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Field efficacy of some insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner)

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Abstract
The field experiment on "Field efficacy of some insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner)" was conducted during *Rabi* 2019-2020, at Central Research Farm, Department of Entomology, SHUATS, Naini, Prayagraj, U.P. The relative efficacy of some insecticides *viz*., Chlorantraniliprole 18.5SC (0.5ml/lit), Spinosad 45%SC (0.5ml/lit), Flubendiamide 20%WG (0.3gm/lit), Novaluron 10EC (1.5ml/lit), Nisco sixer plus (2ml/lit), Novaluron 10EC + Nisco sixer plus (0.75+1ml/lit) and Indoxacarb 14.5SC (1ml/lit) were evaluated against fruit borer (*Helicoverpa armigera)*. The data on incremental percent reduction of different treatments revealed that the treatment Indoxacarb 14.5SC (65.66%) followed by Spinosad 45%SC (63.85%), Novaluron 10EC + Nisco sixer plus (0.75+1ml/lit) (62.21%) > Chlorantraniliprole 18.5SC (60.64%) > Nisco sixer plus (58.19%) > Flubendiamide 20%WG (56.74%) > Novaluron 10EC (55.94%) found to be the most economical viable treatment. The highest cost benefit ratio was obtained from Indoxacarb (1:10.8).

Keywords: *Helicoverpa armigera*, tomato, efficacy, treatments, percent reduction yield and cost benefit ratio

Introduction
Tomato, (*Solanum lycopersicon)* Miller is one of the most popular and widely grown vegetables in the world, ranking second in importance next to potato. It is said to be native of Peru and Mexico. It is a warm season crop as it is relatively short duration crop and give high yield it is economically attractive. It offers great beneficial effects to human health through its high content in potassium and antioxidants such as ascorbic acid, vitamin A, vitamin C, lycopene, essential amino acids and tocopherols that may contribute to fight against carcinogenic substance. (Anonymous, 2014) [2]. In India tomato crop is mainly grown in the states of Andhra Pradesh, Orissa, West Bengal, Karnataka, Bihar, Gujarat, Tamil Nadu, Uttar Pradesh and Rajasthan etc. Total area under the tomato crop in India is about 910 thousand hectare with production of 19193 thousand metric tonnes. (NHB 2011) [7]. The important insect pest of tomato is fruit borer, *Helicoverpa armigera* (Hubner); whitefly, *Bemisia tabaci* (Gen); jassids, *Amrasca devastans* (Ishida); leaf miner, *Liriomyza trifolii* (Blanchard); potato aphid, *Myzus persicae* (Thomas) and Hadda beetle, *Epilachana dedecastigma* (Widemann) (Sharma *et al.,* 2013) [15]. But in India fruit borer is one of the most important pests of tomato, limiting production and market value of crop produce. The fruit borer, *Helicoverpa armigera* (Hubner) is the most destructive pest of tomato in India, which is commonly known as gram pod borer, American bollworm and fruit borer (Meena and Raju 2014) [10]. Tomato fruit borer, *Helicoverpa armigera* (Hub.) is very important pest which causes 40-50 percent damage to the tomato crop (Pareek and Bhargava 2003) [12]. *H. armigera* is a charismatic insect pest in agriculture accounting for the consumption of over 55 percent of total insecticides used in India (Puri *et al.,* 1995) [13]. In recent works, various types of chemicals belonging to different groups are used as spray to manage the pest complex because spraying of chemical insecticides is also a part of IPM. Sometimes we don't know about best insecticide for tomato fruit borer control So, the best one can be identified for the management of tomato fruit borer in tomato, by potential evaluation of few insecticides through comparative effectiveness.

Materials and Methods
Field trails were conducted to study the "Field efficacy of some insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner)" in Prayagraj region at field conditions was carried out during December 2019 to May 2020.

The trails were laid out in RBD having eight treatments and three replications with the plot size 2 x 2m. The experiments were carried out in the tomato variety Lakshmi. One round of spray was given at fifteen days interval using a hand operated sprayer during morning hours to avoid photo oxidation of chemicals. T_1 Chlorantriniliprola (18.5 SC), T_2 Spinosad (45% SC), T_3 Nisco sixer plus, T_4 Flubendamide (20% WG), T_5 Novaluron (10 EC), T_6 Novaluron + Nisco sixer plus, T_7 Indoxacarb (14.5 SC) and T_0 Control.

Observations on percent population reduction were made in tomato fruit borer on 5 randomly selected plants in each replication along with the unsprayed control. Pre and post treatments observations were recorded on 3rd, 7th and 14th days of each spray. The percent population reduction of tomato fruit borer damage over control in field conditions was calculated.

