Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 2215-2218
Received: 12-05-2018
Accepted: 18-06-2018

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Comparative efficacy of selected chemical insecticides and neem products against tomato fruit borer [*Helicoverpa armigera* (Hubner)] in Allahabad

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Abstract
The present investigation entitled, Comparative efficacy of selected chemical insecticides and neem products against tomato fruit borer [*Helicoverpa armigera* (Hubner)] in Allahabad, Were carried out during *Rabi* season of 2017-2018 at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad. The seasonal incidence of fruit borer (*Helicoverpa armigera*) from 1st week of December (2.98% damage) that is 49th week of sowing which gradually increased. The infestation percent reached to its peak level (39.71%) at 3rd week of January. 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 T_3-Spinosad 45% SC (3.17%), followed by T_7-Fipronil SC (3.73%), T_4-Cypermethrin 25EC (4.19%), T_5-Quinalphos 25EC (5.29%), T_6-Indoxacarb 14.5%SC (5.44%), T_2-NSKE (10.05%), T_1-Neem oil (11.23%). However all these treatments were superior over control. The maximum yield was reported in T_3 Spinosad (17.43 q/ha), followed by Fipronil (16.6q/ha), Quinalphos (15.44q/ha), Cypermethrin (14.46q/ha), Indoxacarb (12.38q/ha), NSKE (13.53q/ha), Neem oil (13.32q/ha). The highest cost benefit ration was obtained from Spinosad (1:0.78).

Keywords: Tomato fruit borer, *Helicoverpa armigera*, chemicals treatments (spinosad cypermethrin, Quinalphos, Indoxacarb, Fipronil), Neem product (neem oil, NSKE)

Introduction
Tomato (*Solanum lycopersicum* L.) belonging to family Solanaceae is the most important vegetable grown widely both for fresh market and processing. Tomato fruit contain water 93.1%, protient 1.9%, fat 0.3gm, fibre 0.7%, carbohydrates 3.6%, calorie 23, vitamin A (320 I.U)., vitamin B1 (0.07mg) vitamin B2 (0.01mg), nicotine acid (0.4mg) vitamin C (31mg), calcium (20mg) phosphorus (36mg) and iron (0.8mg) (Mandloi R. 2013) [1].

Tomato is a perennial in its native habitat, although often grown outdoors in temperate climates as an annual. It is grown in 880.00 thousand ha area with 18227 MT production and 20.70 ton/ha productivity (Anonymous, 2012) [2]. In Uttar Pradesh, the total area, production and of tomato during 2017-18 were 8.01 Mha and 223.37 MT respectively (Indian Horticulture Database 2017-18). Insects attack in tomato from the time of planting until the fruit is harvested. The major insect pests which plays most important role in the economic losses of tomato crop are leaf miner, aphid, jassid, and whitefly and fruit borer.

Tomato fruit borer [*Helicoverpa armigera* (Hubner)] is very important pest which causes 40-50 percent damage to the tomato crop (Pareek and Bhargava, 2003) [3]. Pest problem is main limiting factor for tomato cultivation as this is attacked by major insect pests such as *Helicoverpa armigera*. The tomato fruit borer, *Helicoverpa armigera* (Hubner).is a polyphagous pest attacking cotton, tomato, okra, 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, Gosh *et al.* (2010) [4].

It has been estimated that the crops worth Rs.1000 crore are lost annually (Jayraj *et al*. 1994) [5]. Nearly 30 percent insecticides are used alone against [*Helicoverpa armigera* (Hub.)] on different crops chemical insecticides are generally preferred for the control of pest due to their easy availability and applicability, but their excessive and indiscriminate use has resulted in the development of insectidal resistance in the pests and environmental pollution and presence of residue in food stuff (Phokela *et al*. 1990) [6].

The indiscriminate use of synthetic chemical pesticides to control this pest resulted in development of resistance and harmful pesticides residues in fruit. The presents of residues of DDT, HCH, endosulfan, Malathion and primisphos-methyl in market samples of tomato has been reported. Microbial and neem formulations. To reduce the *Helicoverpa armigera* population and fruit damage in tomato.

