DOI: 10.15740/HAS/AU/12.TECHSEAR(6)2017/1612-1616 *Agriculture Update*
Volume **12** | TECHSEAR-6 | 2017 | 1612-1616
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RESEARCH ARTICLE :

Efficacy of certain insecticides against diamondback moth (*Plutella xylostella* L.) on cabbage (*Brassica oleracea* Var. *Capitata* L.)

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ARTICLE CHRONICLE :
Received :
17.07.2017;
Accepted :
01.08.2017

SUMMARY : Diamondback moth (*Plutella xylostella* L.) the most important destructive pest on cruciferous plants including of cabbage (*Brassica oleracea* var. *capitata* L.) through chemical control is effective against diamondback moth, development of resistance to insecticides often necessitates continuous evaluation and new molecules to manage the pest keeping in this view, the present study was conducted to evaluate the efficacy of seven insecticides against the incidence of diamondback moth in cabbage cultivar US-2158 " Among the tested insecticides, Spinosad 45% SC was found to be most effective with maximum reduction of larval population (61.79) to which was significantly suppress to control (64.12). Novaluron followed by chlorfenapyr 10% SC were least effective with larval reduction of 47.73 and 45.09%, respectively in conclusion , it was revealed that foliar application of Spinosad 45%EC at 30-10-2015 to 28-03-2016 is an effective manage chemical strategy to manage of incidence of diamondback moth is cabbage.

KEY WORDS:
Cabbage,
Diamondback moth,
Insecticides

How to cite this article : Venugopal, U., Kumar, Ashwani, Kota, Sathish and Ramya, V. (2017). Efficacy of certain insecticides against diamond back moth (*Plutella xylostella* L.) on cabbage (*Brassica oleracea* Var. *Capitata* L.). *Agric. Update,* **12**(TECHSEAR-6) : 1612-1616; **DOI: 10.15740/HAS/AU/12. TECHSEAR(6)2017/1612-1616.**

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BACKGROUND AND OBJECTIVES

Diamond back moth (*Plutella xylostella* L.) is the most destructive insect pestattacking cruciferous plants throughout the world .the pest was first recorded in 1746 in Europe and since then it has been reported is about 128 countries, with varied levels of infestation ranging from moderate is Asian region than the Mediterranean regions to high in South and Southeast Asians countries (Harcourt, 1963). Diamondback moth causes significant yield losses is cruciferous vegetables that including cabbage and broccoli by First instarlarvae begin feeding by boring through the cuticle of the leaf and mining in the tissue beneath. Depending on the larval of infestation the yield loss can range from to up 60 to 100% (Shelton *et al*., 1993) and the annual, global cost for managing the first is estimated at US $ 1 billion (Talekar rand Shelton,1993). In india, diamondback moth was first recoded is (Fletcher, 1914) in cruciferous vegetables and it is widely distributed in the states of Haryana,

Uttar Pradesh, Orissa, Bihar, West Bengal, Assam, Karnataka, Aandra Pradesh,Maharashtra, Madhya Pradesh and Tamil Nadu (Mehrotra and Phokela, 2000).The infestation of diamondback moth on cabbage (*Plutella xylostella*) can cause significant yield loss of 50-80% (Devjani and Singh, 1999 and Ayalew, 2014) and an economic loss of US $16 million every year (Mohan and Gujar, 2003) Hence, management of the pest is cabbage is inevitable minimize the yield loss and produce a profitable crop. Among the cruciferous crops, cauliflower and cabbage are the preferred hosts for DBM (Uthamasamy *et al.*,2011). Diamondback moth, *Plutella xylostella* is the key pest has developed resistance to all most all the recommend insecticides belonging to major groups in many parts of the world (Talekerand Shelton, 1993). But all ofthese insecticides have become less effective aftertwo to five years use by farmers. Since these problems occur, the farmers have increases the recommended dosage, spraying frequency chemicals to ensure the effective control. To solve these problems, the need for implementation of Integrated Pest Management (IPM) programme where control measures are based on economic threshold, the rightdosage or rate of insecticides application effectively. The most important of study was to observe the initial indication of resistance level of *Plutella xylostella* L.population on cabbage plants. Specifically, todetermine the concentrations of each tested insecticides against *Plutella xylostella* L.In this study, efficacy of certain insecticides against diamondback moth (*Plutella xylostella*) under field condition during *Rabi* season 2015-2016.

