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Relative efficacy of newer insecticides against *Helicoverpa armigera* (Hubner) in tomato under South Gujarat condition

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ABSTRACT

Field experiment conducted on relative efficacy of nine different insecticides against *H. armigera* (Hubner) in tomato during year 2012-13 revealed that all the nine insecticides were significantly superior to untreated control in reducing *H. armigera* infestation. However, flubendiamide 0.004 per cent recorded minimum larval population (0.43 larva/ plant) and 10.09 per cent fruit damage on weight basis than the remaining treatments which was identical with chlorantraniliprole 0.0055 per cent (0.58 larva/plant and 10.62 % fruit damage) and spinosad 0.0068 per cent (0.68 larva/plant and 11.34 % fruit damage). Higher marketable yield recorded from treatments of flubendiamide 0.004 per cent chlorantraniliprole 0.0055 per cent and spinosad 0.0068 per cent with 25.21, 24.84 and 22.20 tonnes/ha, respectively.

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INTRODUCTION

Tomato (*Lycopersion esculentum* Mill) is an important vegetable crop grown around the world occupying the daily food regime of a majority of people. Tomato fruit borer, *Helicoverpa armigera* is an important pest which causes considerable losses in quantity as well as quality of tomato fruits (Singh and Chahal, 1978; Tewari and Moorthy, 1984; Reddy and Zehrm, 2004). The monetary loss due to this pest in India has been estimated over rupees one thousand crore per year (Jayaraj *et al.*, 1994) and yield losses ranged from 14 to 100 per cent on different crops. Due to its economic importance considerable amount of work has been done for its control by biological means but the biological means tried so far have not been successful because the larva is the damaging stage which bores and remains inside the tomato fruit. *H. armigera* has assumed such proportions in the country for the past decade, farmers and plant protection agencies of central and state governments of India have virtually become perplexed regarding its control which ultimately leads to an array of social, economical and political problems. In past decades unreasoned and systematic calendar spraying of chemical control on tomato has been replaced by integrated pest management in India. To improve upon this problem, the most commonly method for the control of this pest is to have a film of a insecticide over foliage and fruiting bodies (Datkhile *et al*., 1992; Sharma *et al*., 1993). The main objective of study is the determination of the efficacy of nine insecticides at field against *Helicoverpa armigera* infesting tomato.

MATERIAL AND METHODS

Field trial was conducted during 2012-13 at College Farm, Navsari Agricultural University, Navsari, Gujarat, India. The experiment was laid out in Randomized Block Design (RBD) with 10 treatments replicated thrice in 3 x 1.35 m^2 plot size with a spacing of 60 x 45cm. The tomato (cv. JT-3) was raised as per the recommended package of practices except plant protection measures. The first spray was initiated at 5 per cent fruit infestation noticed in the field and second and third sprays were given at an interval of 15 days. The spraying was done with the help of lever operated Knapsack sprayer (15 litre capacity). The number of fruit borer larvae, damaged fruits and total number of fruits on weight basis were counted on ten randomly selected plants in each net plot, a day before application of insecticides and at 3, 7, 10 and 14 days after each spray. However, per cent larval and fruit damage reduction over control was calculated. The percentage of damaged fruits on weight basis was recorded from weight of damaged and total weight of fruits at the time of each picking by using following formula (Rahman *et al.*, 2006).

$$\textbf{Per cent fruit infestation (Wt. basis)} = \frac{\textbf{Weight of infested fruits}}{\textbf{Total weight of fruits}} \times 100$$

The data were converted to square root for larval population analysis and arcsine transformation used for per cent fruit damage before statistical analysis. The fruit yield per plot was also recorded at each harvest.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

Larval population :

The results showed that all the insecticidal treatments recorded significantly lowest larval population over control (Table 1). The mean data of first spraying recorded at 3, 7, 10 and 14 DAS revealed that flubendiamide 0.004 per cent found most effective by recording the significantly minimum larval population (0.49 larvae/plant) and found to be at par with chlorantraniliprole 0.0055 per cent (0.66 larva/plant) followed by spinosad 0.0068 per cent (0.72 larva/plant). The treatment indoxacarb 0.0087 per cent (1.02 larvae/ plant) was found to be next succeeding treatment and found statistically at par with emamectin benzoate 0.0015 per cent (1.14 larvae/plant), novaluron 0.0075 per cent (1.18 larvae/plant), chlorfenapyr 0.0075 per cent (1.29 larvae/plant) and profenofos 0.075 per cent (1.30 larvae/ plant).