Materials and Method

Five plants were randomly selected from each plot and tagged. Periodically 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. The treatments neem oil, NSKE, spinosad cypermethrin, Quinalphos, Indoxacarb, Fipronil and controlled were taken during this period in the field condition.

Results and Discussion

Studies on the incidence of fruit borer population with weather parameters. The results showed the occurrence of fruit borer (*Helicoverpa armigera*) in 2017-2018 was commenced from 49th standard week with an average 2.98% infestation. The fruit borer population increased and gradually reached peak level of 39.71% infestation at 3rd standard week.

First spray-percent fruit infestation

The data on the percent infestation of fruit borer on (3rd, 7th and 14th) 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 T_3-Spinosad (7.35%), followed by T_7-Fipronil (8.91%), T_4-Cypermethrin (9.37%), T_5-Quinalphos (9.66%), T_6-Indoxacarb (10.37%), T_2-NSKE (12.98%), T_1-Neem oil (15.22%), Maximum infestation was recorded in T_0-Control (20.68%). Treatments like (T_6, T_5), (T_2, T_1) were non-significant and statistically at par with each other (Table 1).

Second spray-percent fruit infestation

The data on the percent infestation of fruit borer on (3rd, 7th, and 14th) 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 T_3-Spinosad (3.33%), followed by T_7-Fipronil (4.56%), T_4-Cypermethrin (4.98%), T_5-Quinalphos (5.55%), T_6-Indoxacarb (6.05%), T_2-NSKE (9.66%), T_1-Neem oil (10.94%), Maximum infestation was recorded in T_0-Control (19.05%). Treatments like (T_5, T_6), (T_2, T_1) were non-significant and statistically at par with each other (Table 2).

Table 1: Efficacy of selected chemical insecticide and neem products against [*Helicoverpa armigera* (Hubner)] on tomato, (1st spray per cent fruit infestation)

S. No	Treatments	Infestation percent				
		Before Spray	After Spray			
			3 DAS	7 DAS	14 DAS	Mean
T1	Neem oil	25.53 (30.33)	19.81 (26.43)	11.77 (20.06)	14.52 (22.40)	15.22 (22.96)
T2	NSKE	25.00 (29.98)	19.37 (26.11)	5.91 (14.07)	13.23 (21.33)	12.98 (21.12)
T3	Spinosad 45%SC	27.80 (31.81)	13.10 (21.22)	2.45 (9.01)	6.51 (14.78)	7.35 (15.73)
T4	Cypermethrin 25%EC	27.20 (31.42)	16.67 (24.10)	4.71 (12.53)	7.49 (15.05)	9.37 (17.83)
T5	Quinalphos 25%EC	26.93 (31.23)	16.84 (24.23)	5.44 (13.00)	6.74 (15.42)	9.66 (18.10)
T6	Indoxacarb 14.5%SC	26.93 (31.25)	18.18 (25.24)	5.06 (13.49)	7.07 (15.88)	10.37 (18.79)
T7	Fipronil SC	27.26 (31.46)	15.76 (23.39)	4.43 (12.15)	6.54 (14.82)	8.91 (17.37)
T0	Control	27.53 (31.64)	20.01 (20.20)	20.95 (21.13)	21.10 (22.10)	20.68 (22.08)
Overal Mean		26.77	16.44	6.46	9.26	10.72
F-test		NS	S	S	S	S
S. Ed. (±)		1.877	1.512	1.202	1.958	1.568
C. D. (P = 0.05)		3.978	3.205	2.548	4.151	3.324

