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Bio-efficacy of insecticides and neem products against *Helicoverpa armigera* (Hubner) on tomato

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Abstract
Tomato is attacked by several insect pests from the time of planting till fruit is harvested, among them fruit borer, *Helicoverpa armigera* (Hubner) is the major one. Investigations were carried out for three years on bio-efficacy of insecticides and neem products against *Helicoverpa armigera* on Tomato. Resutls revealed that minimum incidence of *Helicoverpa armigera* was observed in treatment flubendiamide 20% WDG @ 2.5 ml and chlorantraniliprole 8.5% SC @ 3.0 ml, first at the time of flowering and second at 15 days after first spray for obtaining higher yield and better return. Results of residue analysis revealed that, the residue content of this insecticide remained below maximum residue limit (MRL) in tomato fruits after three days.

Keywords: Heliothis, *Helicoverpa armigera*, tomato, insecticide, Neem products

Introduction

Tomato (*Lycopersicum esculentum* L.) belongs to the family Solanaceae and is one of the major vegetable crops being grown throughout the world. The origin of tomato is tropical America (Thompson and Kelley, 1957) [1]. Its ripe fruits are consumed as fresh vegetable and also in the form of various processed products. The fruit is a good source of vitamin C and A. Tomato is the most commonly and extensively grown vegetable all over the country occupying an important place in the food basket of Indian consumers. Though tomato occupies maximum area of 865.0 lac ha (IHD, 2011) in India but their productivity is very low.

Pest problem is main limiting factor for tomato cultivation as this is attacked by a large number of insect pests such as tomato fruit borer (*Helicoverpa armigera* Hubner), jassid (*Amrasca biguttula biguttula*), white fly (*Trialeurodes vaporariorum*), mite (*Tetranychus urticae*), aphid (*Myzus persicae*) and leaf miner (*Liriomyza sativae*). Among them, *Helicoverpa armigera* (Hb.) (Lepidoptera: Noctuidae) is a polyphagous pest and is considered as the most important limiting factor in the successful cultivation of the crop (Tewari and Moorthy, 1984) [5]. The fruit borer, *H. armigera* 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) [3]. The production and productivity of the crop is greatly hampered by the fruit borer, *H. armigera*. This is a key pest as it attacks the cashable part of the plant *i.e.* fruits and makes them unfit for human consumption causing considerable crop loss leading up to 55 per cent (Selvanarayanan, 2000) [4]. One of the major constraints identified in their production is the increasing incidence of tomato fruit borer, *Helicoverpa armigera* causing yield loss up to 50-80% (Tewari & Krishnamoorthy, 1984) [2] and fruit damage reached up to 24.43% on late sown tomato at Northern part of West Bengal (Chakraborty *et al*., 2011) [6].

The frequent and rapid changes in cropping patterns and agro-ecosystems, the polyphagous nature of the pest and its cosmopolitan distribution has accentuated the problem globally. The significance of this pest is tremendous because it directly attacks on fruiting structures, has voracious feeding habits, high mobility and fecundity, multivoltine, overlapping generations with facultative diapause, noctural behaviour, migration and host selection by learning (Satpute and Sarode, 1995) [7].

Moths are attracted to tomato in the flowering and fruiting stages. Eggs of the fruit borer are laid singly in the terminal leaflets of tomato plant below the highest open flower cluster. Soon after hatching, the early instars, feed on leaves of the top canopy. The late larval instars enter the fruit at the stalk end and feed inside, creating a watery cavity. Usually the damaged fruits rot or ripen prematurely. The fully-grown larva leaves the plant and burrows into the soil for pupation. The yield losses by this pest vary from 14-100 per cent on different crops in India

(Reddy and Zehr, 2004) [8]. The monetary loss due to this pest in India has been estimated over rupees one thousand crore per year (Jayaraj *et al.,* 1994) [9].

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. The most commonly used method for the control of this pest is to have a film of a persistent effective insecticide over the foliage and fruiting bodies (Deshmukh *et al.,* 1972) [10]. It has now become imperative to select safer insecticides that should protect the crop and keep the pest population below injury level. Hence, attempts were made to evaluate the efficacy of different newer and biorational insecticides for the sustainable management of *H. armigera* on tomato.

