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EFFICACY OF INSECT GROWTH REGULATORS AGAINST DIAMOND BACK MOTH AND TOBACCO CATERPILLAR INFESTING CABBAGE CROP

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ABSTRACT

The diamondback moth, Plutella xylostella and tobacco caterpillar, Spodoptera litura is a serious threat to Brassica vegetables grown all over the country. The effects of different insect growth regulators on P. xylostella and S. litura were investigated using fixed doses of the treatments. Among the different doses used, UPI 106 @ 100 g.a.i/ha was the most effective treatment against cabbage diamond backmoth and tobacco caterpillar with highest per cent reduction of larval population at 3, 7 and 14 days after spray. The lower doses of other chemical insecticides were less effective.

Keywords: Cabbage, *Plutella xylostella* L, *Spodoptera litura* F, IGR

INTRODUCTION

The cabbage (*Brassica oleracea* L. var. *capitata*) is an important cruciferous vegetable grown extensively all over the country and has high nutritive value. India is the second largest cabbage producing country after China in the world. In India, cabbage covers 4.3% of total area of vegetables and the area under cabbage cultivation is 389.6 ha with total production of 8412.1 million tonnes and productivity of 21.6 million tonnes/ha (APEDA 2011-12) and in present situation the area under cabbage cultivation is 372.4 ha with total production of 8534.2 million tonnes and productivity of 22.9 million tonnes/ha (APEDA 2012-13). Cabbage crop is mainly infested by insect pests like diamond back moth (*Plutella xylostella* Linn.), tobacco caterpillar (*Spodoptera litura* Fab.) and head borer (*Hellula undalis* Fab.), cabbage butterfly (*Pieris brassicae* Linn.). Diamond back moth and tobacco caterpillar are widely distributed and regarded as key pests of cole crops. DBM is the most serious pest of cabbage and cauliflower crops and responsible for low productivity of these crops in India in all seasons. Satpathy *et al.* (2005) reported 50-80 per cent loss in marketable yield of cabbage due to attack of *P. xylostella*. The indiscriminate use of conventional pesticides to manage these pests has led to the development of resistance. Therefore, safer, effective and less costly alternate to chemical control are desirable as a part of an IPM. Recently, several pesticides with novel mode of action have been introduced to overcome this situation. Some of the most exciting breakthroughs in agricultural chemicals have come in the last few years with the development of several new classes of chemistry for the control of lepidopteron pests. These insecticides are very effective, relatively selective for larvae, and safe to use and apply. This has been achieved through the development of noble modes of action and type of activity of the compounds tested; most of them are new chemistry with independent modes of action (neurotoxin, metabolic and insect growth regulators). Others must be ingested to be toxic to larvae. Novaluron is a new pesticide molecule belonging to the group of insecticides termed Insect Growth Regulators (IGR) falling in to the class of diflubenzoylureas. Although the compound mainly acts by ingestion, but it still poses some contact activity. IGR are comparatively safer to beneficial insects and environment and are compatible for use in an integrated pest management system (IPM) [Ayalew (2011)]. The extensive and indiscriminate use of pesticide led to the development of resistance to most of the frequently used chemicals causing control failures of DBM and tobacco caterpillar in India. Consequently the use of eco-friendly materials such as botanical and insect growth regulator (IGR) insecticides emerged as a better alternatives to the synthetic insecticides. Hence, the present study was initiated using cabbage as test crop.

MATERIALS AND METHODS

The experiment was carried out during two consecutive years (2010-12) at research farm, College of Agriculture, Indore. The trial was laid out in randomized block design with seven treatments. Treatments were : T_1-UPI 106 (50 ga.i ha^{-1}), T_2-UPI 106 (75 ga.i ha^{-1}), T_3-UPI 106 (100ga.i ha^{-1}), T_4-Novaluron10% EC (75 ga.i ha^{-1}), T_5-Chlorfenapyr 10% EC (30ga.i ha^{-1}), T_6- Lufenuron 5.4% EC (100 ga.i ha^{-1}). One month old healthy cabbage seedling cv. Varun was planted at 40 x 40 cm spacing in 2.8 m x 3.6 m plots. The crop was raised under recommended agronomical practices of the university, except insecticides spray. Spraying of