It can be seen from the mean data of second spray that flubendiamide 0.004 per cent was found to be superior among all other tested insecticides with 0.44 larva per plant. This was found comparable with chlorantraniliprole 0.0055 per cent (0.63 larva/plant) followed by treatment of spinosad 0.0068 per cent (0.67 larva/plant). The effectiveness of remaining insecticides in ascending order was indoxacarb 0.0087 per cent (1.07 larvae/plant) < emamectin benzoate 0.0015 per cent (1.08 larvae/plant) < novaluron 0.0075 per cent (1.16 larvae/plant) < chlorfenapyr 0.0075 per cent (1.31 larvae/plant) < profenofos 0.075 per cent (1.33 larvae/plant) < triazophos 0.05 (1.39 larvae/plant). The highest larval population was recorded in untreated control with 2.15 larvae per plant of *H. armigera.*

The mean data of third spray indicated that all the insecticidal treatments were superior over control. Among the different insecticidal treatments tested, the lowest larval population (0.36 larva/plant) of *H. armigera* was noticed in the treatment of flubendiamide 0.004 per cent and it was statistically comparable with chlorantraniliprole 0.0055 per cent (0.47 larva/plant). However, the larval population in rest of treatments ranged from 0.65 to 1.39 larvae / plant as against control (2.29 larvae / plant).

The average data of first, second and third spray revealed that minimum larval population (0.43 larva/plant) was existed in the treatment of flubendiamide 0.004 per cent which was comparable with treatments of chlorantraniliprole 0.0055 per cent (0.58 larva/plant) followed by spinosad 0.0068 per cent (0.68 larva/plant). The treatments of triazophos 0.05 per cent (1.39 larvae/ plant) were found least effective against *L. orbonalis.* The rest of treatments *viz.*, indoxacarb 0.0087, emamectin benzoate 0.0015, novaluron 0.0075, chlorfenapyr 0.0075 and profenefos 0.075 per cent which were statistically at par with each other by recording 1.02, 1.07, 1.16, 1.28 and 1.32 larval population per plant of *H. armigera*, respectively.

The results of present investigation can be compared with the results of Ameta and Bunker (2007) who found the similar result and noted that flubendiamide @ 48 g a.i/ha caused significantly mean reduction of fruit borer larvae with 65.2, 77.5 and 84.6 per cent at 5 days after first, second and third spray during 2005-06, respectively and it was 70.0, 75.4 and 86.2 per cent during 2006-07. Jat and Ameta (2013) recorded that flubendiamide 480 SC at 200 ml/ha was found significantly most effective which caused highest mean reduction of tomato fruit borer larvae by recording 89.94 per cent. Moreover, Ghosal *et al*. (2012) observed that rynaxypyr 18.5 SC @ 40 g a.i./ha was found superior over other treatments against *Helicoverpa* with 98.04 per cent reduction of fruit borer population.

However, Katroju *et al.* (2014) observed maximum per cent reduction in fruit borer population (65.20 %) in treatment of profenophos (1000 g a.i./ha) whereas, in present investigation the treatment of profenophos recorded highest larval population as compared to other insecticidal treatments. It might be due to pest develop resistance to this insecticide and also different dose, different climatic condition and different experimental place.

Fruit damage on weight basis :

The mean data of first spray revealed that all the insecticidal treatments exhibited significantly lowest per cent fruit infestation of *H. armigera* as compared to control. However, the flubendiamide 0.004 per cent found most effective by recording the significantly minimum fruit infestation (11.34 %) which was significantly identical with chlorantraniliprole 0.0055 per cent (11.90 %) and spinosad 0.0068 per cent (13.01 %). The treatment of triazophos 0.05 per cent was found to be least (22.50 %) effective for the control of tomato fruit borer. The all other treatments recorded fruit infestation ranged from 17.41 to 21.68 per cent.

Almost similar trend was recorded after second spray; flubendiamide 0.004 per cent recorded significantly least per cent fruit damage (9.96 %) among all other tested. This treatment was found comparable with chlorantraniliprole 0.0055 per cent (10.46 %) and spinosad 0.0068 per cent (10.97 %). The effectiveness of remaining insecticides in ascending order was indoxacarb 0.0087 per cent (16.27 %) < emamectin benzoate 0.0015 per cent (16.44 %) < novaluron 0.0075 per cent (16.58 %) < chlorfenapyr 0.0075 per cent (18.21 %) < profenofos 0.075 per cent (18.88 %) < triazophos 0.05 (19.65 %).

