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Management of tomato fruit borer (*Helicoverpa armigera* (Hubner) by chemical insecticides and neem products

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Abstract
Studies on Management of tomato fruit borer (*Helicoverpa armigera* (Hubner) by chemical insecticides and neem products were carried out during Rabi season of 2015-2016 at Central Research Farm, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed to be University), Allahabad. The seasonal incidence of fruit borer (*Helicoverpa armigera*) from 1st week of October with 2.81% damage which gradually increased and reached to its peak level with 39.54% fruit damage at 42nd week of March. It was found that fruit borer infestation on damage increased but mean weather parameters lad no effect on the incidence of *Helicoverpa armigera* only maximum temperature showed positive correlation with fruit damage. Among the data on present infestation of fruit borer after first spraying results were statistically significant. The lowest infestation of fruit borer were recorded in treatments Profenophos 50%EC (4.350), Spinosad 45%SC (5.370), Deltamethrin 2.8%EC (5.90), NSKE (5.90), Chlorantraniliprole 18.5%SC (6.550), Neem oil (6.650). However all these treatments were superior over control. The maximum yield was reported Neem oil (15 q/ha), followed by NSKE (13.00 q/ha), Deltamethrin 2.8%EC (14.00 q/ha), Profenophos 50%EC (16.00 q/ha), Chlorantraniliprole 18.5%SC (12.00 q/ha), Spinosad 45%SC (13.00 q/ha).

Keywords: Chemicals *Helicoverpa armigera*, Neem oil, NSKE, Tomato fruit borer

1. Introduction

Tomato, *Lycopersicon esculentum* (Miller), is one of the most important vegetables in the world, ranking second in importance to potato in many countries. It is warm season crop. It is also grown as off season vegetable in many countries. Tomato supplies vitamin C and adds variety of color and flavour to the foods. The fruits are eaten raw or cooked. Large quantities of tomatoes are used to prepare soup, juice, ketchup, pickle, paste and powder (Choudary *et al*., 2002) [1].

Tomato is grown throughout world either outdoors or indoors, mainly in China, India, U.S.A., Italy, Turkey, Mexico and Japan *etc.* 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. The highest productivity of tomato is incurred by Spain having 66.81 t/ha while India has only 21.2 t/ha. In India, Andhra Pradesh contributed maximum production (3354.47 metric tonnes) but highest productivity was occupied by Karnataka (33.9 t/ha) (Anonymous, 2014) [2].

Tomato, *Lycopersicon esculentum* (Miller), is one of the most popular and widely grown vegetables in the world, ranking second in importance next to potato. Tomato is a good source of all nutrients especially vitamin C, B and K**.** (anonymous, 2014) [2].

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). 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) [4].

Tomato fruit borer, *Helicoverpa armigera* (Hub.) is very important pest which causes 40-50 percent damage to the tomato crop (Pareek and Bhargava, 2003) [5, 7] *H. armigera* is a charismatic insect pest in agriculture accounting for the consumption of over 55 percent of total insecticides used in India (Puri, 1995) [6].

Pest problem is main limiting factor for tomato cultivation as this is attacked by different insect pests such as Helicoverpa and S fruit optera etc. The tomato fruit borer, Helicoverpa armigera Hub, is a polyphagous pest attacking cotton, tomato, tomato, chilli, cabbage, pigeon pea, gram etc. throughout the world as well as in India. Due to its high fecundity, polyphagous nature, quick adaptation against insecticides, control of this pest with any single potent toxicant for a long time is quiet difficult and rather impossible. Now it develops cross resistance to many popular insecticides. To control this insect pest and to save the crop, pesticides are being used in large quantities by human being. But the continuous and enormous use of same or similar groups of pesticides causes problem of pesticide residues in foodstuff and other environmental contamination. This has promoted the necessity for the development of new, safer, biodegradable insecticides and known insecticidal alternatives that could be feasible and effective for insect pest management. Spinosad is one of such new chemicals which are derived from fermentation broth of soil actinomycetes, Saccharopolyspora spinosa, containing a naturally occurring mixture of spinosyn A and spinosyn D. Spinosad have rapid contact and ingestion activity in insects, causing excitation of the nervous system, leading to cessation of feeding and paralysis. The present investigation was therefore undertaken to test the effectiveness of Spinosad in controlling H. armigera in tomato in comparison to lamda cyhalothrin and quinalphos

