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Bio-efficacy of some contemporary insecticides against Tomato fruit borer *Helicoverpa armigera* Hubner in Varanasi region

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Abstract
The field experiment was carried out to study the evaluation of the bio-efficacy of chlorantraniliprole against fruit borer of tomato (*Lycopersicon esculentum* Miller.), and chlorantraniliprole 18.5% SC 40gm a.i. ha-1 was found to be effective in reducing fruit borer population. Application of chlorantraniliprole 18.5% SC 40gm a.i. /ha and chlorantraniliprole 18.5% SC 30gm a.i. /ha were established to be effective in reducing fruit borer of tomato, recording mean overall per cent reduction in larval population by 68.75% and 60.18%, respectively. The overall data on % reduction in larval population is 68.5% in Chlorantraniliprole 18.5%SC 40 gm a.i /ha treated plots which also noted lowest number of damaged fruits (5.36) and highest plot yields (33.04 kg).

Keywords: Tomato fruit borer *Helicoverpa armigera*, Hubner

Introduction
Tomato (*Solanum lycopersicon* L.) is one of the major and remunerative vegetable crops which have achieved tremendous popularity over the last century. It is one of the most important protective crops. Tomato is the world's largest producing vegetable crop after potato and sweet potato and it tops the list of canned vegetables and occupies an area of 4.5 mha in world with an annual production of 130 mt. (Anonymous, 2016) [1]. Tomato is one of the important vegetable grown in India with 774 ('000 ha) area with a production of 18732 ('000 mt) (NHB, 2016). The productivity of tomato in India is very low (15.60 t/ha) compared to the global average (25.09 t/ha). As a short duration crop, tomato is known for its outstanding nutritive value and capable of high productivity and a great potential in modern agriculture. The production and quality of tomato fruits are considerably affected by incidence of insect pests infesting at different stages of crop growth. Though there are dozens of pests on tomato, besides others, fruit borer *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae) is the serious one 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) [6, 9, 4]. Early instar larvae feed on flower buds and foliage while matured instars bore into fruit resulting in yield reduction (Rath and Nath, 1997) [3]. Whereas, yield losses to the extent of 42.50 percent (Dhandpani and Balasubramanium, 1984) [2], 42.55 percent (Kashyap and Verma, 1986) and 51.20 percent (Singh and Narang, 1990) [7]. Among the insect pests tomato fruit borer (*Helicoverpa armigera* Hubner) is a major pest in India (Swarup and Sharma, 1965) [8].

Materials and methods
Experiment was conducted for the study on bioefficacy of different concentration of Chlorantraniliprole against fruit borer *Helicoverpa armigera on* tomato (*Lycopersicon esculentum* Mill.), during *Rabi* 2017-18 at Horticulture Research Farm, Institute of agricultural Science, Banaras Hindu University, Varanasi. Present experiment was conducted on tomato variety "kashi Amrit" released by IVRI Varanasi. Plant of this variety is determinant type and fruit is round, medium to large and red color. In the study observation were recorded on the number of infested fruits and number of fresh fruits in each plot at a given interval on selected plants in a plot picking wise. The percent fruit damage was worked out by using formula as follows:

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

In each treatment the yield data of marketable fruits at different pickings were noted separately and subjected to statistical analysis to test the significance of mean yield in various treatments. The percent increase in yield over control in each treatment was calculated by using the following formula.

$$\text{Percent increase of yield over control} = \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \times 100$$

Experimental findings

An experiment was conducted for evaluating the bio-efficacy of certain insecticides against major insect pests of tomato during *Rabi* 2017-18. Comparative efficacy of various newer insecticide molecules namely chlorantraniliprole 18.5% SC, flubendiamide 39.35%SC, lambda -cyhalothrin 5%EC, Nimbecidine were used for control of *Helicoverpa armigera* on tomato.

The number of damaged fruit was count before the first spray. The mean percent fruit damaged ranges from 18.59 to22.67 and statistically non-significantly (Table-1).

