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Field efficacy of selected insecticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on tomato

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Abstract
The present investigation entitled "Field Efficacy of Selected Insecticides Against Tomato Fruit Borer [*Helicoverpa armigera* (Hubner)]" in Gooty mandal, Anantapur Dist. (A.P.)" cultivar i.e., SWEAKHAR-448 was conducted during August to November 2020. Two applications of seven insecticides *viz.*; T1 Profenophos 40% EC, T2 Fiprony l5%, T3 Profenophos 40% + cypermithrin 4% E.C, T4 Novaluron 10EC, T5 Emamectin benzoate 5% SG, T6 Chlorpyrifos 20EC, T7 Indoxacarb14. 5SL, were evaluated against fruit borer, *Helicoverpa armigera*. Lowest percent infestation of fruit borer was recorded in Indoxacarb 14.5SL (11.36%) followed by Fipronil 5%w/w (10.27%) which was at par Profenophos 40% EC (10.27%), Novaluron 10 EC (10.47%) and followed by Emamectin benzoate 5%SG (11.76%) which was at par Chlorpyrifos 20EC (12.19%) and at last Profenophos 40% + Cypermethrin 4% EC (14.2%) Among all treatments Profenophos 40%+ cypermethrin 4% EC is found to be least effective than all the treatments and Indoxacarb is significantly superior over the control (28.91%). When cost benefit ratio was worked out the best and most economical treatment was in Indoxacarb 14.5SL (1:8.5) which was at par with Fipronyl 5%w/w (1: 8.28), Profenophos 40%EC (1:7.5) which was at par with Novaluron 10 EC (1:6.9). Followed Emamectin benzoate 5% SG (1:6.7) are statistically at par with Chlorpyrifos 20EC (1:6.4) are statistically at par with Profenophos 40% + cypermithrin 4% E.C (1: 6.3) is found to be least effective than all the treatments and is significantly superior over the control (1: 3.9).

Keywords: Benefit cost ratio, efficacy, *Helicoverpa armigera*, insecticides, tomato fruit borer

Introduction
Vegetables are the novel and edible portion of the herbaceous plants and play an important role in the daily intake of our food. They contribute an important status in the agricultural economy of India. The area under vegetable cultivation in the country is about 9,542 in thousand ha and the production is about 169478 in thousand million tons (Anonymous, 2015). Tomato is being cultivated in 808.54 thousand ha producing 19696.92 thousand MT (Horticultural Statistics at a Glance, 2017) [7]. Tomato is a good source of all nutrients especially vitamin C, B and K. (Anonymous, 2014) [15]. 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, *Epilachna vigintioctopunctata* (Widemann). 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 *et al*., 2014).
Early instar larvae feed on flower buds and foliage while matured instars bore into fruit resulting in yield reduction (Rath *et al*., 1997) Considerable economical losses due to *Helicoverpa armigera* reported by many workers to the extent of about 50-60% fruits (Singh *et al*., 1977) and 25.99 to 41.34% fruits in Chhattisgarh. It is cosmopolitan in distribution and attained a status of national pest because of its economical damage caused to several cultivated crop. The early instar larvae feed on foliage, buds and flowers, while later instar larvae bore into the fruits by feeding the content, followed by rotting of fruits due to secondary infection of pathogens causing considerable losses in and even to the extent of 55 per cent damage reported by (Selvanarayanan, 2000).

Objectives
1. To study the field efficacy of chemicals against fruit borer in tomato.
2. To calculate the cost-benefit ratio of the treated insecticides.

Materials and Methods

Due to Covid-19 situation, studies on "to study the efficacy of selected insecticides against tomato fruit borer" In Gooty Mandal, (Anantapur Dist.), under field condition was carried out in Area plot, Andhra Pradesh, India. These are replicated thrice in randomized block design.

Table 1: Details of treatments

Sl. No.	Treatments names	Chemical Names and Formulations	Group	Dosage	References
1.	T0	Control	-	-	-
2	T1	Profenophos 40% EC	Organophosphate insecticides	1000g/ha	Katroju *et al.* (2014)
3	T2	Fipronyl 5% w/w	Phenylpyrazole	10g/ml/li t	Patil *et al.* (2018) [13]
4	T3	Profenophos 40% + cypermithrin 4% E.C	Organophosphate, synthe tic pyrethroid	400g and 40g a.i/ha	Ghosal A ML *et al.* (2017)
5	T4	Novaluron 10 EC	Insect growth regulators	7.5ml/lit	Narendra S *et al.* (2017)
6	T5	Emamectin benzoate5%SG	Semisynthetic avermectin	200g/ha	Mohanny KM *et al.* (2020) [12]
7	T6	Chlorpyrifos 20EC	Carboxylic acid amide group	500 g ai/ha	Solange *et al.* (2015) [17]
8	T7	Indoxacarb 14.5SL	Oxadiazines	7.5g a.i/ha	Patil *et al.* (2018) [13]

Statistical analysis

Statistical analysis was done to test the level of significance and to compare the treatments using the following formula (Kumar. 2009): Formula **(**Kumar. 2009):

$$\tau = \frac{\sum XY - n\,\bar{x}\,\bar{y}}{\sqrt{x^2 - nx^{-2}}\ \sqrt{y^2 - ny^{-2}}}$$

Where,
x = Mean of 1st factor
y = Mean of 2nd factor
n = Total no. of observations
r = correlation coefficient ranges between + 1 to - L

After correlating significant and non-significant is seem through t-test value of n- 2 degrees of freedom. + =

$$+ = \frac{\sqrt{n-2}}{\sqrt{1 - r^2 \sim t}} \text{ (n-2)}$$

Test of significance

If the variance ratio (MSt/EMS) is greater than the tabulated value of F value at 5% and 1% level of significance, the variance between treatments is considered to be significant and if it is lower than the tabulated value, the difference is considered to be non-significant.

