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BIO-EFFICACY OF NEWER MOLECULAR INSECTICIDES AGAINST DIAMONDBACK MOTH (*PLUTELLA XYLOSTELLA* L.) ON CAULIFLOWER

S. K. CHAUHAN, S.V.S. RAJU, B. M. MEENA, R. NAGAR[1]*, V. S. KIRAR AND S. C. MEENA[1]

Department of Entomology and Agricultural Zoology. Institute of Agricultural Sciences, BHU, Varanasi(UP)-221 005, India

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ABSTRACT

A study was conducted at Vegetable Research Farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi on bio-efficacy of newer insecticides i.e. Spinosad 2.5 SC@ 25 g a.i./ha, Alphamethrin 10 SC @ 50 g a.i./ha, Cypermethrin + Chlorpyrephos 55 EC @ 1100 g a.i. /ha, Cypermethrin 25 EC@ 75 g a.i./ha, Indoxacarb14.5 SC@ 350 g a.i./ha, Endosulphan 35 EC@ 450 g a.i./ha, Cartaphydrochloride 50 SP @ 400 g a.i./ha, and NSKE 5% @ 3250 g a.i./ha against diamondback moth (*Plutella xylostella* L.) on cauliflower crop during 2008-09 revealed that all the insecticide treatments were significantly superior over the control in term of higher yield and less infestation of diamondback moth. However, among the insecticidal treatments, comparative higher diamondback moth control and maximum marketable yield was recorded in treatments i.e. Spinosad 2.5 SC @ 25 g a.i./ha (59.71) followed by Indoxacarb 14.5 SC @ 350 g a.i./ha (53.56), Cypermethrin + Chlorpyrephos 55 EC@ 1100 g a.i. /ha (37.59), NSKE 5% @ 3250 g a.i./ha (36.33), Cypermethrin 25 EC @ 75 g a.i./ha (32.68), Alphamethrin 10 SC @ 50 g a.i. /ha, (30.20), Cartaphydrochloride 50 SP @ 400 g a.i./ha (27.96) and Endosulphan 35 EC @ 450 g a.i./ha (17.93).

Keywords:

Bio-efficacy, Diamondback moth, Insecticides

INTRODUCTION

Cabbage (*Brassica oleraceae* var. botrylis L.) is a major vegetable produced and consumed widely in India with production 6.5 million tonne of cabbage per year from 0.349 million ha area with an average productivity of about 18.62 MT/ha. The crop is of considerable economic importance and is often produced under small holder condition. Over the year it is been cultivated more intensively, which has resulted in high pest infestation. It is believed that more than 40% yield loss is caused due to direct pest attack in different vegetables (Srinivasan, 1993) Diamondback moth (DBM), *Plutella xylostella* L. (Lepidoptera: Plutellidae), head caterpillar (*Crocidolomiabinotalis*), web worm (*Hellulaundalis*), cabbage butterflies (*Pierisbrassicae*), aphid (*Liphapiserysimi*) and flea beetle (*Phyllotretabrassicae*) is the major constraints in the profitable cultivation of cole crops. Diamondback moth (DBM) is the most serious pest of cabbage and responsible for low productivity of this crop. It is preferred host plant is cauliflower and cabbage. The loss yield caused by this pest varies from 31-100% (Lingappa *et al.*, 2006). It was estimated least 53-80% present loss in marketable yield is due to DBM attack alone and loss could be more if the attack is severe (Chelliah and Srinivasan, 1986). DBM become the first crop pest in the world to develop resistance to DDT (Ankersmit, 1935; Jhonson, 1953) and now in many countries the DBM has developed resistance to every synthetic insecticides used against it in the field (Telkar *et al.*, 1990). India first report of insecticide resistance development in the moth had come in 1966 around Ludhiyana, Punjab, against DDT and Parathion (Verma and Sandhu, 1968). Since then moth has developed resistance to many of the organophosphates, carbamates and pyrethroids and is well on its way to develop multiple resistance in India.

Novel insecticides with unique mode of action were registered during the late 1990s and early 2000s for insect control in agriculture. Insecticides of this group act on insect processes than human do not experience, such as molting. Low mammalian toxicity, also have greater selectivity and so less likely to harm natural enemies, they are less likely to cause outbreaks of secondary pest. Keeping the above points in view, the experiment was envisaged to evaluate the field efficacy of different insecticides, against diamondback moth on cauliflower.

