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Evaluation of Different Management Schedules against Fruit Borer, *Helicoverpa armigera* on Tomato

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ABSTRACT

Keywords

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Field studies on the "Evaluation of different management schedules against fruit borer, *Helicoverpa armigera* on tomato" was carried out during rabi season of 2014-15 at farmer's field of an extensive tomato growing village Surajgarh, block Matanhail, District Jhajjar, Haryana. These schedules included bio-intensive schedule (S4), schedules comprising of components of bio-control and chemical insecticides (S1, S2, S3, and S5) and chemical insecticide schedule (S6). The data on per cent reduction in larval population over control indicated that efficacy of various management schedules in descending order was S6, S5, S1, S2, S3 and S4. The maximum larval reduction over control was observed in S6 (79. 91%) closely followed by S5 (79. 04) and minimum in S4 (65. 50%) closely followed by S3 (66. 81%).

Introduction

Tomato (*Lycopersicon esculentum*) Miller is an important vegetable crop grown all over the world. Insect pests and diseases are the most important biological limitations in tomato production. Among many factors responsible for low yields of tomato, insect pests are major ones that have been reported to attack tomato at all stages of crop growth. The important insect pests of tomato are fruit borer *Helicoverpa armigera*, whitefly *Bemisia tabaci*, leaf hopper *Amrasca devastans*, leaf miner *Liriomyza trifolii*, potato aphid *Myzus persicae* and hadda beetle, *Epilachana dedecastigma* (Sharma *et al.*, 2013). Out of these insect pests, the damage caused by fruit borer, *Helicoverpa armigera* Hubner surpass the loss caused by all other insect pests together and it has been reported that the losses due to this pest range from 20-50 per cent (Karabhantanal and Awaknavar, 2012). 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.

However, sometimes there has been complete destruction of tomato crop by this pest (Fery and Cuthbert, 1974). In spite of regular spraying of insecticides, its incidence in farmers' fields varies from 10 to 20 per cent and at times, this pest causes yield loss up to 40 per cent (Tiwari and Krishnamoorthy, 1984). With the introduction of new molecules, farmers use a variety of chemical insecticidal sprays in a haphazard manner for management of insect-pests of tomato. This leads to high cost on protection measures with poor insect-pest management. To reduce the ill effects of conventional chemical insecticides, there is great need to evaluate different management schedules based on combination of bio-rational and eco-friendly pesticides, alone and in combination.

Materials and Methods

A field trial was laid out in village Surajgarh, block Matanhail, District Jhajjar, Haryana during Kharif 2014-15 on tomato, cv. Abhinav in randomised block design with seven treatments (six and untreated control) in three repeats and the plot size 6×3 m^2 and spacing 60x45 cm. Different management schedules (Table 1) were evaluated with following specifications: One row of African yellow marigold was alternated after five rows of tomato at the time of transplanting. For this purpose, the nursery of marigold was raised one month in advance of tomato so that there was synchronization of flowering on them in the field. One Yellow sticky trap per replications was installed after establishment of plants.

Observations on larval population of *H. armigera* were recorded per 3 leaves on 5 randomly selected plants in each schedule including untreated (control), one day before each spray and at 3, 5, and 7 days after completion of the schedule using drop sheet method.

Statistical analysis of data

The obtained data were statistically analysed using angular transformation and $\sqrt{n+1}$ square root transformation.

Results and Discussion

The results of the experiment entitled "Evaluation of different management schedules against fruit borer, *Helicoverpa armigera* on tomato" undertaken at farmer's field of an extensive tomato growing village Surajgarh, block Matanhail, District Jhajjar, Haryana, have been presented along with discussion on the experimental finding in the light of scientific reasoning and their conformity with the previous researchers. Different management schedules had been evaluated against *H. armigera.* These schedules included bio-intensive schedule (S4), schedules comprising of components of bio-control and chemical insecticides (S1, S2, S3 and S5) and chemical insecticide schedule (S6). On the basis of studies on effects of first management practice/spray after 10 days in different schedules, it is evident that spray of Nimbecidine 300 ppm @ 2.5 l/ha (S1, S2, S5) or two releases of *Trichogramma chilonis* @ 50000 prasitoids eggs /ha (S3, S4) did not reduce the larval population on tomato. The larval reduction was observed only in S6 i.e. Fenvalerate 20EC @ 188 ml/ha (Table 2) which is well supported by the findings of Mishra (1984); Setiawati (1990) and Walgenbach and Estes (1992). Nimbecidine 300 ppm+ Novaluron 10EC @ 188 ml/ha (both in S1 and S2) reduced larval population 10 days after application as second management practice/spray but reduction was still highest (18.10%) in S6 when crop was sprayed with Malathion 50 EC @1.0 l/ha (Table 3). Mathur *et al*., (1974) also found Malathion to give effective suppression of *H. armigera.*