Results and Discussion

Among all the treatments lowest percent infestation of fruit borer was recorded in (T7) Indoxacarb 14.5SL (11.36%) followed by (T2) Fipronil 5% w/w (10.27%) which was at par (T1) Profenophos 40% EC (10.27%), (T4) Novaluron 10 EC (10.47%) and followed by (T5) Emamectin benzoate5%SG (11.76%) which was at par (T6) Chlorpyrifos 20EC (12.19%) and at last (T3) (Profenophos 40% + Cypermethrin 4% EC (14.2%) among all treatments (T3) (Profenophos + Cypermethrin 40% EC (14.2) is found to be least effective than all the treatments and (T7) Indoxacarb is significantly superior over the control (28.91%).

The yields among the treatment were significant. The highest yield was recorded in (T7) Indoxacarb 14.5SL (192 q/ha) which was at par with (T2) Fipronyl 5%w/w (186 q/ha), (T1) Profenophos 40% EC (170 q/ha) which was at par with (T4) Novaluron 10 EC (156 q/ha). Followed (T5) Emamectin benzoate 5% SG (152 q/ha) are statistically at par with (T6) Chlorpyrifos 20EC (145 q/ha) are statistically at par with (T3) Profenophos 40% + cypermithrin 4% E.C (142 q/ha) is found to be least effective than all the treatments and is significantly superior over the control (89 q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was in (T7) Indoxacarb 14.5SL (1:8.5) which was at par with (T2) Fipronyl 5%w/w (1: 8.28), (T1) Profenophos 40%EC (1:7.5) which was at par with (T4) Novaluron 10 EC(1:6.9). Followed (T5) Emamectin benzoate5%SG (1:6.7) are statistically at par with (T6) Chlorpyrifos 20EC (1:6.4 are statistically at par with (T3) Profenophos 40% + cypermithrin 4% E.C (1: 6.3) is found to be least effective than all the treatments and is significantly superior over the control (1: 3.9).

Table 2: To evaluate the effect of insecticides to fruit borer (*Helicoverpa armigera*) in Tomato (First Spray): percent fruit infestation

Sr. No.	Treatments	% Fruit infestation				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
T1	Profenophos 40% EC	16.80	16.74	7.54	13.96	12.75
T2	Fipronyl 5% w/w	18.47	16.66	7.44	13.92	12.67
T3	Profenophos 40% + cypermithrin 4% E.C	16.97	19.25	14.07	16.61	16.64
T4	Novaluron 10 EC	17.05	16.89	7.86	15.02	13.26
T5	Emamectin benzoate 5% SG	19.15	18.09	11.62	15.58	15.10
T6	Chloropyriphos 20 EC	16.37	19.02	12.34	15.86	15.74
T7	Indoxacarb 14.5 SL	17.28	14.09	6.90	7.22	9.40
T0	Untreated	20.71	25.24	28.32	28.87	27.48
F-Test		NS	S	S	S	S
S.Ed. (±)		2.31	1.46	0.73	1.3	1.88
C.D. (P = 0.05)		4.78	3.03	1.51	2.68	3.88

DBS: Day before spray, DAS: Day after spray

Table 3: To evaluate the efficacy of certain insecticides to fruit borer (*Helicoverpa armigera*) in Tomato (Second Spray): percent fruit infestation

Sr. No	Treatments	% Fruit infestation				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
T1	Profenophos 40%EC	13.96	11.01	8.16	11.65	10.27
T2	Fipronyl 5%w/w	13.92	10.81	8.07	11.25	10.04
T3	rofenophos40%+cypermithrin4%E.C	16.61	13.80	14.86	13.94	14.2
T4	Novaluron 10 EC	15.02	11.13	8.58	11.71	10.47
T5	Emamectin benzoate5%SG	15.58	11.26	12.09	11.94	11.76
T6	Chlorpyrifos 20EC	15.86	11.26	13.18	12.13	12.19
T7	Indoxacarb 14.5SL	12.91	10.00	7.42	9.39	8.93
T0	Untreated	28.87	27.90	29.65	29.19	28.91
F-Test		S	S	S	S	S
S.Ed.(±)		1.3	0.81	0.82	1.01	1.01
C.D. (P = 0.05)		2.68	1.67	1.69	2.09	2.08

Table 4: Overall mean of 1st and 2nd spray

Sr. No	Treatments	Mean of 1st spray	Mean of 2nd spray	Overall mean
T1	Profenophos 40% EC	12.75	10.27	11.51
T2	Fipronyl 5% w/w	12.67	10.04	11.36
T3	Profenophos 40% + cypermithrin 4% E.C	16.64	14.2	15.42
T4	Novaluron 10 EC	13.26	10.47	11.87
T5	Emamectin benzoate 5% SG	15.10	11.76	13.43
T6	Chloropyriphos 20EC	15.74	12.19	13.97
T7	Indoxacarb 14.5SL	9.40	8.93	9.17
T0	Untreated	27.48	28.91	28.20
	F-Test	S	S	S
	S.Ed. (±)	1.88	1.01	1.19
	C.D. (P = 0.05)	3.88	2.08	2.53

From the above discussion it was found that all treatments shown significant control over untreated or control plot among all (T7) Indoxacarb (11.36%) is found to be most effective and it shown highest yield(192 q/ha) among all and bc ratio is also found that best and most economical treatment was in (T7) Indoxacarb (1:8.5).

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