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Alka
M.Sc. Scholar, Department Agriculture Entomology Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India

Dr. SK Singh
Head, Department of Entomology, Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India

Corresponding Author:
Alka
M.Sc. Scholar, Department Agriculture Entomology Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India

Integrated management of pests infesting tomato (*Lycopersicon esculentum* Mill.)

Alka and Dr. SK Singh

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Abstract
Investigations were carried out to study the effect of different modules (IPM, Insecticidal and organic)to control the infestation of whitefly and thrips on tomato, crop and their effect on natural enemies, at Agricultural Research Farm of Raja Balwant Singh College, Bichpuri, Agra, during Rabi season of 2019-2020. The IPM module was found to be more effective for the control of whitefly and thrips. Significantly higher marketable yield (502.15 qha^{-1}) and the highest B:C ratio (3.24) was obtained with the adoption of IPM module. This module is eco-friendly and do not contain synthetic insecticides and hence less harmful to natural enemies (lady bird beetles and *Crossopalpus* sp.).

Keywords: Tomato crop, whitefly, thrips, IPM

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular solanaceous vegetable crops grown all over the world and ranks second in importance after potato. In India, tomato is cultivated in almost all parts of the country and occupy an area of 786 thousand hectare with production of 19377 metric tons during 2017-18. In Uttar Pradesh, average area under tomato for last 5 years is 10.6 thousand hectares with average annual production of 540.67 thousand metric tonnes (NHB, 2019) [5].

Tomato is a good source of vitamin 'A, B' and excellent source of vitamin 'C'. It can be eaten as a fresh fruit and as a salad vegetable. It is used for culinary purpose and also used in preparation of pickles, ketchup, sauces and many products. In India, productivity of tomato is very low as compared to its production potential of the developed countries. There are many factors for low production potential, these include abiotic factors like weather parameters such as temperature, humidity, nutrient deficiency, water deficiency etc. Biotic factors include insect pests, pathogens and weed which limit the productivity of tomato crop. Among them insect-pests infestation is one of the major factors that is responsible for reduction in productivity. The production and quality of tomato fruits are considerably affected by many pests infesting at different stages of crop growth. Amongst various pests reported in India, as many as sixteen of different groups have been observed feeding from germination to the harvesting stage which not only reduce yield but also deteriorate the quality (Butani, 1977) [3]. Among the various insect pest, whitefly (*Bemisia tabaci*) and leaf miner (*Liriomyza trifolii*) are major insect pest causing considerable damage to the crop by attacking the different plant parts of tomato (Brust, 2008; Sharma *et al.*, 2013) [2, 10, 11]. So, it is prime need to find out such insecticides which was effective against leaf miner and whitefly on tomato under field condition for management.

Today great number of chemical control are often used on large scale regardless of their side effects. Indiscriminate use of synthetic pesticides has resulted in development of several problems like environmental pollution, insecticide resistance, pest resurgence, residual toxicity, health hazards and destruction of natural enemy, flora and fauna. It has therefore become necessary to review the chemical use and evaluate the other ecofriendly and bio intensive methods with minimum environmental damage to manage the pest population. Chemical insecticides are very costly, their use in field can laps the economy of the production of any crop. This mainly increases the cost of production. The integrated approach of the pest management can save the problem of losses from pest attack and the problem created from indiscriminate use of the insecticide also the reduction of the cost of production. In IPM, various pest control tactics i.e., physical, cultural, mechanical, biological and the ecofriendly insecticides are used in different combinations.

Materials and Methods

Field experiment was conducted at Agricultural Research Farm of Raja Balwant Singh College, Bichpuri, Agra, during *Rabi* season of 2020-21. The tomato variety Pusa hybrid -1 was sown in a Randomized Block Design with a spacing of 50 cm × 50 cm with gross and net plot size of 6 m × 5 m. All the recommended agronomical practices were adopted for good growth of the crop. Four treatments including untreated control with three replications were evaluated against whitefly (*Bemisia tabaci*), thrips (*F. schultzei*) and natural enemies on tomato. The data was subjected to statistical analysis for drawing conclusion. Statistical analysis was carried out using ANOVA technique given by Panse and Sukhatme (1985) [6]. Various modules tested in the experiment was as under-