Materials and methods

Studies on the "Bio- efficacy of insecticides and neem products against *Helicoverpa armigera* (Hubner) on Tomato" in Navsari were carried out with a view to manage the fruit borer, *H. armigera* with the help of some chemical insecticides and botanicals. The present investigation was carried out during rabi season 2011-2014 at the farm of Horticulture Polytechnic, ASPEE College of Horticulture and Forestry, NAU, Navsari There were eleven treatments including an untreated control and each treatment was replicated three in the 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. The observations on number of healthy and damage fruit, number of *Helicoverpa* per 10 plants per treatment recorded at each picking. All the observations were recorded before spraying and at 3, 7 and 14 days after each spraying. The yield/plot was recorded and converted in ton/ha for each treatment separately.

Results and Discussion

The results of the experiment entitled "Bio- efficacy of insecticides and neem products against *Helicoverpa armigera* (Hubner) on Tomato" undertaken at Horticulture Polytechnic, ASPEE College of Horticulture and Forestry, NAU, Navsari. have been presented along with discussion on the experimental finding in the light of scientific reasoning and their conformity with the previous researchers. Incidence of fruit borer population in each treatment are given in Table-1. Based on overall pooled data recorded before spraying on larvae of *H. armigera* was found to be non significant indicating homogenous population. Overall pooled data indicated that the lowest larval population of *Helicoverpa* was recorded in the treatment of flubendiamide 20% WDG @ 2.5 ml (0.56 larva/plant) which was at par with chlorantraniliprole 8.5% SC @ 3.0 ml (0.66 larva/plant) and emamectin benzoate 5% SG@ 2.0 gm/10 lit (0.73 larva/plant).The next effective treatments were chlorfenpyre 10% SC 7.5 ml (1.13 larvae/plant), indoxacarb 14.5% SC 5 ml (1.20 larvae/plant) and spinosad 2.5% SC 8 ml (1.39 larvae/plant). The descending chronological order of effectiveness of remaining insecticides were quinalphos 25% EC 20 ml (1.74 larvae/plant) > azadirachtin 3000 ppm 20 ml (1.85 larvae/plant) > novaluron 10% EC 7.5 ml (2.16 larvae/plant) > Acephate 75% SP 12 gm (2.52 larvae/plant). Overall pooled data over period, the treatment x period (P x T) interaction was found to be non significant, indication consistent performance of various treatments over the years.

Minimum per cent damaged fruit (Table-2) was observed in treatment flubendiamide 20% WDG @ 2.5 ml. (7.41 per cent damaged fruits) which was at par with chlorantraniliprole 8.5% SC @ 3.0 ml (7.74 per cent damaged fruits). The next effective treatments were emamectin benzoate 5% SG@ 2.0 gm/10 lit (6.69 per cent damaged fruits). The descending chronological order of effectiveness of remaining insecticides were Chlorfenpyre 10% SC 7.5 ml (11.14 per cent damaged fruits)> indoxacarb 14.5% SC 5 ml (12.92 per cent damaged fruits) >spinosad 2.5% SC 8 ml (14.31 per cent damaged fruits)> azadirachtin 3000 ppm 20 ml (17.62 per cent damaged fruits) > quinalphos 25% EC 20 ml (17.91 per cent damaged fruits) > novaluron 10% EC 7.5 ml (19.56 per cent damaged fruits) > Acephate 75% SP 12 gm (22.87 per cent damaged fruits). Based on overall pooled data over period, the treatment x period (P x T) interaction was found to be non significant, indicating consistent performance of various treatments over the year.