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insecticides was done at heading stage, when pest population crossed the ETL followed by second application at 15 days interval. Bio efficacy of different treatments were assessed by recording larval population of DBM and tobacco caterpillar at 3, 7 and 14 days after each application on 10 randomly selected plants from each treatment and per cent reduction of larval population was worked out. The yield of marketable Cabbage curds was recorded from each plot harvest. Observations were recorded on number of larvae/plant, counting the healthy and infested fruits / plant during following periods: Pre treatment observation before 24 hrs. of treatment, 24 hrs. after treatment, 48 hrs. after treatment, 72 hrs. after treatment, 8 days after treatment, 14 days after treatment. The similar procedure of observations was followed after second spray. The reduction percentage of population of DBM and *Spodoptera litura* was calculated by Henderson and Tilton formula (1955);

$$\text{Percent Mortality} = 1 - \frac{T_a \ x\ C_b}{T_b \ x\ C_a} \quad X\ 100$$

Where, T_a = Numbers of larvae after spray in treatment, T_b= Numbers of larvae before spray in treatment, C_a= Numbers of larvae in untreated check after spray and C_b= Numbers of larvae in untreated check before spray. The insect population data were transformed to square root transformation as $\sqrt{X+0.5}$. The percentage data were transformed into angular transformation (Arcsine). The values so obtained were subjected to statistical analysis to test significant variation among different treatments.

RESULTS AND DISCUSSION

The data (Table 1) revealed that UPI 106 @ 100g.a.i/ha (68.6%) was the most effective treatment that showed highest reduction in population of DBM followed by UPI 106 @ 75 g .a.i/ha and Novaluron 10 EC @75 g.a.i/ha (64.9%) over the untreated check at 3 DAS. At 7 DAS, UPI 106 @ 100 g.a.i/ha (78.2%) was the most effective treatment that showed highest reduction in population of DBM followed by UPI 106 @ 75 g .a.i/ha (76.4%), Novaluron 10EC @75 g.a.i/ha (75.9%) over the untreated check. At 14 DAS, UPI 106 @ 100 g.a.i/ha (59.7%) was the most effective treatment for reduction in population of DBM followed by UPI 106 @ 75 g .a.i/ha (57.0 %), Novaluron 10EC @75 g.a.i/ha (56.3 %) over the untreated check. The spraying, based on the mean values, was UPI 106 @ 100 g.a.i/ha (68.80 %) followed by Novaluron 10EC @75 g.a.i/ha (66.30 %), UPI 106 @ 75 g .a.i/ha (66.12 %).

Table 1: Relative efficacy of new insecticidal molecules against DBM population on cabbage (2010-11)

Treatments	Dose (g.a. i/ha)	Pretreatment count/10 plants	% reduction in DBM population over control*			Mean of post spray
			3 DAS	**7 DAS**	**14 DAS**	
UPI 106	50	18.8 (4.84)[#]	55.7 (48.27)**	59.8 (50.65)	54.2 (47.41)	56.50 (48.73)
UPI 106	75	19.1 (4.87)	64.9 (53.67)	76.4 (60.94)	57.0 (49.02)	66.12 (54.40)
UPI 106	100	18.9 (4.85)	68.6 (55.92)	78.2 (62.17)	59.7 (50.59)	68.80 (56.04)
Novaluron 10 EC	75	19.4 (4.90)	64.9 (53.67)	75.9 (60.60)	56.3 (48.62)	66.30 (54.15)
Chlorfenapyr10 SC	100	19.2 (4.88)	59.8 (50.65)	67.3 (55.12)	57.1 (49.08)	61.40 (51.59)
Lufenuron 5.4 EC	30	18.7 (4.82)	62.3 (52.12)	71.0 (57.42)	55.2 (47.98)	62.86 (52.45)
Untreated check	-	18.9 (4.85)	-	-	-	-
CD (P=0.05)	NS	2.39	2.83	1.68	2.98	

**Mean of three replications over two-sprays, DAS- Days after spray.*
***Figures in parentheses are angular transformed value. # Figures in parentheses are √ + 0.5 value, NS – Non significant*

The data (Table 2) revealed that UPI 106 @ 100g.a.i/ha (64.2%) was the most effective treatment for higher showed highest reduction in population of DBM followed by UPI 106 @ 75 g .a.i/ha (62.3%) and Novaluron 10EC @75 g.a.i/ha (62.0 %) over the untreated check at 3 DAS. At 7 DAS, UPI 106 @ 100 g.a.i/ha (74.5 %) was the most effective treatment for reduction in population of DBM followed by UPI 106 @ 75 g .a.i/ha (73.2 %), Novaluron 10 EC @75 g.a.i/ha (71.8 %) over the untreated check. At 14 DAS Similar trend was noticed about the efficiencies of various regulators for controlling caterpillar infestive cabbage crop.