The observation on 3rd days after first spray the lowest mean percent fruit damaged was recorded in treatment (T3) chlorantraniliprole 18.5% SC (0.4 ml/l) and (T2) chlorantraniliprole 18.5% SC (0.3 ml/l) were 10.64 and 13.86 followed by flubendiamide 39.35% SC (0.2 ml/l) 15.41 damaged fruit significantly. The highest percent fruit damaged recorded in (T6) Nimbecidine followed by chlorantraniliprole 18.5% SC (0.2 ml/l) and lambda – cyhalothrin 5%EC (0.6 ml/l). The observation made on 7th days after first spray, the mean per cent fruit damage was lowest chlorantraniliprole 18.5%SC (0.4 ml/ l.) was 7.82, chlorantraniliprole 18.5% SC(0.3 ml/ l.) 10.34 treated plots and differed significantly from each other and rest of the insecticidal treated plot (Table 1). The mean per cent fruits damage in flubendiamide 39.35%SC (0.2) 11.7, Lambda Cyhalothrin 5% EC (0.6 ml/l) 12.22 treated plot was statistically at par. and do not different significantly from each other followed by chlorantraniliprole 18.5% SC (0.2 ml/l) 13.14. The maximum per cent damage was recorded in Nimbecidine (3 ml/ l) (17.85) (Tables 1). However among all treatment maximum field efficacy insecticidal treatment against *Helicoverpa armiger* was observed after 7thdays after first spray (Table 8). The damaged fruit was count on 14th days after first spray the lowest mean per cent fruit damage was observed in chlorantraniliprole 18.5% SC (0.4 ml/l) 9.74 and its followed by chlorantraniliprole 18.5% SC (0.3 ml/l) 12.78 treated plots and differed significantly from each other. Flubendiamide 39.35% SC (0.2 ml/l) 13.60 differed significantly with rest of the all insecticidal treated plots and lambda-cyhalothrin 5% EC (0.6 ml/l) 14.03. The maximum per cent damage was noted chlorantraniliprole 18.5% SC (0.2 ml/l) 14.86 and Nimbecidine (3 ml/ l) (15.51) treated plots (Table 1 and Fig 1).

Second Spray

The Effect of insecticidal treatment *on H. armigera* in terms of average mean fruits damage after second spray was shown in table 2 and fig. 1. The number of damaged fruit was count one day before the second spray. The mean percent fruit damaged ranges from 10.53 to 16.12 and statistically significant (Table-2). Amongst the all treatments was found to be statistically superior to untreated control. The data was collected on 3rd days after spray the mean fruit damage was lowest in chlorantraniliprole 18.5% SC (0.4 ml/l) was 6.74 followed by chlorantraniliprole 18.5% SC (0.3 ml/l) 10.29 significantly. The maximum per cent fruit damage was recorded Nimbecidine 14.09 treated plots (Tables 2 Fig. 1). The all treated plots having less fruit damage than untreated control. Observation was recorded on 7th day after spraying, the mean per cent fruit damage was lowest in chlorantraniliprole 18.5% SC (0.4 ml/l) 4.14, chlorantraniliprole 18.5% SC (0.3 ml/l) 7.61treated plots and differed significantly from each other and rest of the insecticidal treated plot (Table 9).The mean per cent fruits damage in flubendiamide 39.35% SC (8.38), Lambda Cyhalothrin 5% SC (9.49), chlorantraniliprole 18.5% SC (0.2 ml/l) 9.27 treated plot was statistically at par. And do not different significantly from each other. The maximum per cent damage was noted in Nimbecidine 3 ml/l (11.29) treated plots (Tables 2). However among all treatment maximum field efficacy insecticidal treatment against *Helicoverpa armiger* was observed after 7th day days after treatment (Table 9). The data on 14th days after spraying the lowest mean per cent fruit damage was recorded in chlorantraniliprole 18.5% SC (0.4 ml/l) 5.18 treatment had low per cent and its followed by chlorantraniliprole 18.5% SC (0.3 ml/l) treated plots and differed significantly from each other and flubendiamide 39.35% SC 9.55 differed significantly with rest of the all insecticidal treated plots. The maximum per cent damage was recorded in chlorantraniliprole 18.5% SC (0.2 ml/l) and Nimbecidine 3 ml/l treated plots with 10.95 and 12.54 (Table 2 and Fig 1).

Bio-efficacy of some newer insecticides against tomato yield

The study made on the effect of insecticidal treatments on yield shown shown in the table 3 and depicted in figure 2. Among the all the treatments shown superior with less fruit damage compared to untreated control.

The minimum fruit damaged of 62.59% and the highest yield of tomato fruits (27533.22kg/ha.) was observed in a treatment sprayed with chlorantraniliprole 18.5% SC40 gm a.i. /ha. The succeeding best treatment was chlorantraniliprole 18.5% SC @ 30 gm a.i. / ha. Which recorded 26199.89 kg / ha yield with 54.72% increase over control and next best treatment flubendiamide 39.35% SC @ 48 gm a.i./ha in which 25574.89kg / ha yield with 51.03% increase over control was obtained. Among the Lambda Cyhalothrin 5% SC@15 gm a.i. / ha and gave yield (24491.56 kg/ha) with 44.63 % increase over control and followed chlorantraniliprole 18.5% SC 20 gm a.i./ha gave yield (22716.57 kg/ha) with 34.15% increase over control The untreated control recorded lowest yield of 16933.26 kg/ha of tomato fruits.

