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BIO-EFFICACY OF SOME NEWER INSECTICIDES AGAINST *HELICOVERPA ARMIGERA* ON TOMATO CROP

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Abstract

Field experiments were carried out at Horticultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U.P. (India) during the year 2015-16 to control the *H. armigera* in tomato variety Arka vikas (selection 22). Results revealed that among all the insecticide mixtures and individual insecticides after first spray Propargite + Bifenthrin 50% + 5% SE @ 594 + 59.4 g a.i./ha was found to be the most effective in both the sprays with a maximum reduction in fruit borer population (69.26%) and minimum per cent of fruit damage (9.63%) as compared to the untreated control (30.97% fruit damage) after the first spray, while after second spraying this mixture was found to be the most effective with a maximum reduction in fruit borer population (73.75%), minimum per cent of fruit damage (4.34%) as compared to the untreated control (36.35% fruit damage). Propargite 50%+ Bifenthrin 5% SE @ 594 + 59.4 g a.i./ ha conversely increased the fruit yield by 72.56% over untreated control, while lambda cyhalothrin - 5 EC @ 25ml ai/ha showed a minimum increase in yield (41.17%) over control.

Key words : Tomato fruit borer, newer insecticides, bio-efficacy, tomato crop.

Introduction

The tomato (*Lycopersicon esculentum*) Miller is an important crop grown throughout the year in the country. Tomato ranks third largest grown vegetable crops. In india, it is grown under an area of 7,91,000 ha with total production of 17398 thousand tonnes and the productivity of 22,000/ha (Anonymous, 2015). In Uttar Pradesh State, the area under tomato crop is 8.74 thousand hectare with a total production of 358.18 thousand tonnes (Anonymous, 2015). Damage to the tomato fruits to the extent of 18 to 55 per cent by *Helicoverpa* has been noticed on different parts of country (Mathur *et al.*, 1974 and Kakar *et al.*, 1980). Insect pests are major threat to tomato production because this crop is more prone to insect-pests due to its tenderness and softness. Tiwari and Moorthy (1984) reported yield loss ranging from 22.39 to 37.79% due to incidence of *H. armigera.*

H. armigera has attained the status of national pest in recent years, in term of economic damage caused to different agricultural crops throughout India. In our country, it has been reported to attack on 181 plant species from 45 families; 40 dicots and 5 monocots. All these factors pose serious problems in its management. Besides above, a wide array of insecticides used for its control, often leave heavy pesticide residue on the crop. All the above characteristics/measures help the pest to quickly acquire resistance to insecticides. Indiscriminate and injudicious use of pesticides has posed a major problem of developing insecticidal resistance. In the past, the pest has already been reported to have developed resistance to pyrethroidscarbamates and organophosphate including dimethoate (Zheng and Gao, 1995; Rufinger *et al.*, 1999; Sood *et al.*, 2003). Sood *et al.* (2006) reported that the insect is also fastlyacuiring resistance even to neonicotinoid insecticide imidacloprid and suggested its restricted use. As the pest acquires resistance to insecticides rapidly, evaluations of new insecticides are needed in order to avoid continuous influenceof conventional insecticides. Evaluation of toxicity of some novel insecticides against sucking pests has been done and proved effective against the sucking pests (Gavkare *et al.*, 2013). The present study was therefore, undertaken to evaluate some newer insecticides and their mixtures for effective management of this pest.

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Materials and Methods

The present investigations were carried out at Horticulture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U.P. (India) during the year 2015-16. Present study was undertaken to control the *H. armigera* in tomato variety Arka vikas (selection 22). Two spraying of Propargite + Bifenthrin 50% + 5% SE, Propargite + Bifenthrin 50% + 5% SE, Propargite + Bifenthrin 50% + 5% SE, Propargite + Bifenthrin 50% + 5%SE, Fipronil 200SC, Propargite 57% EC, Lamdacyhalothrin 4.9% CS, Control was done on the appearance of insect, at flowering/fruit setting stage. The tomato variety, Arka vikas was sown in 3 × 2 m plot size at row and plant density of 60 × 40 cm, replicated thrice. The spray volume was 400 lit/ha, hollow cone type nozzle and sprayed the crop two times. Larval population was recorded after 5, 10 and 15 days of each spray. However, the performance of each treatment against fruit borer was assessed by recording the number and weight of fresh and infested fruits in 10 randomly selected plants.