MATERIALS AND METHODS

The experiment was carried out during *Rabi* season of the year 2009-10 at Vegetable Research Farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

**Corresponding author email: rajendranagar86@gmail.com, [1]Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, BHU, Varanasi-221005, Uttar Pradesh*

Experiment was conducted in a complete randomized block design with three replications having plot size of 4 × 3m and spacing between row to row and plant to plant as 60 cm and 45 cm respectively. Transplanting of Cauliflower variety Snowboll was done in the field. All the standard agronomic practices were followed to raise the good crop. Nine treatments including control i.e. Spinosad (2.5 SC), Alphamethrin (10 SC), Cypermethrin + Chlorpyrephos (55 EC), Cypermethrin (25 EC), Indoxacarb (14.5 SC), Endosulphan (35 EC), Cartaphydrochloride (50 SP), and NSKE (5%). Record the larval population of diamondback moth during various crop growth stages; one square meter area having 9-10 plants in the center of each plot was randomly selected. The population count was made on total leaves of each plant in one square meter area in each plot. The observations on DBM population were recorded at weekly intervals for decision making to carry out pest control operations. Pre-spray counts of DBM larvae at one day before and post-spray counts on 1st, 3rd, 5th, 7th, and 10th day after the application. The yield data obtained from each plot in each replication. The population data thus obtained was converted into per cent efficacy in population using the method employed by Handerson and Tilton (1955).

$$\text{Percent efficacy} = 1 - \left\{\frac{Cb \times Ta}{Tb \times Ca}\right\} \times 100$$

Where:

Cb = number of larvae on untreated check before treatment

Ta = number of larvae on treated plot after treatment

Tb = number of larvae on treated plot before treatment

Ca = number of larvae on untreated check after treatment

RESULTS AND DISCUSSION

First spray, the mean per cent reduction in larval population in plots receiving, Spinosad @ 25 g a.i/ha, Indoxacarb @ 350 g a.i/ha, Cypermethrin @ 75 g a.i/ha, and Cypermethrin + Chlorpyriphos @ 1100 g a.i/ha are significantly differ from Alphamethrin @ 50 g a.i/ha, Cartap hydrochloride @ 400 g a.i/ha, NSKE @ 3250 g a.i/ha and endosulphan @ 450 g a.i/ha. Highest per cent 62.60 was recorded on first day after Cypermethrin + chlorpyriphos @ 1100 g a.i/ha followed by Spinosad 60.20 per cent (Table-1). The recorded high level of resistance to endosulphan and other organophosphates groups of compounds including quinalphos. Spinosad 2.5 SC at 15 g a.i./ha resulted in significantly better control of diamond back moth larvae in comparison with chlorpyrifos, quinalphos, cypermethrin and *Bacillus thuringiensis* (*Bt*). Similar results were also observed by Shivalingaswami, (2006) on 3rd, 5th, and 7th day of the treatment, lowest DBM population was recorded in insecticidal Spinosad @ 25 g a.i/ha and differed significantly from rest of the standard insecticidal treatment, except with Indoxacarb @ 350 g a.i/ha treatment. The field efficacy in terms of DBM larvae reduction over control of various insecticides when calculated revealed that highest field efficacy of 82.80, 84.00, 80.40 were recorded during 3rd , 5th, and 7th day of Spinosad, followed by Indoxacarb (78.00, 84.00 and 75.60%) treatments (Boas *et al*., 2004). Spinosad, indoxacarb and *B. thuringiensis* var. kurstaki were the most efficient in controlling the pest. A novel insecticide indoxacarb found as effective as spinosad, and significantly more effective than emamectin benzoate (Liu *et al.*, 2003).

The mean larval population per plant and the respective per cent field efficacy of various test insecticides after 2nd insecticidal sprays was given in (Table-2). The mean per cent larval reduction over control with indoxacarb @ 350 g a.i/ha was maximum on 1st and 3rd day of insecticidal applications. After 5th day of second insecticidal application maximum per cent field efficacy was recorded again with Spinosad @ 25 g a.i/ha (94.00) followed by indoxcarb @ 75 g a.i/ha (90.00%) reduction in larval number was observed to be significantly maximum on 7th day of second insecticidal treatments with Spinosad @ 25 g a.i/ha (69.90) followed by Indoxacarb @ 350 g a.i/ha (67.00) treatment. After 10th day of second spray of insecticidal treatments, the per cent field efficacy in spinosad @ 25 g a.i/ha treated plots was as high as 69.90 followed by Indoxacarb @ 350 g a.i/ha (67.00) treated plots. The respective per cent reduction in DBM larval population was significantly differed from rest of insecticidal treatments (Table-2).