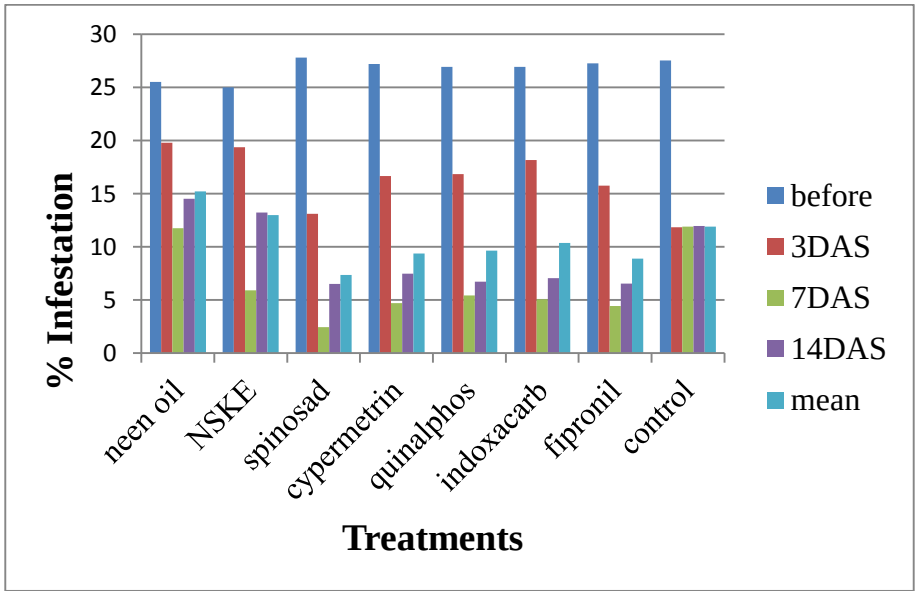

Fig 1: in parenthesis are Arc sine transformed values

Table 2: Efficacy of selected chemical insecticide and neem products against [*Helicoverpa armigera* (Hubner)] on tomato, (2nd spray per cent fruit infestation)

S. No	Treatments	Infestation percent			
		After Spray			
		3 DAS	7 DAS	14 DAS	Mean
T1	Neem oil	11.23 (18.23)	11.17 (19.42)	11.71 (20.01)	10.94 (19.31)
T2	NSKE	10.05 (19.58)	11.06 (19.52)	6.57 (14.83)	9.65 (18.10)
T3	Spinosad 45%SC	3.17 (10.26)	3.45 (10.70)	3.37 (10.58)	3.33 (10.51)
T4	Cypermethrin 25%EC	4.19 (11.81)	5.38 (13.41)	5.50 (13.41)	4.98 (12.90)
T5	Quinalphos 25%EC	5.29 (13.30)	5.73 (13.85)	5.61 (13.70)	5.54 (13.62)
T6	Indoxacarb 14.5SC	5.44 (11.14)	6.15 (13.00)	6.55 (12.78)	6.05 (12.33)
T7	Fipronil SC	3.73 (10.26)	5.06 (10.70)	4.89 (10.58)	4.56 (10.51)
T0	Control	15.78 (27.40)	20.21 (23.39)	21.18 (26.72)	19.05 (25.88)
Overall Mean		7.36	8.52	7.37	8.01
F-test		S	S	S	S
S. Ed. (±)		1.58	1.429	2.26	0.894
C. D. (P = 0.05)		3.349	3.029	4.792	1.896

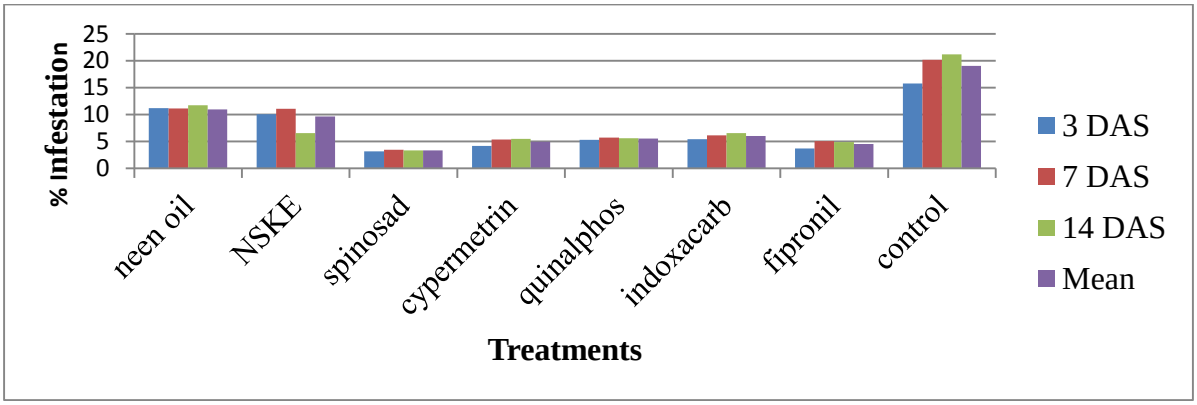

Fig 2: in parenthesis are Arc sine transformed values

Table 3: Efficacy of certain chemical insecticides, neem products against [*Helicoverpa armigera* (Hubner)], (1st spray and 2nd spray percent fruit infestation). Overall mean