M_1: IPM module: Nursery management, (a) Seed treatment with Trichoderma 5 g + imidacloprid 5 g. (b) One spray of thiamethoxam 4 g + mancozeb 20 g/10 lit. water 15 days after germination. (c) Use of Nylon net in nursery for covering the seedling against protection from sucking pest. (d)Preparation of seedling of *Tagetis sp.*

Before transplanting- (a) Sowing of border crop with 2 rows of maize 20 days before transplanting. (b) Seedling root dip in imidacloprid @ 10 ml/10 lit. water for 2 to 3 hours. At transplanting- (a) Soil application of *Trichoderma* 5 kg + *Azotobacter* 6 kg and PSB 6 kg/ha. (b) Planting of one row of marigold after every 10 rows of tomato. (c) Neem cake – 250 kg/ha. After transplanting- (a) Use of yellow sticky trap @ 10/ha for control whitefly and leaf miner. (b)Fixing of bird perches @ 20/ha. (c) Installation of pheromone trap @ 5/ha. (d) Release of *Trichogramma chilonis* @ 1 lakh/ha for control of *Helicoverpa* were made. (e) Two sprays of HaNPV @ 10 ml/10 litre of water at 15 days interval starting from flowering. (f) For leaf miner, 15 days after tomato planting two spray of 4% NSKE were given.

M_2: Insecticidal module: Nursery management- (a) Seed treatment with Trichoderma 5 g + imidacloprid, 5 g/kg of seed. (b) application of copper oxychloride 50 g + carbofuran 20 g. (c) Soil application of phorate 20 g (2x1m). Before transplanting- (a) Seedling root dip in imidacloprid @ 10 ml/10 lit. of water for 2 to 3 hours. After transplanting- (a) For leaf miner, 15 days after transplanting two sprays of 4% NSKE were given (b) Spraying of mancozeb 25 gm in 10 lit. of water. (c) Spraying Triazophos 20 ml/10 lit. of water and Endosulfan 20 ml /10 lit. of water.

M_3: Organic module: Nursery management-(a) Seed treatment with Trichoderma 5 g + Azotobacter + PSB 2.5 g/kg seed. (b) Application of Neem cake + FYM. (c) Spray of NSKE 4% + *Verticillium lecanii* @ 40 g/10 lit. water. Before transplanting-(a) Soil application of Trichoderma 5 kg + Azotobacter 6 kg and PSB 6 kg/ha. (b) Sowing of border crop with 2 rows of maize twenty days before transplanting. At transplanting-(a) Application of Neem cake-250 kg/ha and plantation of one row of marigold every 10 rows of tomato. After transplanting (a) Release of *Trichogramma chilonis* 1 lakh/ha 60 days after transplanting

Untreated Control: Nursery management (a) Seed treatment with Trichoderma @ 5 g/kg seed (b) Application of 0.3% copper oxychloride. After transplanting (a) Spraying of mancozeb @ 25 g in 10 lit. of water.

Results and Discussion

Effect of different modules on whitefly and thrip population

The data on number of survival population of whitefly adult are presented Table-1indicate the significant difference among the modules tested with respect to population of whitefly. The whitefly population was the lowest (3.93 adults/leaf) in module M_1 and it was significantly superior over rest of the modules. The thrip population was the lowest (3.34 adults/leaf) in module M_1 and it was significantly superior over rest of the modules. In module M_1 *i.e.*, integrated pest management for the management of thrips nursery management, border crop maize, seedling root dip in imidacloprid and spray of NSKE were incorporated.

Effect of different modules on natural enemies

It is seen from table-2 that the survival of Coccinellid beetles was maximum in IPM Module M_1 (3.91) followed by Insecticidal module M_2 (3.79) and organic module M_3 (3.76). While minimum number of Coccinellid beetles per leaf was noted with untreated control. During the present investigations, the IPM module M_1 consisted of no harmful chemical sprays. Hence the lady bird beetle survival population with IPM module was at par with untreated control. The data on number of lady bird beetles (*C. septempunctata*) after 15 days of the treatments indicate that the survival of lady bird beetles was maximum in untreated control (4.04). However, it was at par with organic module and IPM module having survival number of lady bird beetles 3.84 and 3.83, respectively.