Spinosad 45 SC @ 188 ml/ha proved most effective in reducing larval population (27.48), in S3 closely followed by *B.t.k*. @ 1.0l/ha (27.37%) in S5 when used as 3rd management practice/spray (Table 4). These findings are in agreement with the observations recorded by Ghos *et al.*, (2010), Lutwama and Matammi (1988), Praveen *et al.*, (2001) and Prasad *et al.*, (2003). When larval population was recorded ten days after 4th management practice/spray (Table 5), highest larval reduction (29.23%) was observed in S1 where Spinosad 45 SC @ 188 ml/ha was sprayed, closely followed by S2 (Novaluron 10EC @ 37 5ml/ha). Nimbecidine 300 ppm @ 2.5 l/ha proved least effective (S3 and S4) in reducing larval population at this stage which is in concurrence with the findings of Mathur *et al.*, (1996). Ten days after 5th management practice/spray, in addition to the efficacy of various schedules there was also natural reduction in the larval population of fruit borer in all the schedules including control (32.97 to 60.33%) but population was still above ETL in control (2.29 larvae/plant).

Based on the data on average larval population of each schedule (Table 6), it is inferred that all the management schedules were superior than untreated control and chemical insecticide based schedule i.e S6 (Fenvalerate 20 EC @ 188 ml/ha followed by Malathion 50 EC @ 1.0 l/ha, Decamethrin 2.8 EC @ 500 ml/ha, Malathion 50 EC @ 1.0 l/ha and Cypermethrin 25 EC @ 150 ml/ha) proved most effective in reducing larval population by 20.35 per cent followed by schedule S5 (Nimbecidine 300 ppm @ 2.5 l/ha followed by Malathion 50 EC @ 1.0 l/ha, *B.t.k.* @ 1.0 kg/ha, Decamethrin 2.8 EC @ 500 ml/ha and Spinosad 45 SC @ 188 ml/ha) and bio- intensive schedule proved least effective.

After complection of all schedules, their efficacy was studied in detail by recording observations on larval population of *H.armigera* after 3,5,7 and 10 days of last spray (Table 6).

At each observation, chemical insecticide schedule i.e S6 (Fenvalerate 20 EC @ 188 ml/ha followed by Malathion 50 EC @ 1.0 l/ha, Decamethrin 2.8 EC @ 500 ml/ha, Malathion 50 EC @ 1.0 l/ha and Cypermethrin 25 EC @ 150 ml/ha) was found most effective with lowest larval population and was at par with S5 (Nimbecidine 300 ppm @ 2.5 l/ha followed by Malathion 50 EC @ 1.0 l/ha, *B.t.k.* @ 1.0 kg/ha, Decamethrin 2.8 EC @ 500 ml/ha and Spinosad 45 SC @ 188 ml/ha) while bio-intensive schedule i.e S4 (African yellow marigold + Yellow sticky trap + *T. chilonis* @ 50000 parasitised eggs/ha (Two releases at 4 days interval) followed by Nimbecidine 300 ppm @ 2.5 l/ha, *B.t.k.*@ 1.0 kg/ha, Nimbecidine 300 ppm @ 2.5 l/ha and *Bt* formulation (Delfin) @ 1.0 kg/ha) was found least effective having highest larval population.

The schedule S1 (Nimbecidine 300 ppm @ 2.5 l/ha followed by Nimbecidine 300 ppm @ 1.25 l/ha + Novaluron 10 EC @ 188 ml/ha, *Bt* formulation (Delfin) @ 1.0 kg/ha, Spinosad 45 SC @ 188 ml/ha and Novaluron 10 EC @ 375 ml/ha) and S2 (Nimbecidine 300 ppm @ 2.5 l/ha followed by Nimbecidine 300 ppm @ 1.25 l/ha + Novaluron 10 EC @ 188ml/ha, *B.t.k.*@ 1.0 kg/ha**,** Novaluron 10 EC @ 375 ml/ha and Novaluron 10 EC @ 375 ml/ha) were at par throughout the obseravation period, however these were at par with S6 and S5 up to 3 days after completion of schedules but lost their efficacy thereafter and occupied a place between two extremes.