2. Materials and methods

Studies on the "Management of tomato fruit borer (*Helicoverpa armigera* (Hubner)) by of chemical insecticides and neem products" in Allahabad (U.P.) were carried out with a view to manage the fruit borer, *Hekucoveroa arnugera* (Hubner) with the help of some chemical insecticides, botanicals and their combinations. The present investigation was carried out during rabi season 2015-2016 at the field of Department of Entomology, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-To- Be-University), (Trans Yamuna Region) Allahabad. There were ten treatments including an untreated control and each treatment was replicated four in the randomized block design.

Fruit Borer

(Efficacy of treatment) the incidence of the borer on the shoot and the fruit were recorded from the five randomly selected plants. Observations were recorded one day before spray 3rd, 7th, 14th, days after spraying. The extent of the damage was computed by using the

Percent fruit infestation –

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

Table 1: Details of insecticides used in experiment

Tr. No	Common name	Trade Name	Dose and formulation	Group of insecticide	References	Source of supply
T_0	Control (water spray)	---------	--------	----------		----------
T_1	Spinosad 45%SC	Tracer	0.2ml/lit.	Spinosyns	Meena and Raju *et al.* 2014 [4]	Dow agro science pvt ltd.
T_2	Chlorantraniliprole 18.5%SC	Coragen	0.5ml/lit.	Diamaide	Gadiya *et al* 2014	EI Dupont company.
T_3	Profenophos 50%EC	Cucracron	2ml/lit	Organophosphate	Aslam *et al* 2014	Syngenta company ltd.
T_4	Deltamethrin 2.8%EC	Decis	1ml/lit.	Synthetic pyrethoid	Hussian and Bilal 2007	Bayer crop science.
T_5	NSKE	Achook	5ml/lit.	Azardiractin	Ram and Singh 2011	T. stans and co.ltd.
T_6	Neem oil	Costar	2ml/lit	Azardiractin	Shah *et a*l 2013	T. stans and co. ltd.

3. Results and Discussion

The results of the experiment entitled "Management of tomato fruit borer (*Helicoverpa armigera* (Hubner) by of chemical insecticides and neem products" undertaken at The Field of horticulture, SHIATS, Allahabad. have been presented in this chapter along with discussion on the experimental finding in the light of scientific reasoning and their conformity with the previous researchers.

Studies on the incidence of fruit borer population with weather parameters given in table 4.1 below. The results showed that earliest occurrence of fruit borer (*Helicoverpa armigera*) in 2015 rainy season was commenced from 36th standard week (August fourth week) with an average 2.50 % infestation. The fruit borer population increased and gradually reached peak level of 39.54 % infestation at 42nd standard week (October 1s week). (Table4.1). Thereafter, declined trend was observed due to fall of maximum and minimum temperatures as optimum weather condition are decreasing.

Similarly, Bishara (1968) reported the fruit borer infestation to peak during October and November on cotton. And Abbas *et al.* (2015) [8]. Effect of Selected Insecticides on Helicoverpa armigera Hubner (Lepidoptera: Noctuidae) on Tomato (*Lycopersicon esculentum* Miller). Also Nadaf AM. Kulkarnik A. (2005). Seasonal Incidence of the fruit borers, *Helicoverpa armigera* (Hubner) and *Spodoptera litura* Fabricius on chilli

Table 2: Population dynamics of fruit borer [*Helicoverpa armigera* (Hubner)] during *rabi* season in 2015-16.