Observation on infested fruits

Observation were recorded on the number of infested fruits and number of marketable fruits in each plot at weekly interval on selected plants in a plot picking wise. The percent fruit damage was worked out by using formula as follows

$$\text{Per cent fruit damage} = \frac{\text{Number of damage fruits}}{\text{Total number of fruits}} \times 100$$

Statistical analysis

Statistical analysis were made to determine the overall effect of each treatment, standard error and CD at 5% of significance were work out. The data transformed made into angular transformation were retransformed to back values to compare each other. The statistical methods was suggested by Fisher (1947) was adopted to analyze the data.

Results and Discussion

The field bio-efficacy of some newer insecticides against *H. armigera* of tomato during *Rabi* 2015-16 was assessed. The average number of insects recorded one day prior to the spray was in a range 15.53 to 15.33 / 10 plants (table 1). The pooled data in table 1 indicates that the larval population of *H. armigera* in different treatments 1 day before spraying of insecticides did not differ significantly.The observations on 5th day after first spray showed that the treatments were statistically superior over untreated control in reducing the larval population of *H. armigera* recorded per 10 plants. Among all the treatment, Propargite 50% + Bifenthrin 5% SE (2.3 ml/ L.) and Propargite 50% + Bifenthrin 5% SE (2.2 ml/ L.) were found to be most effective and significantly superior over all the other treatments by recording the highest reduction of larvae of plant (52.76 and 50.66 percent, respectively) were at par with each other (table 1). The next best treatment was Fipronil 200 SC (0.5ml/ L.) with 46.44 per cent reduction over control. The lowest larvae population reduction was recorded on Propargite 57% EC (33.03 per cent, respectively).

The observations on 10th day after first spray showed that the treatments were statistically superior over untreated control in reducing the larval population of *H. armigera* recorded per 10 plants. Among all the treatment, Propargite 50% + Bifenthrin 5% SE (2.3 ml/L.) and Propargite 50% + Bifenthrin 5% SE (2.2 ml/L.) were found to be most effective and significantly superior over all the other treatments by recording the highest reduction of larvae of plant (82.16 and 81.92 percent, respectively) were at par with each other (table 1). The next best treatment was Fipronil 200 SC (0.5ml/ L.) with (77.59) per cent reduction over control. The lowest larvae population reduction was recorded on Propargite 57%EC (64.11 per cent, respectively). The observations on 15th day after first spray showed that the treatments were statistically superior over untreated control in reducing the larval population of *H. armigera* recorded per 10 plants. Among all the treatment, Propargite 50%+ Bifenthrin 5% SE (2.3 ml/L.) and Propargite 50%+ Bifenthrin 5% SE (2.2 ml/L.) were found to be most effective and significantly superior over all the other treatments by recording the highest reduction of larvae of plant (72.86 and 70.45 percent, respectively) were at par with each other followed by Fipronil 200 SC (0.5ml/ L.) with (66.46) per cent reduction over control. The lowest larval population reduction was recorded on Propargite 57%EC (52.60 per cent, respectively).

Similarly, during the second spray, the average number of larvae was observed in a range of 4.47 to 28.78/ 10 plants, a day before spraying (table 1). The observation made at 5th day after the second spray revealed that Propargite 50% +Bifenthrin 5% (2.3ml/L.) and Propargite50% + Bifenthrin 5% (2.2ml/L.) were the most effective with 52.85 and 50.69 per cent reduction of larval population over control respectively and were statistically at par with each other. The next best treatment was Fipronil 200 SC (0.5ml/ L.) with 46.56 per cent reduction over control. The lowest larvae population reduction was recorded on Propargite 57%EC (35.67 per cent, respectively). The observation made at 10th day

Table 1: Bio-efficacy of treatments against the fruit borer *H. armigera* larvae infesting tomato crop (1st insecticidal spray and 2nd insecticidal spray).