Table.1 Management schedules evaluated against tomato fruit borer, *Helicoverpa armigera* on tomato

Schedule	Management practice/spray				
	1st management practice/spray	**2nd management practice/spray**	**3rd management practice/spray**	**4th management practice/spray**	**5th management practice/spray**
S_1	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	Mixed Spray of Nimbecidine 300 ppm @ 1.25 l/ha +Novaluron 10 EC @ 188 ml/ha)	Spray of *B.t.k.*@ 1.0 kg/ha	Spray of Spinosad 45 SC @ 188 ml/ha	Spray of Novaluron 10 EC @ 375 ml/ha
S_2	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	Mixed Spray of Nimbecidine 300 ppm @ 1.25 l/ha +Novaluron 10 EC @ 188 ml/ha)	Spray of *B.t.k.*@ 1.0 kg/ha	Spray of Novaluron 10 EC @ 375 ml/ha	Spray of Novaluron 10 EC @ 375 ml/ha
S_3	*Trichogramma chilonis* Ishi @ 50000 parasitised eggs/ha (2 releases at 4 days interval)	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	Spray of Spinosad 45 SC @ 188 ml/ha	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	Spray of Novaluron 10 EC @ 375 ml/ha
S_4	African yellow marigold*+ Yellow sticky trap**+ *Trichogramma chilonis* Ishi @ 50000 parasitised eggs/ha (2 releases at 4 days interval)	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	Spray of *B.t.k.*@ 1.0 kg/ha	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	Spray of *B.t.k.*@ 1.0 kg/ha
S_5	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	Spray of Malathion 50 EC @ 1.0 l/ha	Spray of *B.t.k.*@ 1.0 kg/ha	Spray of Decamethrin 2.8 EC @ 500 ml ha	Spray of Spinosad 45 SC @ 188 ml/ha
S_6	Spray of Fenvalerate 20 EC @ 188 ml/ha	Spray of Malathion 50 EC @ 1.0 l/ha	Spray of Decamethrin 2.8 EC @ 500 ml ha	Spray of Malathion 50 EC @ 1.0 l/ha	Spray of Cypermethrin 25 EC @ 150 ml/ha
S_7	Untreated (control)	Untreated (control)	Untreated (control)	Untreated (control)	Untreated (control)

Table.2 Effect of management schedules after 1st management practice/spray on the population of fruit borer, *Helicoverpa armigera* on tomato

Schedule (S)	1st management practice/spray	No. of larvae/plant (average of 5 plants)		
		1 day before spray	10 days after spray	Reduction (%)
S1	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	1.43 (1.55)	1.90 (1.70)[b]	-33.41
S2	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	1.40 (1.52)	1.87 (1.69)[b]	-33.33
S3	*Trichogramma chilonis* Ishi @ 50000 parasitised eggs/ha (2 releases at 4 days interval)	1.28 (1.48)	2.08 (1.75)[c]	-62.66
S4	African yellow marigold*+ Yellow sticky trap**+ *Trichogramma chilonis* Ishi @ 50000 parasitised eggs/ha (2 releases at 4 days interval)	1.20 (1.47)	2.10 (1.76)[c]	-75.00
S5	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	1.33 (1.48)	1.81 (1.68)[b]	-36.09
S6	Spray of Fenvalerate 20 EC @ 188 ml/ha	1.53 (1.54)	1.16 (1.47)[a]	24.35
S7	Untreated (control)	1.45 (1.55)	2.25 (1.80)[d]	-55.17
SE (m)		0.22	0.01	
C.D. (p=0.05)		NS	0.03	

Figures in parentheses are square root transformation ($\sqrt{n+1}$) values
Figures with same letter are non significant

Table.3 Effect of management schedules after 2nd management practice/spray on the population of fruit borer, *Helicoverpa armigera* on tomato

Schedule (S)	2nd management practice/spray	No. of larvae/plant (average of 5 plants)		
		1 day before spray	10 days after spray	Reduction (%)
S1	Mixed Spray of Nimbecidine 300 ppm @ 1.25 l/ha +Novaluron 10 EC @ 188 ml/ha)	1.90 (1.70)[b]	1.75 (1.65)[c]	8.06
S2	Mixed Spray of Nimbecidine 300 ppm @ 1.25 l/ha +Novaluron 10 EC @ 188 ml/ha)	1.87 (1.69)[b]	1.69 (1.64)[c]	9.46
S3	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	2.08 (1.75)[c]	2.62 (1.90)[d]	-26.16
S4	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	2.10 (1.76)[c]	2.51 (1.87)[d]	-19.52
S5	Spray of Malathion 50 EC @ 1.0 l/ha	1.81 (1.68)[b]	1.55 (1.60)[b]	14.36
S6	Spray of Malathion 50 EC @ 1.0 l/ha	1.16 (1.47)a	0.95 (1.40)[a]	18.10
S7	Untreated (control)	2.25 (1.80)[d]	2.96 (2.00)[e]	-31.56
SE (m)		0.01	0.01	
C.D. (p=0.05)		0.03	0.03	

