/ha & 35.65%), Neemta (Azadirachtin 300 ppm) (19.32 t/ha with the yield increase over control of 5.10 t/ha & 34.82%) did not differ significantly from one another.

Table 1. Efficacy of certain bio-rational insecticides against the diamond back moth, *Plutellaxylostella*Linnaeus in cabbage var. "Rare ball" during *Rabi,* 2022-23

Treatments	Dosage/ha (ml/ha)	[1]Mean percent leaf damage due to *P. xylostella*recorded during			Pooled Mean	DBA	[2]Days after Application		
		1st spray	2nd spray	3rd spray			3DAA	5DAA	7DAA
Neemajal (Azadirachtin 1500ppm)	1000	24.32 (2.03)	21.67 (5.36)	20.54 (4.65)	22.37 (5.66)	36.12 (6.01)	19.33 (5.68)	18.42 (5.50)	17.45 (5.19)
Multineem (Azadirachtin 300 ppm)	1500	31.33 (1.75)	27.34 (5.71)	26.47 (5.09)	27.78 (6.32)	40.22 (6.34)	25.67 (6.02)	24.32 (5.75)	23.67 (5.49)
Pestoneem (Azadirachtin 1500ppm)	1000	26.37 (2.05)	25.63 (5.85)	22.72 (4.82)	24.57 (5.64)	37.33 (6.09)	24.37 (5.92)	21.33 (5.68)	21.33 (5.34)
Neemta (Azadirachtin 300ppm)	1500	30.33 (1.97)	28.47 (5.95)	26.52 (5.59)	28.34 (6.58)	38.76 (6.19)	28.47 (6.50)	27.22 (6.13)	24.00 (5.93)
Green racer (*Beauveria bassiana*)	1000	21.33 (1.99)	20.47 (4.93)	19.32 (4.19)	20.37 (5.36)	35.11 (5.92)	16.67 (5.01)	17.67 (4.80)	14.33 (4.37)
Pacer (*Metarhizium anisopliae*)	1000	35.33 (1.98)	32.00 (4.83)	30.33 (4.60)	32.46 (5.70)	33.78 (5.81)	29.33 (5.69)	26.67 (5.53)	25.34 (4.92)
Malathion	500	20.32 (1.87)	19.32 (4.38)	18.45 (4.03)	19.36 (4.87)	27.23 (5.21)	17.68 (4.81)	15.33 (4.59)	12.68 (4.15)
Control (water)	500	52.23 (2.02)	50.34 (7.04)	47.67 (6.52)	50.08 (7.09)	52.45 (7.2)	49.00 (7.09)	47.33 (7.04)	44.33 (6.89)
S.E(d)+		0.11	0.17	0.23	0.13	0.19	0.12	0.25	0.28
CD(P=0.05)		0.24	0.31	0.46	0.25	NS	0.20	0.46	0.52

Figures in parentheses are angular transformed values;

DBA= Day before application;

NS= Non-Significant

[1]Composite means of three post treatment observations recorded at 3, 5 and 7 days after application

[2]Mean of 3 replications based on 3 applications data

Table 2.Efficacy of certain bio-rational insecticides against the cabbage butterfly *Pieris brassicae*Linnaeus in cabbage var. "Rare ball" during *Rabi*, 2022-23

Treatments	Dosage/ha (ml/ha)	[1]Mean percent leaf damage due to *P. brassicae*recorded during	Pooled Mean	DBA	[2]Days after Application