The data averaged into respective parameter requisite will be subjected to suitable transformation. After analysis, data will be accommodated in the table as per the needs of objectives for interpretation of results. The standard procedures in agriculture statistics given by Gomez and Gomez (1984) [6] were consulted throughout. The interpretation of data will be done by using the critical difference value calculated at 0.05 probability level. The level of significance will be expressed at 0.05 probabilities.

Results and Discussion

The result (Table: 1) after spray revealed that all the treatments were significantly superior to control in reducing the pest population of *Helicoverpa armigera* on tomato. The data percent population reduction of *Helicoverpa armigera* i.e., Indoxacarb (14.5SC) recorded highest reduction of tomato fruit borer (65.66%) which was significantly superior over control. Followed by Spinosad 45% SC (63.85%), Novaluron + Nisco sixer Plus (62.02%), Chlorantraniliprole 18.5SC (60.64%), Nisco sixer Plus (58.19%), Flubendamide 20% WG (56.74%) and Novaluron (55.94%) was least effective among all the treatments.

The minimum larval population was recorded in Indoxacarb 14.5SC. These results were similar to the findings reported by (Kumar *et al.*, 2016) [8] (Yogeeswarudu *et al.*, 2014) [18]. (Gautam *et al.*, 2018) [4], (Singh *et al.*, 2017) [16] reported that among all the treatments lowest number of fruit borer was recorded in Indoxacarb 14.5SC. Spinosad found to be the next best which was reported by (Ghosal *et al.*, 2012) [5], (Kumar and sarada 2015) [9] and (Nitharwal *et al*., 2017) [11] (Sreekanth *et al.*, 2010) [17] Findings concluded that new generation insecticides like Chlorantraniliprole 18.5SC, Flubendamide 20% WG and Spinosad were found effective against Lepidoptera caterpillar *viz*., *Spodoptera exigua* and *Helicoverpa armigera*. (Deshmukh *et al.*, 2010 [3], (Regmi *et al.*, 2018) [14] reported Flubendamide is the most effective treatment in controlling the fruit borer population in tomato. (Anil *et al.*, 2010) [1] findings clearly indicated that new generation insecticides like Novaluron and Flubendamide were found effective against Lepidopteran pest.

The yield among the treatments was significant. The highest yield was recorded in Indoxacarb 14.5SL (225q/ha) followed by Spinosad 45%SC (220q/ha), Novaluron 10 EC+Nisco sixer plus (200q/ha), Chlorantraniliprole 18.5%SC (195q/ha), Nisco sixer plus (175q/ha), Flubendamide 20%WG (172q/ha), Novaluron 10 EC (168q/ha) as compared to T_0 control (110q/ha).When the benefit cost ratio was worked out, interesting results was achieved. Among the treatment studied the best and most economical treatment was Indoxacarb 14.5SC (1:10.8), followed by Spinosad 45%SC (1:9.6), Novaluron10EC+Nisco sixer plus (1:9.4), Cholrantraoniliprole 18.5SC (1: 8.5), Nisco sixer plus (1:8.3), Flubendamide 20%WG (1:7.8), Novaluron 10EC (1:7.7) as compared to control T_0 (1:5.6).

Table 1: Efficacy of some insecticides on percent population reduction of *Helicoverpa armigera* (Hubner) on tomato.

Treatments		One day before spray	3rd DAS	7th DAS	14th DAS	Mean	Yield (Kg/ha)	B:C Ratio
T_1	Chlorantraniliprole 18.5SC	5.0	61.07	72.89	47.95	60.64	195.00	1:8.5
T_2	Spinosad 45% SC	5.4	62.02	73.30	56.23	63.85	220.00	1:9.6
T_3	Nisco Sixer Plus	4.8	55.80	71.70	47.07	58.19	175.00	1:8.3
T_4	Flubendamide 20% WG	4.4	55.15	68.60	46.47	56.74	172.00	1:7.8
T_5	Novaluron 10EC	4.0	54.43	67.85	45.53	55.94	168.00	1:7.7
T_6	Novaluron + Nisco Sixer Plus	5.0	61.49	73.26	51.88	62.21	200.00	1:9.4
T_7	Indoxacarb 14.5SL	5.7	63.18	74.11	59.68	65.66	225.00	1:10.8
T_0	Control	6.2	0.00	0.00	0.00	0.00	110.00	1:5.6
	F-Test	NS	S	S	S	S	S	
	S.Ed(+)	0.685	6.939	5.31	6.753	3.54	0.599	
	C.D at 5%	1.469	14.88	11.40	14.48	7.61	1.284	

Conclusion

From the analysis of present findings, it can conclude that among all the treatments Indoxacarb, Spinosad, Chlorantraniliprole, Nisco sixer Plus and Flubendamide were found effective against Lepidopterian caterpillar *Helicoverpa armigera* along with additional yield level in tomato. Hence it is suggested that the effective insecticides may be alternated in harmony with the existing Integrated pest management programs in order to avoid the problems associated with insecticidal resistance, pest resurgence etc.

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