A day after third insecticidal treatments the mean per cent field efficacy of Spinosad @ 25 g a.i/ha, Cypermethrin + chlorpyriphos @ 1100 g a.i/ha and Indoxacarb @ 350 g a.i/ha was observed to be highest when compared to the other treatment. Cartap hydrochloride at 500 g a.i/ha recorded significantly lower numbers of diamondback moth larvae/head. Difenthiuron at 300 g a.i/ha and thiodicarb at 750 g a.i/ha were next best in efficacy (Satpathy and Rai, 1999) Rajavel and Babu, (1989). The mean per cent field efficacy of Spinosad @ 25 g a.i/ha (96.00) followed by Indoxacarb @ 350 g a.i/ha (82.80) was highest on 5th day after insecticidal application and differed significantly from rest of the other treatments. The mean per cent field efficacy was observed to be significantly maximum on 7th day of insecticidal treatment with Spinosad @ 25 g a.i/ha (91.00%) followed by Indoxacarb @ 350 g a.i/ha (74.80%) treated plots. The mean per cent field efficacy was again observed to be maximum on 10th day of insecticidal treatments with Spinosad @ 25 g a.i/ha (78.00) followed by Indoxacarb @ 350 g a.i/ha (64.00) treated plots (Table-3). Thiodan 35 EC at 1000 ml/ha and Padan 50 SP cartaphydrochloride at 500 g/ha. The three new insecticides resulted in significantly maximum reduction in *Plutella xylostella* larval population ranging

from 84.54 to 93.58% on cauliflower and 89.24 to 91.49% on cabbage crop compared to 43.14-58.60% reduction in standard controls on cauliflower and 68.61-77.45% reduction on cabbage crop, respectively (Satpathy *et al.*, 2007; Gill *et al*., 2008).

Table 1 Bio-efficacy of newer insecticidal molecules against *Plutella xylostella* larvae on Cauliflower during r*abi* season 1st spray

Treatment	Mean per cent 1st spray					Mean
	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
Cypermethrin + Chlorpyrephos 55EC@1100 g.a.i. /ha	62.60 (52.30)	66.60 (54.70)	57.40 (49.26)	42.20 (40.51)	40.10 (39.29)	53.70 (47.12)
Alphamethrin 10SC @50 g.a.i. /ha	50.20 (45.11)	56.00 (48.45)	45.60 (42.48)	34.00 (35.67)	31.60 (34.20)	43.48 (41.44)
Spinosad2.5SC@25g.a.i./ha	60.20 (50.89)	82.80 (65.5)	84.00 (66.42)	80.40 (63.72)	65.40 (53.97)	74.56 (59.67)
Indoxacarb 14.5SC@350 g.a.i./ha	57.00 (49.02)	78.00 (62.03)	84.00 (66.42)	75.60 (60.40)	63.10 (52.59)	71.40 (57.67)
Cypermethrin 25EC@75 g.a.i./ha	53.50 (47.01)	58.40 (49.84)	43.50 (41.27)	39.00 (38.65)	26.30 (30.85)	44.14 (44.48)
Cartaphydrochloride50SP@400 g.a.i./ha	41.70 (40.22)	70.00 (56.79)	72.00 (58.05)	49.00 (44.43)	45.00 (42.13)	55.50 (48.16)
Endosulphan35EC@ 450g.a.i./ha	29.50 (32.90)	52.70 (46.55)	55.00 (47.87)	50.00 (45.00)	26.70 (31.11)	42.78 (40.86)
NSKE5%@3250 g.a.i./ha	36.00 (36.87)	55.50 (48.16)	57.90 (49.55)	45.10 (42.19)	36.00 (36.87)	46.10 (42.76)
CD (*P*=0.05)	4.89	2.91	4.01	3.59	2.94	-

Figures in the parentheses are angular transformation values, DAS=Days after spray

Table 2 Bio-efficacy of newer insecticidal molecules against *P. xylostella* larvae on Cauliflower during *rabi* season 2nd spray

