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Efficacy of insecticides against fruit borer, *Helicoverpa armigera* on *Lycopersicon esculentum* Mill

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Abstract
Tomato fruit borer controls with six more recent pesticides were used. viz., Quinalphos 25% EC, Novaluron 10% EC, Chlorantraniliprole 18.5% SC, Flubendamide 39.35% SC, Emamectin benzoate 5% SG & Indoxacarb 14.5% SC. The total two of sprays were done. The treatment Quinalphos 25% EC, Novaluron 10% EC, Chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SG & Indoxacarb 14.5% SC was on par with each other in terms of quality. Among them Flubendamide 39.35% SC was determined to be the most effective treatment of all. In both sprays, the descending order of efficacy was noted as chlorantraniliprole 18.5% SC>Emamectin benzoate 5% SG>Indoxacarb 14.5% SC>Quinalphos 25% EC>Novaluron 10% EC.

Keywords: Tomato, fruit borer, pesticides, efficacy, spray

Introduction
Tomatoes, *Lycopersicon esculentum* (Mill), are one of the most popular and widely farmed vegetables in the world, second only to potatoes in India in terms of importance. Tomato fruits can be eaten fresh, cooked, or utilized in soups, juices, ketchup, purees, pastes, & powders, among other things. Tomato is also rich in medicinal value. Tomatoes contribute a healthy and good balanced diet. It is rich in minerals, vitamins, essential amino acids, dietary fibers and sugar. Tomato contains of vitamin A, B and C, phosphorus and iron. In India total cultivated area under tomato is8, 13,000 hectares with the production of 21,195,000 MT during. Whereas, in Madhya Pradesh, the annual production of tomato is 2419.56 thousand MT from 84.53 thousand hectares area with the average productivity of 28.62 MT ha-1(Agri. Coop 2019) [1]. This crop is attacked by a number of insects which became a major constraint in optimum production of tomato (Wajombe *et al.* 2006) [4]. Tomato fruit borer, *Helicoverpa armigera* (Hubner) and leaf miners, *Liriomyza trifolii* (Burgess) and tobacco caterpillar, *Spodoptera litura* are important pest. Tomato fruit borer, which causes 40-50 percent damage in tomato crop (Pareek and Bhargava, 2003) [8]. *H. armigera* is a charismatic insect in agriculture accounting for the consumption of over 55 percent of total insecticides used in India. Almost all the stages of tomato crops, from nursery to maturity are attacked by many insect pests. Therefore, application of no. bio-pesticides including ready mix insecticides is felt one of the safe, economic and effective management options that can substantially reduce yield losses caused by fruit borer.

Materials and Methods
Studies on the "Efficacy of different insecticides against fruit borer *Helicoverpa armigera* on tomato (*Lycopersicon esculentum* Mill)" were carried out with a view to manage the fruit borer, *H. armigera* with the help of some chemical insecticides. The present investigation was carried out during *Kharif* season 2020 at college farm, JNKVV, Jabalpur. There were seven treatments including an untreated check and each treatment was replicated in the three randomized block design. In each treatment two sprays was given i.e. first spray at the time of flowering and second spray at 15 days after first spray. The observation on number of *Helicoverpa larvae* per plant was recorded from 10 randomly selected plants from each treatment. At each picking, the number of healthy and damaged fruits, as well as the count of *Helicoverpa per* 10 plants per treatment, were recorded. All the observations were recorded before the spraying and at 1, 3, 5 and 10 days after each spraying. The yield/plot was recorded and converted in kg/ha for each treatment separately.

Result

The fruit borer (*H. armigera*) mean population was recorded before first spray and 1, 3,5,10 days intervals after both spray have been presented in Table-1 The data revealed that before first spray fruit borer population was uniform in various treatments since the difference in population was not significant. After first spray the data of all 1, 3,5,10 days interval in all the treatments were found significantly effective in controlling the fruit borer population when compared to untreated control. (Patel *et al.*, 2019) [9] the mean amongst the treatments Flubendiamide 39.35% SC (1.68) was more effective at each observation time with low pest population. Next treatment in order of effectiveness was Chlorantraniliprole 18.5% SC (1.81), followed by Emamectin benzoate 5% SG (1.90) (Hanafy and Sayed, 2013) [3], Indoxacarb 14.5% SC (1.94). These four insecticides were statistically at par to each other. Amongst the treatments Quinalphos 25% EC was least effective treatment. The highest Fruit borer was recorded in untreated control. In second spray reveled that larval population of *H. armigera* in Flubendiamide 39.35% SC (1.79) Proved most effective insecticide followed by Chlorantraniliprole 18.5% SC (1.89). These two insecticides were statistically at par to each other. Where Novaluron 10% EC and Quinalphos 25% EC registered (4.25) and (4.58) larval population of *H. armigera* these are less effective amongst insecticides.