In case of yield (Table-3), the highest fruit yield was received in the treatment of flubendiamide 20 per cent WDG @ 2.5 ml (34.7 ton/ ha.). The next effective treatments pertaining to yield of tomato were chlorantraniliprole 18.5% SC @ 3.0 ml (32.9 ton/ ha), emamectin benzoate 5% SG@ 2.0 gm/10 lit (30.4 ton/ ha), Chlorfenpyre 10% SC 7.5 ml (28.2 ton/ ha), indoxacarb 14.5% SC 5 ml (25.9 ton/ ha), spinosad 2.5% SC 8 ml (24.7 ton/ ha), quinalphos 25% EC 20 ml (23.0 ton/ ha), azadirachtin 3000 ppm 20 ml (21.7 ton/ ha), novaluron 10% EC 7.5 ml (20.2 ton/ ha) > acephate 75% SP 12 gm (19.4 ton/ ha). The lowest yield was found in control treatment (16.8 ton/ ha).

Muhebullah and Ashwani (2016) [11] observed that 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) and Neem oil (6.650). Baikar and Naik (2016) [13] conducted a laboratory experiment to test the efficacy of some insecticides against fruit borer, The result revealed that the treatment emamectin benzoate (0.002%) recorded 36.67 per cent corrected mortality of fruit borer, *H. armigera* and was found to be the best treatment. Both are in agreement with present studies.

Singh *et al*. (2017) [12] tested nine insecticides, among them indoxacarb 14.5 SC (0.01%) was found most effective against fruit borer followed by novaluron 10 EC (0.01%) and acephate 75 SP (0.037%). This investigation does not support the present result.

Hanafy and Sayed (2013) [14] observed that the highest reduction in infestation of *H. armigera* on tomato fruit was recorded in treatment spinosad followed by emamectin. Meanwhile, Pyridalyl was significantly more effective than Indoxcarb in reducing infestation percentage of *H. armigera* does not support the present result.

Table 1: Average number of *Helicoverpa armigera* on Tomato in different insecticidal treatments (Pooled)

Sr. No.	Treatment	Conc.	2011-12	2012-13	2013-14	Overall Pooled
1	Spinosad 2.5% SC	0.0020	1.35 (1.33)	1.41 (1.50)	1.36 (1.35)	1.36 (1.39)[f]
2	Indoxacarb 14.5% SC	0.0075	1.27 (1.11)	1.33 (1.28)	1.30 (1.20)	1.28 (1.2)[de]
3	Emamectin benzoate 5% SG	0.001	1.03 (0.55)	1.25 (1.06)	1.04 (0.59)	1.10 (0.73)[abc]
4	Flubendiamide 20% WDG	0.005	1.00 (0.50)	1.11 (0.72)	0.99 (0.47)	1.02 (0.56)[a]
5	Chlorfenpyre 10% SC	0.0075	1.26 (1.11)	1.35 (1.34)	1.18 (0.89)	1.26 (1.13)[d]
6	Novaluron 10% EC	0.0075	1.58 (2.00)	1.76 (2.61)	1.55 (1.91)	1.62 (2.16)[i]
7	Chlorantraniliprole 8.5%SC	0.006	1.05 (0.61)	1.16 (0.84)	1.02 (0.54)	1.06 (0.66)[ab]
8	Azadiractin 3000 ppm	0.0006	1.47 (1.66)	1.62 (2.11)	1.51 (1.79)	1.52 (1.85)[h]
9	Quinalphos 25%EC	0.03	1.44 (1.57)	1.62 (2.11)	1.45 (1.62)	1.48 (1.74)[g]
10	Acephate 75% SP	0.05	1.68 (2.33)	1.92 (3.17)	1.60 (2.07)	1.73 (2.52)[j]
11	Control	-	2.13 (4.06)	2.29 (4.72)	1.92 (3.19)	2.09 (3.97)[k]
	S.Em.± (T)		0.04	0.15	0.02	0.06
	C.D. at 5% (T)		0.13	0.46	0.06	0.18
	S.Em. ± (P x T)		0.18	0.17	0.01	0.04
	C.D. at 5% P X T		0.55	0.52	NS	NS
	S.Em. Y X P X T		-	-	-	0.03
	C.D. Y X P X T		-	-	-	NS
	CV%		6.18	8.29	2.58	7.21