Table 1: Efficacy of chlorantraniliprole on fruit damage caused by *H. armigera* larvae in tomato during *Rabi 2017-18*

Treatment	Dose ml/l	Pretreatment Fruit damage	Mean per cent fruit damage			
			First spray			
			3 DAT	7 DAT	14 DAT	Over all mean
Chlorantraniliprole 18.5% SC	0.2	18.59 (25.52)	16.42* (23.86)**	13.14 (21.22)	14.86 (22.65)	14.81 (22.60)
Chlorantraniliprole 18.5% SC	0.3	19.58 (26.23)	13.86 (21.82)	10.34 (18.73)	12.78 (20.94)	12.33 (20.51)
Chlorantraniliprole 18.5% SC	0.4	21.14 (27.35)	10.64 (19.00)	7.82 (16.17)	9.74 (18.15)	9.4 (17.81)
Flubendiamide 39.35% SC	0.2	21.01 (27.24)	15.41 (23.10)	11.7 (19.97)	13.60 (21.62)	13.57 (21.58)
Lambda- cyhalothrin 5% EC	0.6	20.81 (27.02)	16.87 (24.22)	12.22 (20.42)	14.03 (21.97)	14.37 (22.23)
Nimbecidine	3	21.22 (27.41)	17.87 (24.97)	14.54 (22.39)	15.51 (23.15)	15.97 (23.52)
Untreated control	-	22.67 (28.41)	22.75 (28.46)	13.14 (29.34)	27.14 (31.37)	24.64 (29.73)
SE(±m)		-	0.814	0.748	0.66	0.551
CD at 5%		NS	2.536	2.33	2.057	1.715

*Mean of three replication,
NS-non-significant
**value in parentheses are angular transformed values
DAT- days after treatment

Table 2: Efficacy of chlorantraniliprole on fruit damage caused by *H. armigera* larvae in tomato during *Rabi 2017-18*(2nd spray)

Treatment	Dose ml/l	Pretreatment fruit damage	Mean per cent fruit damage			
			2nd spray			
			3DAT	7DAT	14DAT	Over all mean
Chlorantraniliprole 18.5% SC	0.2	15.18 (22.91)	13.50 (21.53)	9.27 (17.70)	10.95 (19.29)	11.24 (19.52)
Chlorantraniliprole 18.5% SC	0.3	12.95 (21.05)	10.29 (18.68)	7.61 (15.99)	9.32 (17.75)	9.07 (17.49)
Chlorantraniliprole 18.5% SC	0.4	10.53 (18.89)	6.74 (15.02)	4.14 (11.60)	5.18 (13.12)	5.36 (13.31)
Flubendiamide 39.35% SC	0.2	13.98 (21.93)	10.98 (19.32)	8.38 (16.79)	9.55 (17.97)	9.64 (18.05)
Lambda- cyhalothrin 5% EC	0.6	14.50 (22.35)	12.14 (21.26)	9.49 (17.91)	11.14 (19.45)	10.92 (19.57)
Nimbecidine	3	16.12 (23.64)	14.09 (22.00)	11.29 (19.62)	12.54 (20.72)	12.64 (20.79)
Untreated control	-	29.92 (33.13)	32.17 (34.53)	34.29 (35.82)	37.17 (37.44)	34.54 (35.97)
SE(±m)	-	0.821	0.481	0.738	0.685	0.586
CD at 5%	-	2.557	1.497	2.299	2.134	1.825

*Mean of three replication
**value in parentheses are angular transformed values
NS-non-significant
DAT- days after treatment