Table 2: Relative efficacy of different new insecticidal molecules against DBM population on cabbage (2011-12)

Treatment	Dose (g.a.i/ha)	Pre treatment count/10 plants	% reduction in DBM population over control*			Mean of post spray
			3 DAS	7 DAS	14 DAS	
UPI 106	50	17.5 (4.68)#	51.4 (45.80)	62.4 (52.18)	57.4 (49.26)	57.10 (49.08)
UPI 106	75	18.9 (4.85)	62.3 (52.71)	73.2 (58.82)	64.0 (53.13)	66.57 (54.68)
UPI 106	100	18.9 (4.85)	64.2 (53.25)	74.5 (59.67)	66.7 (54.76)	68.41 (55.80)
Novaluron 10 EC	75	17.6 (4.70)	62.0 (51.94)	71.8 (57.92)	63.9 (53.07)	65.90 (54.27)
Chlorfenapyr 10 SC	100	18.1 (4.75)	59.7 (50.59)	64.0 (53.13)	51.4 (45.80)	58.37 (49.82)
Lufenuron 5.4 EC	30	18.5 (4.80)	60.1 (50.83)	69.3 (56.35)	62.4 (52.18)	62.17 (53.09)
Untreated check	-	17.9 (4.73)	-	-	-	-
CD (P=0.05)		NS	1.38	1.78	1.68	1.73

**Mean of three replications over two-sprays, DAS- Days after spray,*
***Figures in parentheses are angular transformed value, # Figures in parentheses are √ + 0.5 value, NS – Non significant*

The data (Table 3) revealed that UPI 106 @ 100g.a.i/ha (74.1%) was the most effective treatment that showed highest reduction in population of *Spodoptera litura* followed by UPI 106 @ 75 g .a.i/ha (71.6%) and Novaluron 10EC @ 75 g.a.i/ha (69.8 %) over the untreated check at 3 DAS. At 7 DAS, UPI 106 @ 100 g.a.i/ha (85.3 %) was the most effective treatment that showed highest reduction in population of *Spodoptera litura* followed by UPI 106 @ 75 g .a.i/ha (82.8%), Novaluron 10EC @ 75 g.a.i/ha (82.4%) over the untreated check. At 14 DAS, UPI 106 @ 100 g.a.i/ha (65.7 %) was the most effective treatment that showed highest reduction in population of *Spodoptera litura* followed by UPI 106 @ 75 g .a.i/ha (65.8%), Novaluron 10EC @ 75 g.a.i/ha (63.4) over the untreated check. The most effective treatment over the untreated check post spray, based on the mean values, was UPI 106 @ 100 g.a.i/ha (75.03%) followed by UPI 106 @ 75 g .a.i/ha (73.40%), Novaluron 10EC @75 g.a.i/ha (71.87%).

Table 3: Relative efficacy of different new insecticidal molecules against tobacco caterpillar on cabbage (2010-11)

Treatments	Dose (g.a. i/ha)	Pre treatment count/10 plants	% reduction in *Spodoptera litura* population over control*			Mean of post spray
			3 DAS	7 DAS	14 DAS	
UPI 106	50	24.4 (5.44)#	60.2 (50.89)**	77.4 (61.61)	53.7 (47.12)	63.77 (52.9)
UPI 106	75	23.9 (5.39)	71.6 (57.80)	82.8 (65.50)	65.8 (54.21)	73.40 (58.9)
UPI 106	100	22.8 (5.27)	74.1 (59.41)	85.3 (67.46)	65.7 (54.15)	75.03 (60.0)
Novaluron 10 EC	75	23.6 (5.36)	69.8 (56.66)	82.4 (65.20)	63.4 (52.77)	71.87 (57.9)
Chlorfenapyr10 SC	100	23.5 (5.35)	63.7 (52.95)	77.8 (61.89)	62.6 (52.30)	68.03 (55.5)
Lufenuron 5.4 EC	30	22.9 (5.29)	62.9 (52.48)	74.2 (59.47)	61.3 (51.53)	66.13 (54.4)
Untreated check	-	23.4 (5.34)	-	-	-	-
CD (P=0.05)	NS	2.92	2.86	1.82	2.15	