Table 2: Mean per cent damaged fruit at each picking (Pooled)

Sr. No.	Treatment	2011-12	2012-13	2013-14	Overall Pooled
1	Spinosad 2.5% SC	23.04 (15.55)	23.94 (17.04)	23.84 (15.35)	23.03 (14.31)[f]
2	Indoxacarb 14.5% SC	20.84 (13.42)	23.28 (16.18)	22.62 (13.81)	21.91 (12.92)[de]
3	Emamectin benzoate 5% SG	16.11 (7.88)	16.21 (8.08)	18.88 (9.48)	19.09 (9.69)[abc]
4	Flubendiamide 20% WDG	14.01 (6.11)	13.33 (5.53)	15.71 (6.37)	16.86 (7.41)[a]
5	Chlorfenpyre 10% SC	19.08 (10.70)	21.54 (14.26)	20.84 (11.66)	20.39 (11.14)[cd]
6	Novaluron 10% EC	25.67 (18.94)	36 (35.44)	28.09 (21.2)	26.97 (19.56)[ghi]
7	Chlorantraniliprole 8.5%SC	13.71 (5.65)	14.19 (6.26)	16.83 (7.38)	17.20 (7.74)[ab]
8	Azadiractin 3000 ppm	25.78 (19.09)	32.84 (30.79)	27.25 (19.98)	25.56 (17.62)[g]
9	Quinalphos 25%EC	23.77 (16.80)	32.51 (29.78)	26.53 (18.95)	25.78 (17.91)[gh]
10	Acephate 75% SP	28.04 (22.45)	37.79 (38.38)	31.01 (25.56)	29.25 (22.87)[j]
11	Control	32.64 (29.31)	45.13 (48.92)	36.79 (34.87)	34.12 (30.46)[k]
	S.Em.± (T)	1.96	2.63	0.54	0.78
	C.D. at 5% (T)	5.78	7.32	1.59	2.34
	S.Em. ± (P x T)	1.61	14.64	0.17	0.32
	C.D. at 5% P X T	4.74	5.46	NS	NS
	S.Em.Y X P X T	-	-	-	0.23
	C.D. Y X P X T	-	-	-	NS
	CV%	15.39	5.27	10.83	8.34

Table 3: Overall pooled data of yield of fruits (ton/ha)

Sr. No.	Treatment	2011-12	2012-13	2013-14	Overall Pooled
1	Spinosad 2.5% SC	29.63	19.14	25.23	24.7
2	Indoxacarb 14.5% SC	29.93	19.89	27.95	25.9
3	Emamectin benzoate 5% SG	32.44	25.47	33.28	30.4
4	Flubendiamide 20% WDG	34.37	30.86	38.91	34.7
5	Chlorfenpyre 10% SC	31.41	22.67	30.52	28.2
6	Novaluron 10% EC	24.74	16.99	19.01	20.2
7	Chlorantraniliprole 18.5%SC	32.74	29.39	36.64	32.9
8	Azadiractin 3000 ppm	26.07	17.48	21.58	21.7
9	Quinalphos 25%EC	28.15	17.60	23.26	23.0
10	Acephate 75% SP	24.59	16.55	17.19	19.4
11	Control	22.96	13.45	14.07	16.8
	S.Em.± (T)	1.59	1.11	1.44	5.75
	C.D. at 5% (T)	4.70	3.29	4.24	17.42
	S.Em. ± (P x T)	-	-	-	1.17
	C.D. at 5% P X T	-	-	-	NS
	S.Em. Y X P X T	-	-	-	1.04
	C.D. Y X P X T	-	-	-	NS
	CV%	9.6	9.25	9.51	10.58

Conclusion

For effective control of tomato fruit borer, it is advised to apply two sprays of either Flubendiamide 20 WDG @ 2.5 g/10 litre or Chlorantraniliprole 18.5 SC @ 3.0 ml/10 litre, first at the time of flowering and second at 15 days after first spray for obtaining higher yield and better return. Further, the residue content of this insecticide remained below MRL in tomato fruits after three days.

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