RESOURCES AND METHODS

The field trial was laid out at the university farm in Randomized Block Design with eight treatments including an untreated control, each with three replications. The cabbage cultivar "US-2158"was Seed beds were prepared it soon after germination stated. Seedlings were ready within 4-5 weeks with 5 to 6 leaves were transplanted in the well prepared field. Light irrigation immediately after transplanting and then at an intervals of 1-2 days were given for proper establishment of young seedlings, The plot size was 2m x 2m and the spacing between rows and plants was maintained at 45 and 45 cm, respectively. Selected seven insecticides used in this experiment and the latest recommend insecticides, reduction of *Plutella xylostella*. The first spray was applied as soon as the pest level crossed the ETL *i.e.* 4-5 larvae per plant and the second spray was given after 10 days first spray. All the respective spray fluids were sprayed thoroughly to cover each plant in every treatment. Spraying was done with the help of a knapsack sprayer.

Observations on diamondback moth, (*Plutella xylostella*) of cabbage and its population counts were recorded by randomly selecting 5 plants. The population

Table A: Details of insecticides used in experiment

Teatments	Cemicals name and formulation	Tade name	Goup	Dses (%)	Surce	Mde of action
T_1	Chlorantraniliprole 18.5%SC	Coragen	Diamide	0.0060	Ryanodine receptors modulators	Ryanodine receptor modulators
T_2	Emamectin benzoate 5% sp	Proclaim	Avermectin	0.015	Chloride channel activators.	Cl^- channel activator
T_3	Chlorfenapyr 10%SC	Intreprid	Haloginated Pyrroles	0.020	Distrupting Adenosine triphosphate	Disrupting of production Adenosine triphosphate
T_4	Spinosad 45%SC	tracer	Spinosyn	0.0030	Nicotinic acetyl choline Esterase blocking	Nicotinic acetylcholine Receptors antagonist
T_5	Indoxacarb 14.5%SC	Avaunt	Oxadiazine	0.030	Sodium channel inhibitors	Voltage dependent sodium channel blocker
T_6	Novaluron 10%EC	Rimon	Benzyl phenyl urea	0.015	Chitin synthase inhibitors	Chitin synthatase inhibitors
T_7	Flubendiamide 39.5%SC	Fame	diamide	0.0096	Ryanodine receptor modulators	Rynodine receptor modulators
T_0	Water (control)	-	-	-	-	-

count of diamondback moth larvae was recorded on the day before every spray which served as pre-treatment treatments observation and the subsequent counts were taken on three, seven and fourteen days after each spray (Post-treatment) following formula: (Henderson and Tilton, 1955).

$$P = 1 - \frac{C_b \times T_a}{T_b \times C_a} \times 100$$

where,

P = Per cent reduction in the population of pest.

C_b= Number of larvae on untreated check before treatment

T_a = Number of larvae on treated plot after treatment

T_b=Number of larvae on treated check after treatment

C_a=Number of larvae on untreated check after treatment

On the basis of population existing earlier (Pre-treatment) and surviving after application on three, seven and fourteen days, the observation on the larval population were taken preferably during morning hours. From these data the percentage reduction of diamondback moth, (*Plutella xylostella*)population was worked out and the data was subjecting to statistical analysis.

OBSERVATIONS AND ANALYSIS

The results of this study indicates that various insecticides concentration have difference effects on reducction of *Plutella xylostella*. 3 days after first spray, Spinosad 45 SC was most effective recorded highest reduction of diamond back moth population *i.e.* (60.06%), followed by Emamectin benzoate 5%SG (57.02%) Chlorantraniliprole 18.5%SC (51.02%), Flubendiamide 39.35% SC (50.72%), Indoxacarb 14.5% SC(48.56%), Novaluron 10% EC (45.54%), where as Chlorfenapyr 10% SC (40.03%) was least effective among all the treatments. Seven days after first spray, Spinosad 45 SC was still the best treatment in diamond back moth population *i.e.* (61.28%), followed by Emamectin benzoate 5%SG (60.06%), Chlorantraniliprole 18.5%SC (53.72%), Flubendiamide 39.35% SC(52.78%),%), Indoxacarb14.5%SC (49.82%), Novaluron 10%EC (48.52%), Chlorfenapyr 10% SC (42.71%) was least effective among all the treatments. Fourteen days after first spray same treatment continuous Spinosad 45 SC was best treatment reduction india mond back moth population *i.e.*(61.15%), followed by Emamectin benzoate 5%SG (59.53%) Chlorantraniliprole 18.5%SC (553.14%), Flubendiamide 39.35%SC (52.58%), Indoxacarb 14.5% SC (47.53%), Novaluron 10%EC(47.94%), whereas Chlorfenapyr 10%SC (43.42%) was least effective among all the treatments.