Mean of three replications over two-sprays, DAS- Days after spray,
***Figures in parentheses are angular transformed value, # Figures in parentheses are √ + 0.5 value, NS – Non significant*

The data (Table 4) revealed that UPI 106 @ 100g.a.i/ha (68.1%) was the most effective treatment that showed highest reduction in population of *Spodoptera litura* followed by Novaluron 10EC @75 g.a.i/ha (65.4%) UPI 106 @ 75 g .a.i/ha (63.2%), over the untreated check at 3 DAS. At 7 DAS, UPI 106 @ 100 g.a.i/ha (81.4%) was the most effective treatment that showed highest reduction in population of *Spodoptera litura* followed by UPI 106 @ 75 g .a.i/ha and Novaluron 10EC @75 g.a.i/ha (78.4%) over the untreated check. At 14 DAS, UPI 106 @ 100 g.a.i/ha (68.1%) was the most effective treatment that showed

Table 4: Relative efficacy of different new insecticidal molecules against obacco caterpillar on cabbage (2011-12)

Treatments	Dose (g.a. i/ha)	Pre treatment count/10 plants	% reduction in *Spodoptera litura* population over control*			Mean of post spray
			3 DAS	7 DAS	14 DAS	
UPI 106	50	23.6 (5.36) #	59.4 (50.42)	71.2 (57.54)	60.4(51.00)	63.67(52.9)
UPI 106	75	24.3 (5.43)	63.2(54.45)	78.4 (62.31)	66.8(54.82)	70.47 (57.0)
UPI 106	100	23.6 (5.36)	68.1(55.61)	81.4 (64.45)	68.1(55.61)	72.53(58.3)
Novaluron 10 EC	75	23.4 (5.34)	65.4(53.97)	78.4(62.31)	64.9(53.67)	69.57 (56.5)
Chlorfenapyr 10 SC	100	23.1 (5.31)	63.1 (52.59)	74.2 (59.47)	63.6 (52.89)	66.97 (54.9)
Lufenuron 5.4 EC	30	24.0 (5.40)	64.2(53.25)	73.7 (59.15)	62.3 (52.12)	66.73 (54.7)
Untreated check	-	23.8(5.38)	-	-	-	-
CD at 5%	NS	1.98	2.71	2.01	2.14	

**Mean of three replications over two-sprays, DAS- Days after spray,*
***Figures in parentheses are angular transformed value, # Figures in parentheses are √ + 0.5 value, NS – Non significant*

highest reduction in population of *Spodoptera litura* followed by UPI 106 @ 75 g .a.i/ha (66.8%), Novaluron 10EC @75 g.a.i/ha (64.9 %).

Data (Table 5) revealed that significant higher yield was also recorded with UPI 106 @ 100 g.a.i/ha which was, however, at par with UPI 106 @ 75 g.a.i/ha and Novaluron 10 % EC @ 75 g.a.i/ha in both the years of experimentation. Lowest yield was recorded in untreated plot due to highest infestation with DBM and *Spodoptera litura*. The pooled yield of cabbage ranged from 114.6 to 173.5 q ha^{-1}. The similar findings were reported by Paliwal (2000), Murthy and Ram (2002), Arora *et al.*, (2003) and Mahmoudvand *et al.* (2011).

Table 5: Influence of new insecticidal molecules with respect to yield of cabbage

S. No.	Treatments	Dose (g.a. i/ha)	Yield (q ha^{-1})*		
			2010-11	2011-12	Pooled
T_1	UPI 106	50	135.4	120.5	128.02
T_2	UPI 106	75	178.0	153.8	165.7
T_3	UPI 106	100	186.9	160.2	173.5
T_4	Novaluron 10 EC	75	176.3	150.1	163.2
T_5	Chlorfenapyr 10 SC	100	173.2	148.5	160.8
T_6	Lufenuron 5.4 EC	30	170.5	140.6	155.3
T_7	Untreated check	-	110.8	118.7	114.6
	CD at 5%		14.1	11.07	11.9

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