Treatment	Dose (g a.i. ha^{-1})	Mean larval population per 10 leaf at									
		First Spray					Second Spray				
		1 DBT	5 DAT	10 DAT	15 DAT	Overall Mean	1 DBT	5 DAT	10DAT	15 DAT	Overall Mean
Propargite 50% + Bifenthrin 5% SE	**486+48.6**	13.73	36.49*(37.14)**	66.12(54.39)	58.80(50.05)	53.80(47.19)	9.09	39.00*(38.63)**	70.21(56.90)	67.22 (55.06)	58.81(50.19)
Propargite 50% + Bifenthrin 5% SE	**540+54.0**	13.91	37.26(37.59)	66.61(54.69)	59.47(50.44)	54.44(47.57)	9.59	39.93(39.16)	71.69(57.90)	68.04(55.56)	59.88(50.87)
Propargite 50% + Bifenthrin 5% SE	**594+59.4**	13.33	50.66(45.36)	81.92(64.84)	70.45(57.05)	67.67(55.75)	6.13	50.69(45.37)	79.76(63.27)	75.74 (60.48)	68.60(56.37)
Propargite 50% + Bifenthrin 5% SE	**621+62.1**	12.53	52.76(46.56)	82.16(65.02)	72.86(58.59)	69.26(56.72)	4.47	53.85(47.19)	85.69(67.78)	81.71 (64.66)	73.75(59.87)
Fipronil 200 SC	**50**	14.11	46.44(42.94)	77.59(61.73)	66.46(54.59)	63.49(55.08)	6.77	46.56(43.01)	77.71 (61.81)	72.45 (58.33)	65.57(54.38)
Propargite 57% EC	**627**	13.41	33.03(35.06)	64.11(53.19)	52.60(46.47)	49.91(44.90)	10.96	35.67(36.63)	64.35 (53.32)	59.58 (50.51)	53.20(46.82)
Lambda cyhalothrin 4.9 CS	**12.5**	15.33	42.25(40.52)	73.33(58.89)	63.58(52.86)	59.72(50.75)	8.54	42.85(40.86)	74.18 (59.44)	70.67 (57.20)	62.56(54.50)
Untreated check	-	14.23	-	-	-	-	28.78	-	-	-	-
S.Em.	-	0.70	0.81	0.85	0.44	-	0.78	0.91	0.96	0.79	-
CD at 0.05%	-	N/A	2.54	2.65	1.37	-	2.39	2.86	3.00	2.48	-

*Mean of three replications, **Values in parentheses are angular transformed values. NS: Non Significant DAT: days after treatment PTLP: DAT: days after treatment.

after the second spray revealed that Propargite 50% +Bifenthrin 5% (2.3ml/L.) and Propargite50% +Bifenthrin 5% (2.2ml/ L.) were the most effective with 85.69 and 79.76 per cent reduction of larval population over control (table 1), respectively and were statistically at par with each other. The next best treatment was Fipronil 200 SC (0.5ml/ L.) with 77.71 per cent reduction over control. The lowest larvae population reduction was recorded on Propargite 57%EC (64.35 per cent, respectively). The observation made at 15th day after the second spray revealed that Propargite 50% +Bifenthrin 5% (2.3ml/ L.) and Propargite50% +Bifenthrin 5% (2.2ml/L.) were the most effective with 81.71 and 75.74 per cent reduction of larval population over control (table 1), respectively and were statistically at par with each other. The next best treatment was Fipronil 200 SC (0.5ml/ L.) with 72.45 per cent reduction over control. The lowest larvae population reduction was recorded on Propargite 57%EC (59.58%).

The data on overall efficacy after second spraying against larvae of *H. armigera* on tomato was shown in per cent reduction population in decreasing orders as: Propargite + Bifenthrin (2.3ml/L.) 73.75 >Propargite +Bifenthrin (2.2ml/L.) 68.60 >Fipronil 200 SC65.57 > Lambda Cyhalothrin 4.9% CS 62.56 >Propargite +Bifenthrin (2 ml/L.) 59.88 >Propargite +Bifenthrin (1.8 ml/L.) 58.81 >Propargite 57%EC 53.20 (Table 1). Hence, the mixture Propargite 50%+ Bifenthrin 5% SE was highly effective in suppressing the fruit borer population. The efficacy of propargite alongwith the synthetic pyrethroid may be attributed to the fact that the mixture of propargite and pyrethroid insecticide causes potentiation which is a valuable tool for management of *Helicoverpa* sp. (Shaw and Watson, 2001).

Per cent of fruit damage

The results on the impact of insecticidal treatments after first insecticidal spray were shown in table 2. The results on the impact of insecticidal spray against *H. armiger* after first insecticides were shown in table 2. The average number of insects recorded

Table 2 : Bio-efficacy of newer insecticides on fruit damage caused by *H. armigera* larvae in tomato during *rabi* 2015-16.