The results of this study indicates that various insecticides concentration have difference effects on reduction of *Plutella xylostella*. It was observed 3 days after second spray spinosad 45 SC recorded highest reduction of diamond back moth population *i.e.* (59.84%), followed by Emamectin benzoate 5%SG (56.38%) Chlorantraniliprole 18.5%SC (54.87%), Flubendiamide 39.35% SC(54.52%),Indoxacarb 14.5%SC (47.25%), Novaluron 10%EC(46.63%), where as Chlorfenapyr 10%SC (45.51%)was least effective among all the treatments. Seven days after second spray, Spinosad 45 SC was still the best treatment reduction of diamond back

Table 1 : Efficacy of certain insecticides against diamond back moth (*Plutella xylostella*)on cabbage during *Rabi* 2015-2016 (1st spray)

Treatment No.	Treatments	% Reduction in larval population of diamond back moth				
		Before spray	3 days	7 days	14 days	Mean
T_1	Chlorantraniliprole	4.58	51.20 (45.66)	53.72 (47.10)	54.52 (45.50)	53.14 (46.75)
T_2	Emamectin benzoate	4.63	57.02 (49.00)	60.06 (50.74)	61.52 (51)	59.53 (50.32)
T_3	Chlorfenapyr	4.34	40.03 (39.12)	42.71 (40.78)	47.54 (43.54)	43.42 (41.18)
T_4	Spinosad	4.72	60.06 (50.74)	61.28 (52.27)	61.78 (51.45)	61.15 (51.49)
T_5	Indoxacarb	4.41	48.56 (44.12	49.82 (44.86)	51.40 (45.78)	49.94 (44.92)
T_6	Novaluron	4.34	45.54 (42.04)	48.52 (44.12)	48.53 (44.12)	47.53 (43.54)
T_7	Flubendiamide	4.45	50.72 (45.30)	52.78 (46.52)	54.26 (47.39)	52.58 (45.38)
T_0	Control	4.16	64.53 (53.40	64.62 (53.46)	64.42 (53.34)	64.52 (53.04)
	Overall Mean	4.45	52.21	53.87	53.49	53.19
	F- test	NS	S	S	S	S
	S.E.±	0.05	0.16	0.12	0.13	0.08
	C. D. (P = 0.05)	0.22	0.54	0.40	0.26	0.38

*Figures in parentheses are arc sin transformed value NS= Non-significant S=Significant

moth population *i.e*. (69.90)%, followed by Emamectin benzoate 5% SG (59.83%), Chlorantraniliprole 18.5% SC (55.44%), Flubendiamide 39.35% SC (54.52%), Indoxacarb 14.5%SC (47.25%),Novaluron 10%EC (46.63%), Chlorfenapyr 10%SC (45.51%) was least effective among all the treatments. Fourteen days after second spray Spinosad 45 SC as best treatment reduction of diamond back moth population *i.e.* (62.43%), followed by Emamectin benzoate 5%SG (59.99%), Chlorantraniliprole18.5%SC (56.69%), Flubendiamide 39.35%SC (54.76%), Indoxacarb 14.5% SC (49.74%), Novaluron10% EC(48.53%), where as Chlorfenapyr 10%SC (46.76%) was least effective among all the treatments. But all treatments better reduction over control.

The results in reduction of *Plutella xylostella* over control on first and second spray revealed that all the treatments were significantly superior over control. Among all the treatments, Spinosad 45 SC recorded highest reduction of diamond back moth population *i.e*. (61.79)% which was significantly superior over control followed by Emamectin benzoate 5%SG (59.76%), Chlorantraniliprole 18.5%SC (55.06%), Flubendiamide 39.35%SC(53.76%), Indoxacarb 14.5%SC (49.25%), Novaluron 10%EC (48.73%), Chlorfenapyr 10%SC (45.09%) was least effective among all the treatments.