The mean data of third spray on weight basis revealed that significantly the lowest fruit infestation (8.96 %) of *H. armigera* was observed in the treatment of flubendiamide 0.004 per cent. This was at par with chlorantraniliprole 0.0055 and spinosad 0.0068 per cent which exhibited 9.50 and 10.04 per cent fruit infestation, respectively. The rest of treatments recorded fruit infestation ranged from 16.32 to 19.82 per cent.

The mean of data first, second and third spray during 2012-13 revealed that minimum fruit infestation (10.09 %) was existed in the treatment of flubendiamide 0.004 per cent which was comparable with treatments of chlorantraniliprole 0.0055 per cent (10.62 %) and spinosad 0.0068 per cent (11.34 %). The treatments of chlorfenapyr 0.0075 per cent (19.10 %), profenofos 0.075 per cent (19.90 %) and triazophos 0.05 per cent (20.66 %) found least effective against *H. armigera.* The rest of treatments *viz.*, indoxacarb 0.0087, emamectin benzoate 0.0015 and novaluron 0.0075 per cent which were statistically at par with each other recorded 16.66, 16.90 and 17.26 per cent fruit infestation of *H. armigera*, respectively.

In past, Singh *et al*. (2005) revealed that acephate 75 SP @ 2 kg/ha had minimum fruit damage (7.44 %) which was at par with indoxacarb 14.5 SC @ 500 ml/ha recorded 8.93 per cent fruit damage. Kubendran *et al*. (2008) noted lowest mean per cent fruit damage (3.41 %) was recorded in plots treated with flubendiamide 480 SC @ 125 ml/ha followed by flubendiamide 480 SC @ 100 ml/ha and spinosad 45 SC @ 200 ml/ha which showed 6.00 and 6.28 per cent fruit damage, respectively. Kuttalam *et al*. (2008) found lowest per cent fruit damage in treatment of flubendiamide 480 SC @ 48 g a.i./ha recorded 0.08 and 3.06 per cent during 2005 and 2007, respectively. Moreover, Ha *et al*. (2013) testedemamectin benzoate 19 EC and found that significantly lowest per cent fruit infestation per plant during first, second, third and fourth spray with 1.59, 1.08, 0.65 and 1.22 per cent, respectively.

The result of present experiment matched with

Table 1 : Relative efficacy of different insecticide on *H. armigera* infesting tomato

Sr. No.	Treatments	Conc. (%)	Mean larval population of *H. armigera*/plant					Mean fruit infestation of *H. armigera* (Weight basis)					Yield (t/ha)
			1 DBS	1st spray	2nd spray	3rd spray	Mean	1 DBS	1st spray	2nd spray	3rd spray	Mean	
1.	Spinosad	0.0068	1.19	0.84	0.81	0.80	0.82	31.63	20.88	19.19	18.14	19.40	22.20
	45 SC		(1.42)*	(0.72)	(0.67)	(0.65)	(0.68)	(27.66)**	(13.01)	(10.97)	(10.04)	(11.34)	
2.	Emamectin benzoate	0.0015	1.21	1.06	1.04	1.00	1.04	31.61	24.95	23.85	23.77	24.19	20.89
	5 SG		(1.46)	(1.14)	(1.08)	(1.01)	(1.07)	(27.69)	(17.88)	(16.44)	(16.39)	(16.90)	
3.	Indoxacarb	0.0087	1.22	1.01	1.03	0.98	1.01	32.30	24.51	23.71	23.70	23.97	21.30
	14.5 SC		(1.50)	(1.02)	(1.07)	(0.96)	(1.02)	(28.74)	(17.41)	(16.27)	(16.32)	(16.66)	
4.	Flubendiamide	0.004	1.18	0.68	0.64	0.57	0.63	32.08	19.43	18.17	17.09	18.23	25.21
	20 WG		(1.39)	(0.49)	(0.44)	(0.36)	(0.43)	(28.20)	(11.34)	(9.96)	(8.96)	(10.09)	
5.	Chlorantraniliprole	0.0055	1.19	0.80	0.78	0.67	0.75	30.81	19.91	18.66	17.59	18.72	24.84
	18.5 SC		(1.43)	(0.66)	(0.63)	(0.47)	(0.58)	(26.23)	(11.90)	(10.46)	(9.50)	(10.62)	
6.	Chlorfenapyr	0.0075	1.21	1.14	1.14	1.11	1.13	31.36	26.94	25.17	25.37	25.83	19.35
	10 EC		(1.46)	(1.29)	(1.31)	(1.23)	(1.28)	(27.21)	(20.62)	(18.21)	(18.47)	(19.10)	
7.	Profenofos	0.075	1.22	1.14	1.15	1.15	1.15	30.58	27.68	25.70	25.90	26.42	17.91
	50 EC		(1.49	(1.30)	(1.33)	(1.32)	(1.32)	(26.25)	(21.68)	(18.88)	(19.16)	(19.90)	
8.	Novaluron	0.0075	1.17	1.08	1.08	1.07	1.08	32.53	25.29	23.92	24.06	24.42	19.88
	10 EC		(1.37)	(1.18)	(1.16)	(1.15)	(1.16)	(29.05)	(18.44)	(16.58)	(16.76)	(17.26)	
9.	Triazophos	0.05	1.16	1.18	1.18	1.18	1.18	32.45	28.25	26.25	26.34	26.95	16.67
	40 EC		(1.34)	(1.40)	1.39)	(1.39)	(1.39)	(28.93)	(22.50)	(19.65)	(19.82)	(20.66)	
10.	Control	-	1.18	1.36	1.47	1.51	1.45	31.59	32.32	31.89	32.82	32.34	12.63
			(1.39)	(1.84)	(2.15)	(2.29)	(2.09)	(27.45)	(28.69)	(27.94)	(29.40)	(28.68)	
	S. E. ±			0.05	0.05	0.06	0.05		0.89	0.60	0.77	0.43	1.15
	C.D. (P=0.05)		NS	0.15	0.16	0.17	0.15	NS	2.63	1.78	2.29	1.28	3.43
	C.V. (%)			8.68	8.87	10.12	8.74		6.13	4.40	5.68	3.09	9.94