Treatment	Dose (g a.i. ha^{-1})	Pre-treatment fruit damage	Mean per cent fruit damage							
			First spray				Second spray			
			5DAT	10DAT	15DAT	Overall mean	5 DAT	10DAT	15 DAT	Overall mean
Propargite 50%+ Bifenthrin 5%	486+48.6	22.37(4.83)	19.01*(4.47)**	12.30(3.64)	14.76(3.96)	15.35(4.02)	13.16(3.76)	8.51(3.08)	10.27(3.35)	10.64(3.39)
Propargite 50%+ Bifenthrin 5%	540+54.0	20.85(4.67)	16.68(4.20)	10.42(3.37)	12.51(3.67)	13.20(3.74)	10.66(3.41)	6.66(2.76)	7.36(2.88)	8.22(3.01)
Propargite 50%+ Bifenthrin 5%	594+59.4	21.85(4.77)	14.20(3.89)	7.64(2.93)	9.17(3.18)	10.33(3.33)	6.61(2.75)	3.55(2.13)	5.31(2.51)	5.15(2.46)
Propargite 50%+ Bifenthrin 5%	621+62.1	22.96(4.89)	13.77(3.84)	6.88(2.80)	8.26(3.04)	9.63(3.22)	5.55(2.56)	2.77(1.94)	4.71(2.38)	4.34(2.29)
Fipronil 200 SC	50	24.17(5.01)	16.92(4.23)	9.67(3.26)	11.60(3.55)	11.73(3.68)	8.72(3.11)	4.98(2.44)	6.93(2.81)	6.87(2.78)
Propargite 57%EC	627	21.51(4.74)	19.36(4.51)	15.00(3.99)	17.99(4.35)	17.45(4.28)	16.41(4.17)	10.46(3.37)	12.25(3.63)	13.04(3.72)
Lambda Cyhalothrin 4.9% CS	12.5	22.70(4.86)	17.02(4.24)	10.06(3.32)	12.08(3.61)	13.05(3.72)	9.35(3.21)	5.61(2.56)	7.71(2.95)	7.50(2.90)
Untreated check	-	22.68(4.86)	27.22(5.31)	31.29(5.68)	34.42(5.95)	30.97(5.64)	34.04(5.91)	36.44(6.11)	38.58(6.28)	36.35(6.10)
SE m(±)	-	-	0.07	0.05	0.06	-	0.08	0.08	0.10	-
CD at 5%	-	N/S	0.21	0.17	0.19	-	0.27	0.26	0.30	-

*Mean of three replications, **Values in parentheses are square root transformed values, NS: Non Significant. DAT: days after treatment.

one day prior to the spray was in range 20.85 to 24.17 fruits damage (table 2). Five days after spray the mean per cent fruit damage was lowest in Propargite 50%+ Bifenthrin 5% SE (2.3 ml/L.) was 13.77 followed by Propargite 50%+ Bifenthrin 5% SE (2.2 ml/L.) 14.20 significantly. The highest per cent damage was recorded in Propargite 57% EC (19.36) treated plots (tables 2). On 10th day after spraying, the mean per cent fruit damage was lowest Propargite 50%+ Bifenthrin 5% SE (2.3 ml/ L.) was 6.88, Propargite 50%+ Bifenthrin 5% SE (2.2 ml/ L.) 7.46 treated plots and differed significantly from each other and rest of the insecticidal treated plot (table 3). The per cent fruits damage in fipronil 200 SC (9.67), Lambda Cyhalothrin 4.9% CS (10.06),Propargite 50%+ Bifenthrin 5% SE 2 ml/ L. (10.42) treated plot was statistically at par. And do not different significantly from each other. The higest per cent damage was recorded in Propargite 50% + Bifenthrin 5% SE 1.8 ml/ L (12.30) and Propargite 57% EC (15.00) treated plots (table 2). In all treatment maximum field efficacy insecticidal treatment against *Helicoverpa armiger* was observed after 10 days after treatment (table 3). On 15th day after spraying the lowest mean per cent fruit damage was observed in Propargite 50% + Bifenthrin 5% SE (2.3 ml/ L.) 8.26, treatment had low per cent and its followed by Propargite 50%+ Bifenthrin 5% SE (2.2 ml/ L.) 9.17 treated plots and differed significantly from each other and Fipronil 200 SC (11.60) differed significantly with rest of the all insecticidal treated plots.

The result on the Impact of insecticidal treatment *on H. armigera* in terms of average mean fruits damage after second spray was shown in table 3. One day before the spray, the average mean of larvae was observed in a range of 8.26 to 34.42 fruits damage. Five days after spray the mean fruit damage was lowest in Propargite 50%+ Bifenthrin 5% SE (2.3 ml/ L.) was 5.55% followed by Propargite 50%+ Bifenthrin 5% SE (2.2 ml/ L.) 6.61%. On 10th day after spraying, the mean per cent fruit damage was lowest Propargite 50%+ Bifenthrin 5% SE (2.3 ml/ L.) was 2.77, Propargite 50%+ Bifenthrin 5% SE (2.2 ml/ L.) 3.55 treated plots- and differed significantly from each other and rest of the insecticidal

Table 3 : Impact of insecticidal treatments on tomato yield.