The concentration of treatments in reduction of larval population of *P. xylostella* reported that spinosad gave the highest percentage of reduction (61.79%).These

Table 2 : Efficacy of certain insecticides against diamondback moth (*Plutella xylostella)* on cabbage during *Rabi* 2015-2016 (2nd spray)

Treatments No.	Treatments	% Reduction in larval population of diamond back moth				
		Before spray	3 days	7 days	14 days	Mean
T_1	Chlorantraniliprole	3.62	54.87 (47.73)	55.54 (48.13)	59.82 (49.06	56.69 (48.31)
T_2	Emamectin benzoate	3.74	56.38 (48.06)	59.83 (50.63)	60.78 (51.15)	59.99 (50.50)
T_3	Chlorfenapyr	3.35	45.51 (42.40)	47.25 (43.8)	47.4 (43.49)	46.76 (42.89)
T_4	Spinosad	3.72	59.84 (50.63)	62.71 (52.33)	64.74 (53.52)	62.43 (52.16)
T_5	Indoxacarb	3.58	47.25 (43.37)	48.56 (44.12)	49.39 (44.58)	49.74 (44.02)
T_6	Novaluron	3.46	46.63 (43.03)	47.50 (43.49)	49.11 (44.35)	48.53 (43.56)
T_7	Flubendiamide	3.59	54.52 (47.02)	54.83 (47.44)	54.94 (47.79)	54.76 (47.41)
T_0	Control	3.81	63.76 (52.93)	63.62 (52.8)	63.82 (52.98)	63.73 (52.9)
	Overall mean	3.60	53.95	54.98	56.18	55.03
	F- test	NS	S	S	S	S
	S.E.±	0.10	0.25	0.19	0.12	0.06
	C.D. (P = 0.05)	0.10	0.35	0.25	0.28	0.40

*Figures in parentheses are arc sin transformed values NS= Non-significant S= Significant

Table 3: Efficacy of certain insecticides against diamond back moth (*Plutella xylostella*) on cabbage during *Rabi* 2015-2016 (Overall mean)

Treatments No.	Treatments	% Reduction over control larval population of diamond back moth		
		1st spray mean	2nd spray mean	Overall mean
T_1	Chlorantraniliprole	53.14 (46.75)	56.69 (48.83)	55.06 (47.54)
T_2	Emamectin benzoate	59.53 (50.45)	59.99 (50.69)	59.76 (50.57)
T_3	Chlorifenapyr	43.42 (41.19)	46.76 (42.89)	45.09 (42.04)
T_4	Spinosad	61.15 (51.45)	62.43 (52.33)	61.79 (51.89)
T_5	Indoxacrab	49.94 (44.92)	48.53 (44.06)	49.25 (44.49)
T_6	Novaluron	47.53 (43.43)	49.94 (43.56)	48.73 (43.49)
T_7	Flubendiamide	52.58 (46.47)	54.76 (47.71)	53.67 (47.09)
T_0	Control	64.52 (53.40)	63.73 (52.90)	64.12 (53.15)
	Overall mean	53.98	55.06	54.52
	F- test	S	S	S
	S.E. ±	0.08	0.06	0.12
	C. D. (P = 0.05)	0.35	0.40	0.52

*Figures in parentheses are arc sin transformed values S= Significant

results were reported by Nikam *et al*., 2014 (75.98). Its results are supported by Siddarth *et al*., 2015 (71.98). Emamectin benzoate was found to be next effective treatment 58.16% reduction over control reported that Chauan *et al*.,2014 (71.96%). These results was were similarly supported by Nikam *et al*., 2014 (69.65%). Chlorantraniliprole was reduction of population percentage (55.06%). These results were supported by Nikam *et al*., 2014. Flubendiamide treatment was reduction of population percentage (53.76%), its results was supported by Ayalew, 2014. Indoxacarb was reduction of population percentage (49.25%). These was results supported by Nikam *et al.*, 2014. Novaluron was reduction population percentage (48.73%). These results was supported by Ayalew, 2014, where as Chlorfenapyr was was least effective among all the treatments, compared with control.

Conclusion:

There were significant difference between different concentration and effectiveness, Spinosad, Emammectin benzoate, Chlorantraniliprole, Flubendiamide, Indoxacarb, Novaluron Chlorefenapyr, on the reduction of *Plutella xylostella*. The concentration 0.0030% and Emamectin benzoate 0.009% was the best concentration for controlling *Plutella xylostella* L. with reduction in more than 50 to 75%, respectively, these insecticides to control diamondback moth in cabbage (*Brassica oleracea* var. *capitata*) Spinosad was found to be the most effective followed by Emmamectin benzoate while the least effective insecticides Chlorfenapyr. Therefore, insecticides of short residuals effect on and bio pesticide like Spinosad may be useful in devising proper integrated management strategy against diamondback moth.

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