Treatment	Mean per cent 2nd spray					Mean
	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
Cypermethrin + Chlorpyrephos 55EC@1100 g.a.i. /ha	57.40 (49.26)	59.20 (50.30)	50.80 (45.46)	43.00 (4.98)	37.70 (37.88)	49.62 (44.77)
Alphamethrin 10SC @50 g.a.i. /ha	50.70 (45.40)	55.20 (47.98)	43.00 (40.98)	34.00 (35.67)	32.80 (34.94)	43.14 (41.03)
Spinosad 2.5SC@25g.a.i./ha	64.00 (53.13)	83.00 (65.65)	94.00 (75.82)	89.30 (70.91)	69.90 (56.37)	80.04 (63.43)
Indoxacarb 14.5SC@350 g.a.i./ha	66.00 (54.33)	83.70 (66.19)	90.00 (71.57)	85.00 (67.21)	67.00 (54.94)	78.34 (62.24)
Cypermethrin 25EC@75 g.a.i./ha	53.20 (46.83)	61.50 (51.65)	44.30 (41.73)	41.80 (40.28)	24.60 (29.73)	45.08 (42.19)
Cartaphydrochloride50SP@400 g.a.i./ha	52.00 (46.15)	74.00 (59.34)	81.00 (64.16)	63.20 (52.65)	54.10 (47.35)	64.86 (53.61)
Endosulphan35EC@ 450g.a.i./ha	37.60 (37.82)	40.10 (39.29)	55.50 (48.16)	46.30 (42.88)	25.00 (30.00)	40.90 (39.76)
NSKE5%@3250 g.a.i./ha	35.40 (36.51)	56.50 (48.73)	63.30 (52.71)	49.40 (44.66)	38.40 (38.29)	48.60 (44.20)
CD (*P*=0.05)	4.35	3.02	4.76	4.01	3.51	-

Figures in the parentheses are angular transformation values, DAS=Days after spray

The overall mean larval population of post insecticidal spray was observed to be lowest in Spinosad @ 25 g a.i/ha (0.75) with 85.56 mean per cent bio-efficacy and was significantly differed from all other treatments. Cartap hydrochloride @ 400 g a.i/ha treated plot recorded an overall mean larval population of 1.35/plant when compared with over all mean larval population of 9.10 larvae/plant in untreated plot. The mean per cent population reduction of DBM larvae among the test insecticides after spray was compared with larval population present on the crop before spray (Zhihua *et al.*, 2006). The mean per cent field efficacy was observed to be maximum after the post insecticidal spray

with Spinosad @ 25 g a.i/ha (85.56%) followed by Indoxacarb @ 350 g a.i/ha (70.90%) treated plots. Nagesh and Shashi (1997) determined the comparative efficacy of bio rational insecticide and newer molecular insecticides.

Effect of insecticides on marketable cabbage head yield

The data on yield of harvested cauliflower heads from the plots receiving insecticidal treatments as well as from controlled plots was presented in Table-4. Marketable heads were harvested in three pickings. During the first picking a maximum of 9.25 kg/plot cauliflower heads were harvested from Indoxacarb @ 350 g a.i/ha followed by Spinosad @ 25 g a.i/ha (9.00 kg) treated plots. No statistically significant difference in these treatments in terms of yield was observed during the first picking. The mean yield of harvested heads in control plots after first picking was 5.50 kg/plot and was significantly low when compared to the yield observed in the entire insecticidal treated plot.

The mean yield of harvested heads after second picking was as high as 14.00 kg per plot in Spinosad @ 25 g a.i/ha followed by Indoxacarb @ 350 g a.i/ha (13.00 kg/plot) treated plots and differ significantly from cauliflower yield recorded from rest of the insecticidal treated plots. Even during the third picking of cauliflower heads, a maximum of 9.50 kg/plot was recorded with Spinosad @ 25 g a.i/ha and Indoxacarb @ 350 g a.i/ha (9.00 kg/plot) treated plots and differed significantly from the yield recorded in the plots treated with Endosulphan @450 g a.i/ha (6.00 kg/plot).

The total yield of all the three pickings of different plots receiving various insecticidal treatments including control, ranged from 20.35-32.50 kg/plot. The yield was maximum in Spinosad @ 25 g a.i/ha (32.50 kg) treated plot followed by Indoxacarb @ 350 g a.i/ha (31.25 kg) and NSKE @ 3250 g a.i/ha (27.75 kg). The mean yield in the former two treatments did not differ significantly, but differed significantly from the yield recorded from rest of the insecticidal treated plots. Lowest yield of 24.00 kg was recorded in plots receiving endosulphan @ 450 g a.i/ha mean yield was highest in Spinosad @ 25 g a.i/ha (270.83 q/ha) followed by Indoxacarb @ 350 g a.i/ha (260.41 q/ha), Cypermethrin + chlorpyriphos @ 1100 g a.i/ha (233.33 q/ha), NSKE @ 3250 g a.i/ha (231.25q/ha), Cypermethrin @ 75 g a.i/ha (225.00 q/ha) treatments. As high as 59.71% increase in yield over control treatment was recorded in Spinosad @ 25 g a.i/ha (59.71%) treated plot followed by Indoxacarb @ 350 g a.i/ha (53.56%).