		1st spray	**2nd spray**	**3rd spray**			**3DAA**	**5DAA**	**7DAA**
Neemajal (Azadirachtin 1500ppm)	1000	33.54 (5.84)	27.65 (5.91)	25.32 (5.70)	28.67 (5.84)	83.33 (9.12)	30.33 (5.94)	33.25 (5.38)	31.67 (5.62)
Multineem (Azadirachtin 300 ppm)	1500	37.33 (6.10)	36.67 (6.04)	34.67 (5.97)	35.56 (6.05)	87.33 (9.34)	34.12 (6.11)	36.67 (6.06)	34.33 (5.85)
Pestoneem (Azadirachtin 1500ppm)	1000	35.67 (5.45)	34.67 (5.83)	34.00 (5.78)	34.78 (5.90)	88.67 (9.42)	33.45 (5.95)	34.78 (5.90)	32.45 (5.69)
Neemta (Azadirachtin 300ppm)	1500	38.33 (6.17)	36.33 (5.93)	36.00 (5.87)	36.89 (6.07)	92.33 (9.61)	35.89 (6.23)	37.22 (6.10)	35.89 (6.00)
Green racer (*Beauveria bassiana*)	1000	27.67 (5.22)	26.33 (5.11)	24.33 (4.92)	26.12 (5.11)	87.67 (9.36)	24.67 (5.26)	21.33 (5.03)	20.33 (4.92)
Pacer (*Metarhizium anisopliae*)	1000	38.33 (5.87)	37.67 (5.72)	34.56 (5.59)	37.11 (5.80)	91.33 (9.55)	36.67 (5.80)	32.33 (5.68)	36.33 (5.68)
Malathion	500	23.67 (4.86)	23.00 (4.79)	21.33 (4.62)	22.67 (4.76)	86.33 (9.29)	23.56 (4.85)	20.56 (4.51)	19.57 (4.51)
Control (water)	500	82.65 (7.05)	83.34 (6.90)	80.45 (6.80)	82.56 (6.84)	90.33 (9.50)	88.45 (6.96)	86.11 (6.79)	84.45 (6.81)
S.E(d)		0.55	0.64	0.58	0.06	0.15	0.17	0.19	0.24
CD(P=0.05)		1.18	1.37	1.24	0.13	NS	0.25	0.41	0.52

Figures in parentheses are angular transformed values;

DBA= Day before application;

[1]Composite means of three post treatment observations recorded at 3, 5 and 7 days after application

[2]Mean of 3 replications based on 3 applications data

Treatment	**Dosage/ha (ml/ha)**	**[1]Mean percent leaf damage due to**		**Cabbage Yield (t/ha)**
		P. xylostella	***P. brassicae***	
Neemajal (Azadirachtin 1500 ppm)	1000	22.37 (5.31)	28.67 (5.84)	20.09
Multineem (Azadirachtin 300 ppm)	1500	27.78 (5.62)	35.56 (6.05)	19.44

Pestoneem (Azadirachtin 1500 ppm)	1000	24.57 (5.54)	34.78 (5.90)	20.04
Neemta (Azadirachtin 300 ppm)	1500	28.34 (5.90)	36.89 (6.07)	19.32
Green racer (*Beauveria bassiana*)	1000	20.37 (4.56)	26.12 (5.11)	22.67
Pacer (*Metarrhizumanisoplae*)	1000	32.46 (5.02)	37.11 (5.80)	18.43
Malathion 50 EC	500	19.36 (4.35)	22.67 (4.76)	23.67
Control (water)	500	50.08 (7.01)	82.56 (6.84)	
SEm		0.13	0.06	
CD (P= 0.05)		0.25	0.13	

Table 3. Overall effect of insecticides on the extent of leaf damage due to *Plutellaxylostella*Linnaeus &*Pieris brassicae*Linnaeus and yield of cabbage during *Rabi*, 2022-23

Figures in parentheses are angular transformed values;

[1]Mean percent leaf damage of three time intervals under observations based on 3 applications data

Conclusion

The bio-rational evaluated against major pests *viz*., *Plutellaxylostella* and *Pieris brassicae* in cabbage crop under Manipur valley were significantly effective than the untreated control. However, the

pooled mean of leaf damage of three sprays suggests that the treatment Malathion 50 EC registered best for managing both these pests and thus returning to higher yields. This was followed byGreen racer (*Beauveria bassiana*), these bio-rational used in the present studies were eco-friendly and may be further recommended for the management of these major pests of cabbage in Manipur valley in the farmer's fields whenever necessary.

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