Standard week	Percent infestation	Temperature		Humidity %		Rainfall (mm)	Wind Velocity	Sunshine (hr/day)
		Max.	Min.	Morning	Evening			
29	0	34.08	27.74	90.57	55.42	2.20	1.33	5.82
30	0	35.97	27.51	92.42	53.42	5.00	1.28	5.34
31	0	33.22	27.00	92.85	58.28	12.48	2.22	4.80
32	0	35.45	27.42	90.71	54.85	11.85	2.55	5.74
33	2.81	36.42	27.20	89.71	45.42	0.00	1.68	7.97
34	5.24	37.48	27.37	86.71	47.14	0.00	2.17	8.70
35	9.72	35.65	28.05	86.28	55.71	0.60	1.17	7.11
36	16.29	36.42	27.80	90.71	47.14	0.20	1.84	7.17
37	22.8	36.11	27.85	89.00	50.14	0.00	1.56	8.45
38	31.15	35.77	27.82	90.85	51.57	0.00	1.35	8.68
39	39.54	35.85	23.88	78.28	51.40	0.00	0.96	8.57
	r=	0.119	-0.604	-0.343	-0.313	-0.580	-0.660	0.686
	t=	0.415	-2.625	-1.264	-1.143	-2.467	-3.046	3.267
	F- test	NS	S	NS	NS	S	S	S

Table value = (2.141)

Efficacy of certain chemicals and neem products on fruit borer [*Helicoverpa armigera* (Hubner)] in tomato (*Lycopersicon esculentum)*

Table 3: Management of tomato fruit borer (*Helicoverpa armigera* (Hubner) of chemical insecticides and neem products (First spray)

Treatments		Before	3 DAS	7 DAS	11 DAS	15 DAS	Mean
T_0	Control (water spray)	9.30	14.78	12.92	12.34	12.92	13.24
T_1	Spinosad 45%SC	9.44	4.06	5.12	6.09	6.21	5.37
T_2	Chlorantraniliprole 18.5%SC	11.02	5.20	6.45	7.35	7.20	6.55
T_3	Profenophos 50%EC	7.06	3.35	4.25	5.40	4.40	4.35
T_4	Deltamethrin 2.8%EC	8.43	4.40	5.35	6.25	7.60	5.90
T_5	NSKE	8.14	5.10	4.35	6.35	7.80	5.90
T_6	Neem oil	8.96	5.60	7.20	6.40	7.40	6.65
Overal Mean		**8.91**	**6.07**	**6.52**	**7.17**	**7.65**	**6.85**
F- test		NS	S	S	S	S	S
S. Ed. (±)		3.718	1.623	1.409	1.516	0.984	0.660
C. D. (P = 0.05)		7.883	3.441	2.986	3.213	2.086	1.399

Evaluation of efficacy of certain chemicals, and neem products against fruit borer [*Helicoverpa armigera* (Hubner)] of tomato (*Lycopersicon esculentum).*

The infestation in all the treatment were taken a day before imposition of treatments as indicated in tables

Assessment of infestation

First spray

The efficacy of certain chemical insecticides and neem products against fruit borer are depicted in table 4.1

Percent infestation 3 DAS: Bar diagram CD= 3.441

T0	T2	T5	T4	T1	T3	T6
14.78	5.20	5.10	4.40	4.06	3.35	5.60

The data on the percent infestation of fruit borer on third day after spray revealed that all the chemical and neem products treatments were significantly superior over control. Among all the treatments lowest percent infestation of fruit borer was recorded in Profenophos 50%EC (3.35), followed by Spinosad 45%SC (4.06), Deltamethrin 2.8%EC (4.40), NSKE (5.10), Chlorantraniliprole 18.5%SC (5.20), Neem oil (5.60), Maximum infestation was recorded in Control (water spray) (14.78).

Percent infestation of 7 DAS: Bar diagram CD= 2.986

T0	T6	T2	T4	T1	T5	T3
12.92	7.20	6.45	5.35	5.12	4.35	4.25

The data on the percent infestation of fruit borer on 7th day after spray revealed that all the chemical and neem products treatments were significantly superior over control. Among all the treatments lowest percent infestation of fruit borer was recorded in Profenophos 50%EC (4.25), T_5 NSKE (4.35), Spinosad 45%SC (5.12), Deltamethrin 2.8%EC (5.35), Chlorantraniliprole 18.5%SC (6.45), Neem oil (7.20). Maximum infestation was recorded in T_0 Control (water spray) (12.92).