The table-2 showed that pre application count of fruit damage by larva of fruit borer was no significantly from each other and control. After 7 days of first spray, lowest fruit damage by larva of fruit borer was recorded in Flubendiamide 39.35% SC and Chlorantraniliprole 18.5% SC at (13.33) and (14.25) followed by Emamectin benzoate 5% SG (16.21) and Indoxacarb 14.5% SC 9 (16.60) as compare to other treatments including control. These four insecticides were statistically at par to each other. After 14 days of first spray, lowest fruit damage by larva of fruit borer was recorded in Flubendiamide 39.35% SC (12.97) and Chlorantraniliprole 18.5% SC (13.90.) Followed by Emamectin benzoate 5% SG (15.87) and Indoxacarb 14.5% SC (15.87) as compare to other treatments including control. These four insecticides were statistically at par to each other. The highest larval population of fruit borer was recorded both spray in Novaluron 10% EC except control treatment (17.67). After 7 days of second spray, lowest fruit damage by larva was recorded in Flubendiamide 39.35% SC and Chlorantraniliprole 18.5% SC at (11.15) and (12.20) followed by Emamectin benzoate 5% SG (13.97) and Indoxacarb 14.5% SC 9 (14.37) as compare to other treatments including control. All four insecticides were statistically at par to each other. After 14 days of second spray the data similarly correlated to 7 days of second spray. All six insecticides reported superior to control (25.47) in respect of number of fruit damage by larva of fruit borer.

Table 1: Efficacy evaluation of larval population of *H. armigera* on tomato during Kharif – 2020

Treatment	Treatment	Dose Formulation (ml/ha)	Before first spray	Mean no. of larval population of *Helicoverpa armigera*/10 plants									
				Days after I spray				Mean	Days after II spray				Mean
				1 DAS	3 DAS	5 DAS	10 DAS		1 DAS	3 DAS	5 DAS	10 DAS	
T_1	Quinalphos 25% EC	1000	7.00 (2.73)	6.67 (2.67)	5.00 (2.33)	4.33 (2.18)	5.33 (2.40)	5.33 (2.41)	3.00 (1.86)	4.67 (2.26)	4.33 (2.20)	6.33 (2.59)	4.58 (2.24)
T_2	Novaluron 10% EC	750	5.33 (2.41)	5.00 (2.34)	4.00 (2.12)	3.67 (2.04)	5.00 (2.32)	4.42 (2.21)	4.00 (2.11)	4.00 (2.11)	3.67 (2.03)	5.33 (2.41)	4.25 (2.17)
T_3	Chlorantraniliprole 18.5% SC	150	5.00 (2.32)	4.00 (2.10)	2.33 (1.68)	1.67 (1.46)	3.33 (1.94)	2.83 (1.81)	5.67 (2.48)	2.00 (1.56)	1.67 (1.46)	3.67 (2.00)	3.25 (1.89)
T_4	Flubendiamide 39.35% SC	100	4.33 (2.19)	3.67 (2.03)	1.67 (1.46)	1.33 (1.29)	3.00 (1.86)	2.42 (1.68)	5.00 (2.34)	2.00 (1.58)	1.33 (1.34)	3.00 (1.86)	2.83 (1.79)
T_5	Emamectin benzoate 5% SG	200	6.33 (2.59)	6.00 (2.54)	2.33 (1.68)	2.67 (1.77)	2.00 (1.58)	3.25 (1.90)	6.00 (2.54)	3.00 (1.86)	2.00 (1.56)	5.00 (2.34)	4.00 (2.09)
T_6	Indoxacarb 14.5% SC	500	4.67 (2.26)	4.00 (2.10)	2.33 (1.68)	2.33 (1.68)	4.67 (2.26)	3.33 (1.94)	4.00 (2.11)	2.67 (1.77)	2.33 (1.64)	5.67 (2.48)	3.67 (2.02)
T_7	Untreated control	-	6.67 (2.66)	7.00 (2.72)	9.67 (3.16)	10.33 (3.28)	11.67 (3.46)	10.08 (3.24)	8.00 (2.89)	13.33 (3.71)	13.33 (3.72)	13.67 (3.76)	12.08 (3.53)
	S.Em (±)		0.18	0.17	0.15	0.14	0.18	0.14	0.17	0.16	0.16	0.18	0.17
	CV (%)		12.76	12.24	12.47	12.57	14.04	12.54	12.71	13.21	13.97	12.67	14.88
	CD at 5%		NS	0.51	0.45	0.44	0.56	0.40	0.53	0.50	0.50	0.56	0.50