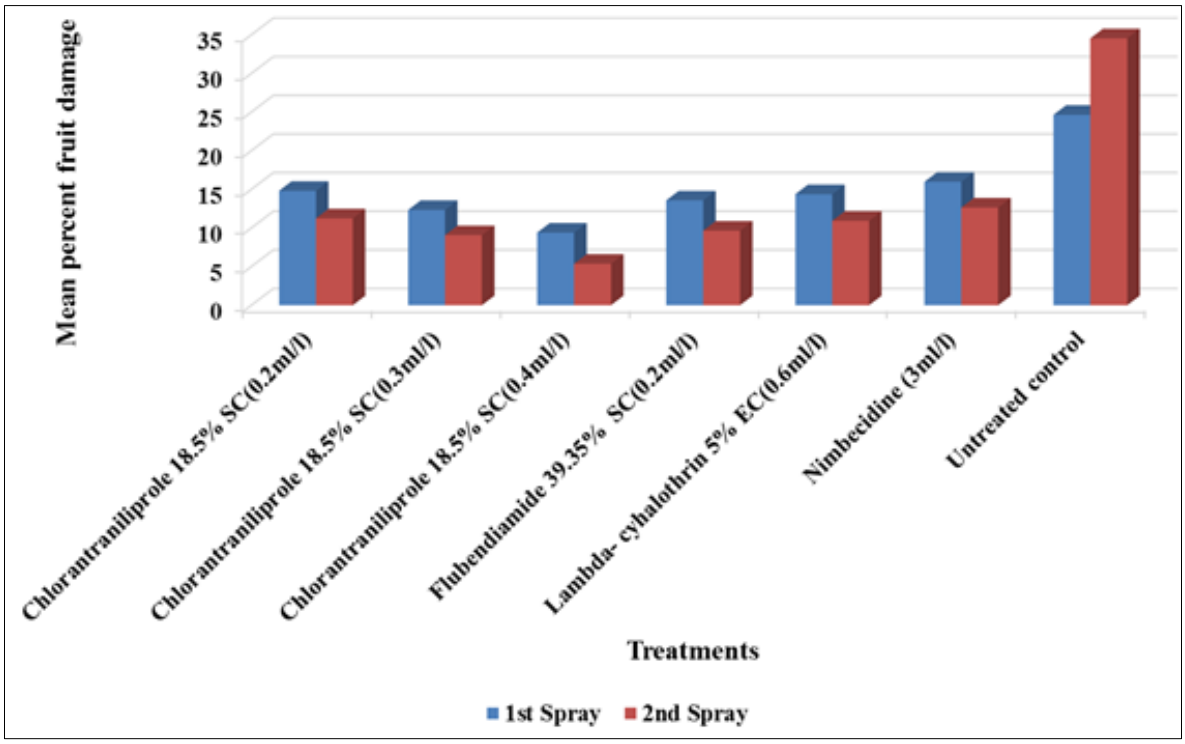

Fig 1: Efficacy of newer insecticides on fruit damage caused by *H. armigera* larvae in tomato

Table 3: Impact of insecticidal treatments on tomato yield.

Treatment	Dose gm a.i/ ha	Yield (Kg /plot)	Yield (Kg/ha)	% increase in yield over control
Chlorantraniliprole 18.5% SC	20	27.26* (5.31)**	22716.57	34.15
Chlorantraniliprole 18.5% SC	30	31.44 (5.69)	26199.89	54.72
Chlorantraniliprole 18.5% SC	40	33.04 (5.83)	27533.22	62.59
Flubendiamide 39.35% SC	48	30.69 (5.61)	26199.89	51.03
Lambda- cyhalothrin 5% EC	15	29.39 (5.51)	24491.56	44.63
Nimbecidine		26.72 (5.26)	22266.57	31.49
Untreated control	-	20.32	16933.26	-
SE(±m)	-	0.143	-	-
C.D at 5%	-	0.444	-	-

*mean of three replications

**value in parentheses are squire root transformed value

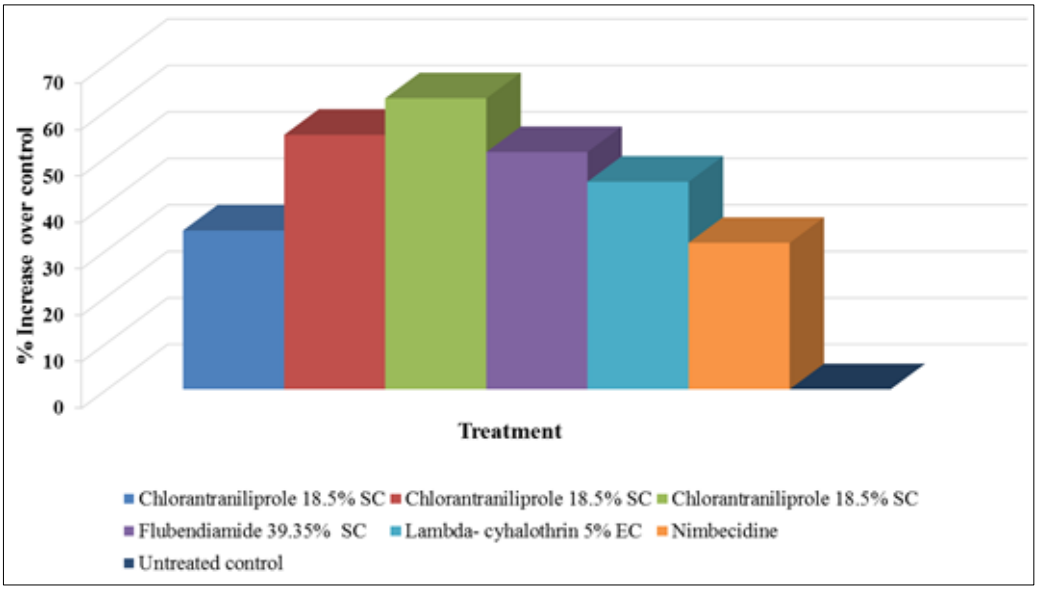

Fig 2: Impact of insecticidal treatmentson tomato yield

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