Figures in parentheses are square root transformation ($\sqrt{n+1}$) values
Figures with same letter are non significant

Table.4 Effect of management schedules after 3rd management practice/spray on the population of fruit borer, *Helicoverpa armigera* on tomato

Schedule (S)	3rd management practice/spray	No. of larvae/plant (average of 5 plants)		
		1 day before spray	10 days after spray	Reduction (%)
S1	Spray of *B.t.k.*@ 1.0 kg/ha	1.75 (1.65)c	1.30 (1.52)c	25.86
S2	Spray of *B.t.k.*@ 1.0 kg/ha	1.69 (1.64)c	1.26 (1.50)c	25.49
S3	Spray of Spinosad 45 SC @ 188 ml/ha	2.62 (1.90)d	1.95 (1.70)d	27.48
S4	Spray of *B.t.k.*@ 1.0 kg/ha	2.51 (1.87)d	2.06 (1.75)d	17.95
S5	Spray of *B.t.k.*@ 1.0 kg/ha	1.55 (1.60)b	1.12 (1.46)b	27.37
S6	Spray of Decamethrin 2.8 EC @ 500 ml ha	0.95 (1.40)a	0.89 (1.38)a	5.96
S7	Untreated (control)	2.96 (2.00)e	3.77 (2.18)e	-27.48
SE (m)		0.01	0.01	
C.D. (p=0.05)		0.03	0.04	

Figures in parentheses are square root transformation ($\sqrt{n+1}$) values
Figures with same letter are non-significant

Table.5 Effect of management schedules after 4th management practice/spray on the population of fruit borer, *Helicoverpa armigera* on tomato

Schedule (S)	4th management practice/spray	No.of larvae/plant (average of 5 plants)		
		1 day before spray	10 days after spray	Reduction (%)
S1	Spray of Spinosad 45 SC @ 188 ml/ha	1.30 (1.52)c	0.92 (1.39)b	29.23
S2	Spray of Novaluron 10 EC @ 375 ml/ha	1.26 (1.50)c	0.98 (1.41)b	22.02
S3	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	1.95 (1.72)d	1.90 (1.70)c	2.56
S4	Spray of Nimbecidine 300 ppm @ 2.5 l/ha	2.06 (1.75)d	2.00 (1.73)d	2.76
S5	Spray of Decamethrin 2.8 EC @ 500 ml ha	1.12 (1.46)b	0.95 (1.40)b	16.86
S6	Spray of Malathion 50 EC @ 1.0 l/ha	0.89 (1.38)a	0.79 (1.34)a	11.57
S7	Untreated (control)	3.77 (2.18)e	3.70 (2.16)e	2.03
SE (m)		0.01	0.06	
C.D. (p=0.05)		0.04	0.02	

Figures in parentheses are square root transformation ($\sqrt{n+1}$) values
Figures with same letter are non significant

Table.6 Effect of management schedules after 5th management practice/spray on the population of fruit borer, *Helicoverpa armigera* on tomato

Schedule (S)	5th management practice/spray	5th management practice /spray			
		No.of larvae/plant (average of 5 plants)			Average reduction
		1 day before	10 days after	Reduction (%)	
S1	Spray of Novaluron 10 EC @ 375 ml/ha	0.92 (1.39)b	0.62 (1.27)[b]	32.97	12.54
S2	Spray of Novaluron 10 EC @ 375 ml/ha	0.98 (1.41)b	0.66 (1.29)[b]	32.65	11.26
S3	Spray of Novaluron 10 EC @ 375 ml/ha	1.90 (1.70)c	0.76 (1.33)[c]	59.82	-0.30
S4	Spray of *B.t.k.*@ 1.0 kg/ha	2.00 (1.73)d	0.79 (1.34)[c]	60.33	-2.70
S5	Spray of Spinosad 45 SC @ 188 ml/ha	0.95 (1.40)b	0.48 (1.22)[a]	49.65	14.13
S6	Spray of Cypermethrin 25 EC @ 150 ml/ha	0.79 (1.34)a	0.46 (1.21)[a]	41.77	20.35
S7	Untreated (control)	3.70 (2.16)e	2.29 (1.81)d	38.05	-12.03
SE (m)		0.06	0.005		
C.D (p=0.05)		0.02	0.02		

Figures in parentheses are square root transformation ($\sqrt{n+1}$) values
Figures with same letter are non significant

From the critical analysis of the present findings it can be concluded that Insecticides like nimbecidine malathion, cypermethrin, spinosad, novaluron can be suitably incorporated in integrated pest management schedule against fruit borer, *Helicoverpa armigera* 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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