S. No	Treatments	1st Spray mean	2nd Spray mean	Overall mean
T1	Neem oil	15.22	10.94	13.08
T2	NSKE	12.98	9.66	11.32
T3	Spinosad 45% EC	7.35	3.33	5.34
T4	Cypermenthrin 25% EC	9.37	4.98	7.18
T5	Quinalphos 25% EC	9.66	5.55	7.61
T6	Indoxacarb 14.5% SC	10.37	6.05	8.21
T7	Fipronil SC	8.91	4.56	6.74
T0	Control	19.05	20.68	19.86
Over all mean		11.61	8.21	9.91
F-test		S	S	S
S. Ed. (±)		1.568	0.894	0.795
C. D. (P = 0.05)		3.324	1.896	1.686

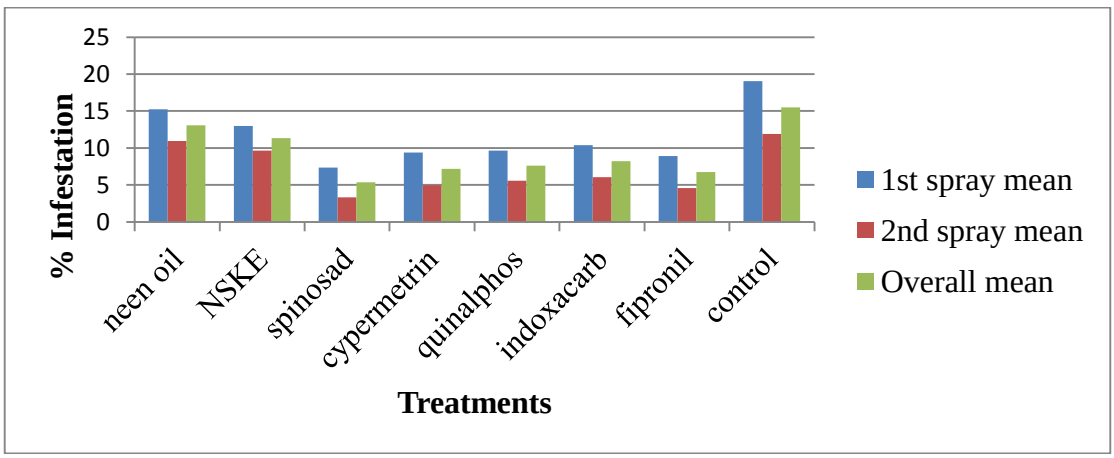

Fig 3: in parenthesis are Arc sine transformed values

The data on the percent infestation of fruit borer on (1st and 2nd spray) 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 T_3-Spinosad (5.34%), T_7-Fipronil (6.74%), T_4-Cypermethrin (7.18 %), T_5-Quinalphos (7.61%), T_6-Indoxacarb (8.21%), T_2-NSKE (11.32%), T_1-Neem oil (13.08%). Maximum infestation was recorded in T_0-Control (19.86%). Treatments like (T_4, T_7), (T_5, T_6), (T_2, T_1) were non-signficant and statistically at par with each other.

Conclusion

Among all the treatments, Spinosad found most effective against tomato fruit borer (*Helicoverpa armigera*). Followed by Fipronil, Cypermethrin, Quinalphos, Indoxacarb, NSKE, Neem oil are effective. Spinosad gave the highest benefit & cost ratio under Allahabad agro climatic condition. The present finding are limited to one crop season (November to march, 2017-2018) under Allahabad agro climatic condition as such more trails are required for future thrust.

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