The data on number of survival *Crossopalpus* flies per plant before and 15 days after the treatments are also presented in Table-2 indicate that the survival of *Crossopalpus* flies were maximum in untreated control (4.72). However, it was at par with organic module (4.42). In the IPM module survival number of *Crossopalpus* was (3.42). During the present study no harmful chemicals were used in module M_1 i.e., integrated pest management. Hence the survival no. of *Crossopalpus* was at par with untreated control. Hence it is clear that module M_1 is eco-friendly and could be used for the management of tomato pest.

Yield of tomato fruit

The data on yield of tomato fruits obtained in various insecticidal treatments are summarized in Table 3. It is clear from the table-2 that the different modules exert significant influence on marketable yield of tomato. The yield of marketable fruits was highest (502.15 q ha^{-1}) in IPM module M_1 and it was significantly higher than all other modules and untreated control tested in this experiment. The Insecticidal Module M_2 also produced significantly higher yield of marketable fruits than organic module M_3 and untreated control.

Economics of different modules

The data enumerated in Table-4reveal that the highest net profit of Rs. 383633 ha^{-1} was recorded with Integrated Pest Management Module (M_1) followed by Insecticidal module (M_2) gave net return Rs. 93500. The highest additional net profit over control (Rs. 111433) was also obtained IPM module. As the return over one rupee invested is concerned the highest B:C ratio (3.24) was obtained in Integrated Pest Management Module (M_1) followed by organic module.

The integration of pest management tactics was cheaper than synthetic insecticides even though the chemical module gave good control of pests. Therefore, Integrated Pest Management of tomato pests could be adopted successfully as alternative to chemical insecticides.

Table 1: Effect of different modules on whiteflies (*B. tabaci*) and thrips (*F. schultzei*) population

Module	No. of whiteflies/leaf	No. of thrips/leaf
IPM Module- (M_1)	3.93 (2.10)	3.34 (1.96)
Insecticidal Module- (M_2)	5.00 (2.35)	4.06 (2.14)
Organic Module- (M_3)	5.89 (2.53)	5.41(2.43)
Untreated control	12.09 (3.55)	9.20 (3.12)
SEm±	0.026	0.276
CD at 5%	0.073	0.76

*Average of ten observations

Figures in parentheses indicate $\sqrt{n+0.5}$ transform values

Table 2: Effect of different modules on natural enemies

Module	No. of adult *C. septempunctata* /plant		No. of adult *Crossopalpus* /leaf	
	Before spray	After spray	Before spray	After spray
IPM Module- (M_1)	3.91(2.10)	3.83(2.08)	5.07(2.36)	3.42(1.98)
Insecticidal Module- (M_2)	3.79(2.07)	1.22(1.31)	4.80(2.30)	1.77(1.51)
Organic Module- (M_3)	3.76(2.06)	3.84(2.08)	4.74(2.29)	4.72(2.29)
Untreated control	3.88(2.09)	4.04(2.13)	5.11(2.37)	4.72(2.28)
SEm±	0.03	0.171	0.087	0.052
CD at 5%	0.084	0.48	NS	0.142

*Average of ten observations

Figures in parentheses indicate $\sqrt{n+0.5}$ transform values

Table 3: Effect of different modules on yield of marketable fruits (q ha^{-1})

Module	Marketable Yield (qha^{-1})
IPM Module- (M_1)	502.15
Insecticidal Module- (M_2)	490.22
Organic Module- (M_3)	440.79
Untreated control	377.22
SEm±	19.82
CD at 5%	54.47

Table 4: Economics of different modules

Module	Gross Income (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net Profit (Rs ha^{-1})	Additional income over control (Rs ha^{-1})	B:C Ratio
IPM Module- (M_1)	502133	118500	383633	111433	3.24
Insecticidal Module- (M_2)	490200	124500	365700	93500	2.94
Organic Module- (M_3)	440767	108000	332767	60567	3.08
Untreated control	377200	105000	272200		2.59

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