The values in parenthesis have been square-root converted. NS – Non-Significant DAT – Days After Spray

Table 2: Efficacy evaluation of tomato fruit damaged by *H. armigera* during Kharif 2020

Treatment	Treatment	Dose Formulation (ml/ha)	Before first spray	Mean no. of fruit damage /100 Fruit at 10 plants/plot			
				Days after I spray		Days after II spray	
				7 DAS	14 DAS	7 DAS	14 DAS
T1	Quinalphos 25% EC	1000	12.00 (20.69)	9.33 (18.24)	9.00 (17.85)	7.33 (16.05)	6.00 (14.59)
T2	Novaluron 10% EC	750	12.33 (20.97)	10.33 (19.10)	9.67 (18.50)	7.67 (16.37)	6.33 (14.88)
T3	Chlorantraniliprole 18.5% SC	150	10.33 (19.20)	5.67 (14.25)	5.33 (13.90)	4.00 (12.20)	3.00 (10.71)
T4	Flubendiamide 39.35% SC	100	12.33 (20.99)	5.00 (13.33)	4.67 (12.97)	3.33 (11.15)	2.33 (9.46)
T5	Emamectin benzoate 5% SG	200	12.67 (21.25)	7.33 (16.21)	7.00 (15.87)	5.33 (13.97)	4.00 (12.20)
T6	Indoxacarb 14.5% SC	500	12.00 (20.69)	7.67 (16.60)	7.00 (15.87)	5.67 (14.37)	4.33 (12.69)
T7	Untreated control	-	12.33 (20.97)	16.67 (24.46)	17.67 (25.22)	18.00 (25.47)	18.00 (25.47)
	S.Em (±)		0.64	1.27	1.20	1.27	1.33
	CV (%)		5.34	12.62	12.09	14.08	16.15
	CD at 5%		NS	3.92	3.69	3.92	4.10

The values in parenthesis have been square-root convertedNS – Non-Significant DAT – Days After Spray

Discussion

Efficacy of seven insecticides against the tomato fruit borer during the kharif season, 2020. The efficiency of various treatments against the tomato fruit borer, *H. armigera*, revealed that all treatments were significantly superior to the control in terms of mean tomato fruit borer larvae reduction and mean fruit damage. Flubendamide 39.35 percent SC was determined to be the most effective against tomato fruit borer, followed by Chlorantraniliprole 18.5 percent SC and Emamectin benzoate 5 percent SG. The current findings are consistent with those of Narendra *et al*. (2017) [7], Meena *et al*. (2013) [5-6], and Tatagar *et al*. (2014) [11]. To partially confirm the current findings, a spray of Flubendamide 39.35 percent SC was used to corroborate the present finding of minimal fruit damage. In the current investigations, Chlorantraniliprole 18.5 percent SC was found to be a fairly efficient pesticide against tomato fruit borer, followed by Emamectin benzoate 5 percent SG and Indoxacarb 14.5 percent SC. The current findings are in some ways similar to those of (Ameta *et al*. 2008 [2].

Conclusion

For effective control of tomato fruit borer, advised to apply two sprays of Flubendamide 39.35% SC @ 100ml/ha or Chlorantraniliprole 18.5% SC @150ml/ha first spray at the time of flowering and the second at 15 days after first spray for obtaining higher yield and better return.

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