*Figures in parentheses are original values while those outside are square root transformed values NS=Non-significant

** Figures in parentheses are original values while those outside are arcsine transformed values

DBS- Days before spraying

DAS- Days after spraying

results of Kubendran *et al*. (2008) and Kuttalam *et al*. (2008) who observed lowest fruit damage in treatment of flubendiamide. However, Katroju *et al*. (2014) observed that the profenophos (1000 g a.i./ha) showed minimum per cent of fruit damage (28.80 %) while, in present investigation profenophos recorded comparatively higher fruit damage it might be due to pest developed resistance against this insecticide, different climatic factors and different experimental places.

Yield of tomato fruits :

The data on yield of tomato fruits presented in revealed that significantly highest (25.21 t/ha) fruit yield obtained when crop was treated with flubendiamide 0.004 per cent which was remain at par with chlorantraniliprole 0.0055 per cent (24.84 t/ha) and spinosad 0.0068 per cent (22.20 t/ha). The lowest (12.63 t/ha) fruit yield obtained in control plot. However, treatments *viz*., indoxacarb 0.0087, emamectin benzoate 0.0015, novaluron 0.0075, chlorfenapyr 0.0075, profenofos 0.075 and triazophos 0.05 showed 21.30, 20.89, 19.88, 19.35, 17.91 and 16.67 t/ha yield of tomato fruits, respectively.

Prior, Singh *et al*. (2005) recorded maximum yield (602.78 q/ha yield) in treatment indoxacarb 14.5 SC @ 500 ml/ha. Similarly, Shivalingaswamy *et al*. (2008) found significantly highest yield (260.78 q/ha) from indoxacarb (75 g a.i./ha) treatmetnt followed 50 and 60 g a.i./ha which were 259.78 and 257.35 q/ha fruit yield, respectively. Ghosal *et al*. (2012) observed that rynaxypyr 18.5 SC @ 40 g a.i./ha was found superior over other treatments against *Helicoverpa* and recorded significantly highest yield of 34.74 q/ha. Jat and Ameta (2013) noted highest marketable yield of 265.68 q/ha in case of flubendiamide 480 SC @ 200 ml/ha followed by spinosad 45 SC @ 200ml/ha (251.29 q/ha) and Beta-cyfluthrin 2.5 SC @ 750 ml/ha (238.38 q/ha). Katroju *et al*. (2014) observed that the profenophos (1000 g a.i./ha) gave maximum fruit yield (13.21 t/ha).

The result of present investigation matched with results of Jat and Ameta (2013) and Ghosal *et al*. (2012) who recorded highest tomato fruit yield from the treatment of flubendiamide and chlorantaniprole, respectively. In present study profenophos showed lower yield than other insecticidal treatments whereas, Katroju *et al*. (2014) recorded maximum yield from profenophos. It might be due to different experimental doses, climatic factors, different experimental places or pest develops resistance to profenophos.

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