Percent infestation of 11 DAS: Bar diagram CD = 3.213

T0	T2	T6	T5	T4	T1	T3
12.34	7.35	6.40	6.35	6.25	6.09	5.40

The data on the percent infestation of fruit borer on 7th day after spray revealed that all the chemical and neem products treatments were significantly superior over control. Among all the treatments lowest percent infestation of fruit borer was recorded in T_3 Profenophos 50% EC (12.34), NSKE (7.35), Spinosad 45% SC (6.40), Deltamethrin 2.8%EC (6.35), Chlorantraniliprole 18.5%SC (6.25), T_6 Neem oil (6.09). Maximum infestation was recorded in Control (water spray) (5.40).

Percent infestation of 15 DAS: Bar diagram CD= 2.086

T0	T5	T4	T6	T2	T1	T3
12.92	7.80	7.60	7.40	7.20	6.21	4.40

The data on the percent infestation of fruit borer on 15h day after spray revealed that all the chemical and neem products treatments were significantly superior over control. Among all the treatments lowest percent infestation of fruit borer was recorded in Profenophos 50%EC (4.40), Spinosad 45%SC (6.21), Chlorantraniliprole 18.5%SC (7.20), Neem oil (7.40), Deltamethrin 2.8%EC (7.60), NSKE (7.80). Maximum infestation was recorded in Control (water spray) (12.92).

Percent infestation of Mean (3, 7, 11 and 15 DAS): Bar diagram CD= 1.399

T0	T6	T2	T5	T4	T1	T3
13.24	6.65	6.55	5.90	5.90	5.37	4.35

The data on the percent infestation of fruit borer on (3, 7, 11 and 15) day mean after spray revealed that all the chemical and neem products treatments were significantly superior over control. Among all the treatments lowest percent infestation of fruit borer was recorded in Profenophos 50%EC (4.350), Spinosad 45%SC (5.370), Deltamethrin 2.8%EC (5.90), NSKE (5.90) Chlorantraniliprole 18.5%SC (6.550), Neem oil (6.650). Maximum infestation was recorded in Control (water spray) (13.240).

Benefit cost ratio

Table 4.5: Economics of Cultivation

S. No.	Treatment	Yield of q/ha	Cost of yield/Rs/kg	Total cost of yield	Common cost	Treatment cost	Total cost	C:B ratio
T_1	Spinosad 45%SC	13	3000 Rs/q	511260	47258	6510	53768	1:9.50
T_2	Chlorantraniliprole18.5%SC	12	3000 Rs/ q	506130	47258	3780	51038	1:9.91
T_3	Profenophos 50%EC	16	3000 Rs/ q	477060	47258	1860	49118	1:9.71
T_4	Deltamethrin 2.8%EC	14	3000 Rs/ q	637590	47258	4600	51858	1:12.29
T_5	NSKE	13	3000 Rs/ q	535680	47258	2040	49298	1:10.86
T_6	Neem oil	15	3000 Rs/ q	595560	47258	1150	48408	1:12.30
T_0	Control	12	3000 Rs/ q	241320	47258	------	47258	1:5.10

The yields among the treatment were significant. The highest yield was recorded in T_6 Neem oil (15 q/ha), followed by T_5 NSKE (13.00 q/ha), T_4 Deltamethrin 2.8%EC (14.00 q/ha), T_3 Profenophos 50%EC (16.00 q/ha), T_2 Chlorantraniliprole 18.5%SC (12.00 q/ha), T_1 Spinosad 45%SC (13.00 q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T_6 Neem oil (1:12.30), followed by T_4 (1:12.29), T_5 (1:10.86), T_2 (1:9.91), T_3 (1:9.71), T_1 (1:9.50), as compared to control T_o (1:5.10).

4. Conclusion

From the critical analysis of the present findings it can be concluded that shoot and fruit bore population increased with maximum temperature and decreased with decline in maximum and minimum temperature. Insecticides like Neem oil, NSKE, Deltamethrin and EC can be suitably incorporated in integrated pest management schedule against fruit borer as an effective tool under chemical control, in order to avoid indiscriminate use of pesticides causing pollution in the environment and not many harmful to beneficial insects.

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