Treatments	Dose (g a.i/ha)	Yield (Kg/plot)	Yield (kg/ha)	% Increse over control
Propargite 50%+Bifenthrin 5%	486+48.6	24.55	20458.33	27.79
Propargite 50%+Bifenthrin 5%	540+54.0	26.71	22258.33	39.04
Propargite 50%+Bifenthrin 5%	594+59.4	31.97	26641.66	66.42
Propargite 50%+Bifenthrin 5%	621+62.1	33.15	27625	72.56
fipronil 200 sc	50	28.72	23933.33	49.50
Propargite 57%EC	627	23.12	16766.66	20.35
Lambda Cyhalothrin 4.9% CS	12.5	27.12	22600	41.17
Untreated check		19.21	16008.33	-

treated plot (table 2). The per cent fruits damage in fipronil 200 SC (4.98), Lambda Cyhalothrin 4.9% CS (5.61), Propargite 50%+ Bifenthrin 5% SE 2 ml/ L. (6.66) treated plot was statistically at par. After 15th day of spraying the lowest mean per cent fruit damage was observed in Propargite 50%+ Bifenthrin 5% SE (2.3 ml/ L.) 4.71, treatment had low per cent and its followed by Propargite 50%+ Bifenthrin 5% SE (2.2 ml/ L.) 5.31 treated plots and differed significantly from each other and Fipronil 200 SC (9.93) differed significantly with rest of the all insecticidal treated plots. The overall efficacy after second spraying against larvae of *H. armigera* on tomato fruits was shown per cent mean population in orders as: Propargite +Bifenthrin (2.3ml/L.) 4.34 <Propargite +Bifenthrin (2.2ml/L.) 5.15 <Fipronil 200 SC6.87 < Lambda Cyhalothrin 4.9% CS 7.50 <Propargite +Bifenthrin (2 ml/L.) 8.22 <Propargite +Bifenthrin (1.8 ml/L.) 10.64 <Propargite 57%EC 13.04 < Control 36.35 (table 2). Similar results was obtained by Sinha and Nath (2011). He evaluated efficacy of foliar sprays of some insecticides against tomato fruit borer, *Helicoverp aarmigera*. Bifenthrin and fipronil were the most effective treatments on weight and number bases.

Impact of the newer insecticides on tomato yield

The investigation made on the impact of insecticidal treatments on yield revealed that the highest yield of tomato fruits (27625 kg/ha.) was obtained in a treatment with Propargite 50%+ Bifenthrin 5% SE @ 621 + 62.1 a.i./ha. And this treatment recorded 72.56 per cent increase in yield over control. The next best treatment was Propargite 50%+ Bifenthrin 5% SE @ 594 + 59.4 a.i./ha. Which recorded 26641.66 kg / ha yield with 66.42 per cent increase over control and next best treatment Fipronil 200 SC @50 a.i./ha in which 23933.33 kg / ha yield with 49.50 per cent increase over control was obtained. Among the Lambda Cyhalothrin 4.9% CS @12.5 a.i. / ha gave yield (22600 kg/ha) and per cent increase 41.17 over control The untreated control recorded lowest of 16008.33 kg / ha of tomato fruits (table 3). Similarly result found Meena and Raju (2015) reported the efficacy of fipronil in controlling the fruit borer in tomato. Saini and Raj (2008) also reported similar findings in which lambda cyhalothrin was effective against fruit borer of tomato. Hence, the mixture Propargite 50%+ Bifenthrin 5% SE was highly effective in suppressing the fruit borer population. Synthetic pyrethroids have been reported most effective against fruit borer (Ashok Kumar, 2008). Similar studies were conducted by Suganya Kanna *et al.* (2005) and Murugaraj *et al.* (2006). Lambda Cyhalothrin was most effective against fruit borer.

The experiment reveals that application of propargite bifenthrin mixture in EC formulations was effective against *Helicoverpa armigera*. Such compounds can be used in the pest management strategy to achieve the desired control. Effective use of the newer insecticides coupled after intensive scouting to obtain accurate estimates of populations of various pest species present in a field will lead to sustainable managements of tomato fruit borer.

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