Table 3 Bio-efficacy of newer insecticidal molecules against *Plutella xylostella* larvae on Cauliflower during *rabi* season 3st spray

Treatment	Mean per cent 3rd spray					Mean
	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
Cypermethrin + Chlorpyrephos 55EC@1100 g.a.i. /ha	59.30 (50.36)	66.00 (54.33)	54.60 (47.64)	46.90 (43.22)	37.00 (37.46)	52.76 (46.49)
Alphamethrin 10SC @50 g.a.i. /ha	54.50 (47.58)	61.30 (51.53)	49.20 (44.54)	45.60 (42.48)	34.20 (35.79)	48.96 (44.37)
Spinosad2.5SC@25g.a.i./ha	73.20 (58.82)	89.60 (71.19)	96.00 (78.46)	91.00 (72.54)	78.00 (62.03)	85.56 (67.70)
Indoxacarb 14.5SC@350 g.a.i./ha	56.40 (48.68)	76.50 (61.00)	82.80 (65.50)	74.80 (59.66)	64.00 (53.13)	70.90 (57.35)
Cypermethrin 25EC@75 g.a.i./ha	51.60 (45.92)	57.70 (49.43)	39.50 (38.94)	37.00 (37.46)	32.00 (34.45)	43.56 (41.32)
Cartaphydrochloride50SP@400 g.a.i./ha	55.50 (48.16)	75.30 (60.20)	88.70 (70.36)	66.80 (54.82)	58.00 (49.60)	68.86 (56.07)
Endosulphan35EC@ 450g.a.i./ha	33.90 (35.61)	55.60 (48.22)	63.70 (52.95)	55.80 (48.33)	32.20 (34.57)	48.24 (43.97)
NSKE5%@3250 g.a.i./ha	51.60 (45.92)	71.00 (57.42)	79.00 (62.73)	58.00 (49.60)	50.00 (45.00)	61.92 (51.88)
CD (*P*=0.05)	3.34	2.86	4.72	2.25	4.00	-

Figures in the parentheses are angular transformation values, DAS=Days after spray

In untreated control the mean yield was only 20.35 kg/plot and differed significantly from all the other insecticidal treatments. Wemin and Wesis (2006) observed the effects of P. xylostella on the yield of treatments consisted of 1.25 litre endosulphan/ha (first spray) + 2.0 litre sazadirachtin (second spray) + 1.25 kg B.t.k [*Bacillus thuringiensis* subsp. kurstaki]/ha (third spray), M1; 2.0 litresazadirachtin + 1.25 kg B.t.k. + 15.0 g spinosada.i./ha, M2; 1.25 litre endosulfan + 750.0 ml beta-cyfluthrin + 2.0 litre sazadirachtin/ha, M3; 1.25 kg B.t.k. + 200.0 g diflubenzuron + 1.25 litreendosulfan/ha, M4; 15.0 g spinosad (a.i.) + 2.0 litre sazadirachtin + 1.25 kg B.t.k./ha, M5; 200.0 g diflubenzuron + 15.0 g spinosad + 2.0 litre sazadirachtin/ha.

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Table 4 Impact of various insecticidal treatments on cauliflower yield during *rabi* season 2009-10

Treatment	Mean weight (Kg/plot)			Total yield (Kg/plot)	Mean yield (Q/ha)	Yield increase over control (%)
	1st pick	2nd pick	3rd pick			
Cypermethrin + Chlorpyrephos 55EC@1100 g.a.i. /ha	7.75	11.00	9.25	28.00	233.33	37.59
Alphamethrin 10SC @50 g.a.i. /ha	7.50	10.75	8.25	26.50	220.80	30.20
Spinosad 2.5SC@25g.a.i./ha	9.00	14.00	9.50	32.50	270.83	59.71
Indoxacarb 14.5SC@350 g.a.i./ha	9.25	13.00	9.00	31.25	260.41	53.56
Cypermethrin 25EC@75 g.a.i./ha	7.50	10.75	8.75	27.00	225.00	32.68
Cartaphydrochloride50SP@400 g.a.i./ha	8.10	10.00	8.00	26.10	217.50	27.96
Endosulphan35EC@ 450g.a.i./ha	6.75	11.25	6.00	24.00	200.00	17.93
NSKE5%@3250 g.a.i./ha	8.25	12.50	7.00	27.75	231.25	36.33
Control	5.50	8.35	6.50	20.35	169.58	-
CD (P=0.05)	0.63	1.28	0.95	1.88	-	-

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