

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 12; December 2025; Page No. 929-934

Received: 21-10-2025
Accepted: 23-11-2025

Indexed Journal
Peer Reviewed Journal

Field evaluation of different pest management modules against the incidence of thrips on tomato during summer season

¹Shruthi CR, ²Gangadhar Narabench, ³Kamala Devappa Gaddennavar and ⁴Afsanabanu Manik

¹Ph.D. Scholar (Entomology), Department of Entomology, College of Horticulture, Bagalkot, Karnataka, India

²Associate Professor, Department of Entomology, COH, Kolar, Karnataka, India

³Ph.D. Scholar (Entomology), Department of Entomology, College of Horticulture, Bengaluru, Karnataka, India

⁴Ph.D. Scholar (Crop Physiology), Department of Crop Physiology, College of Agriculture, Raichur, Karnataka, India

DOI: <https://www.doi.org/10.33545/26180723.2025.v8.i12l.2963>

Corresponding Author: Kamala Devappa Gaddennavar

Abstract

Results of summer season trial indicated the superiority of chemi-intensive module by keeping both thrips population and Groundnut Bud Necrosis Virus (GBNV) disease incidence under the check up to 12 weeks after transplantation. The next best module emerged was Integrated Pest Management module (IPM). Whereas, relatively lesser level of reduction in the thrips and disease incidence was recorded with Bio-intensive Module and it was inferior to that of Recommended Package of Practice (RPP). Among the different modules tested, IPM module registered highest yield and B:C ratio as compared to other modules tested. Hence, IPM module can be suggested to farmers for the management of thrips and GBNV disease in tomato.

Keywords: Thrips, groundnut bud necrosis virus, bio-intensive, chemi-intensive

Introduction

Tomato is one of the most important "protective foods" as it is a rich source of minerals, vitamins and organic acids. Large quantities of tomatoes are used to prepare soup, juice, ketchup, puree, pickle, paste and powder etc. It is also used as a vegetable. Tomato has very few competitors in the value addition chain of processing. (Chattopadhyay *et al.*, 2013) [4].

Tomato crop is grown in India in an area of 789 thousand hectares with a production of 19.38 thousand tonnes. The major tomato producing states in the country are Madhya Pradesh, Karnataka, Andhra Pradesh, Telangana, Gujarat, Odisha, West Bengal, Bihar, Maharashtra, Chhattisgarh, Tamil Nadu, Uttar Pradesh, Haryana and Himachal Pradesh. These States account for 91 per cent of the total production of the country. In Karnataka, it occupies an area of 63.73 thousand hectares with a production of 2,138.13 thousand million tonnes and productivity of 33.55 tonnes per hectare. Kolar, Haveri, Belgaum, Chikballapur, Mandya, Tumkur, Davangere, Mysore and Chamarajanagar are the major tomato growing districts of Karnataka (Anon., 2018).

So far, more than 7400 thrips species of the order Thysanoptera were described worldwide. Of which only a few are key pests on important horticultural crops and inflict substantial qualitative and quantitative losses due to their feeding, transmission of pathogens and their relevance as quarantine pests. India hosts about 700 thrips species (Ananthakrishnan and Sen, 1980; Bhatti, 1990) [1, 3]. The genus *Scirtothrips* Shull itself contains more than 100

species, of which 10 species have been reported as serious pests of agricultural and horticultural crops. Within this devastating genus, *Scirtothrips dorsalis* Hood is a polyphagous pest with more than 100 reported hosts among 40 different families of plants (Mound and Palmar, 1981) [6]. Tomato is reported to be susceptible plant to over 40 viruses belonging to different genera and families. Among them, Tospoviruses (*Tomato spotted wilt virus* as type species) are very important. Incidence of Tospoviruses in vegetable crops is increasing year by year and more so in tomato (Krishna Reddy *et al.*, 1997) [5]. Among the tospovirus reported in India, *Groundnut bud necrosis virus* (GBNV), *Peanut yellow spot virus* (PYSV) and *Watermelon Bud Necrosis Virus* (WBNV) have been reported to infect broad range of vegetables (tomato, potato, chilli, peppers and watermelon). GBNV is currently recognized as the most economically important tospovirus, as losses due to GBNV alone have been estimated at more than US\$89 million per annum in Asia (Reddy *et al.*, 1995) [7].

GBNV is transmitted by at least 11 species of thrips, including *Frankliniella fusca* (Hinds), *Frankliniella occidentalis* (Pergande), *Frankliniella schultzei* Trybom, *Thrips palmi* Karny, *Scirtothrips dorsalis* Hood, *Thrips setosus* Moulton, *Thrips tabaci* Lindemon etc. However, in the past two decades increased globalization and open agricultural trade has resulted in the expansion of the geographical distribution and host range of the thrips pest (Rugman-Jones *et al.*, 2006) [8].

Some of the thrips attributes such as polyphagy, rapid

development, high fecundity, ability for rapid dispersal and rapid development of insecticide resistance make management a serious challenge.

Development of effective IPM practices for thrips is still in its infancy. Though AVRDC has come out with several recommendations, those practices serve as a basic management template for the control of this pest. The template involves recommendations for crop rotation, removal of weeds, insecticide rotation and using natural enemies such as predators and parasitoids. Further improvisation on these practices needs attention.

Generally, farmers spray insecticides heavily for managing thrips. Despite heavy chemical insecticide sprays, losses have become inevitable. Contact insecticides are often not effective against thrips due to their oviposition in tissue, the presence of adults inside tight buds and migration to and from surrounding plants. Systemic insecticides also often do not kill thrips fast enough to slow down disease epidemics. Existence of insecticide resistant thrips biotypes and lack of resistant varieties of tomato to thrips and GBNV pose further threat to the farmers (Pretty and Bharucha, 2015). The present investigations were, therefore, planned to evaluate efficacy of different pest management modules against thrips and GBNV disease incidence on tomato.

Materials and Methods

The field experiment was conducted during *summer* seasons of 2017 at the farmer's fields of Maragondanahalli, Bengaluru rural district. Experiment was laid out in a randomized block design with five modules replicated four

times. The details of different components of each module are mentioned in the Table 1. The tomato seedlings of 30 days old were transplanted at spacing of 90 × 60 cm during first fortnight of February in a plot size of 6 × 5 m for each replication. The “501” variety of tomato was used for *summer* season. A healthy crop was raised by following the recommended agronomical practices as per the package of practices of University of Horticultural Sciences, Bagalkot. The components of different pest management modules were applied according to the schedule mentioned in Table 1. The spray solutions were prepared just before the application and the spray was done with the help of knap sack sprayer.

Observations

The number of thrips was recorded from 10 randomly selected plants in each replication at 5, 6, 7, 8, 9, 10, 11 and 12 weeks after transplantation. Since the thrips are mostly congregated towards terminal parts of plants; the observations were recorded by tapping the terminal shoots against black paper board and the fallen thrips were counted visually. Sprays were given at two weeks interval, first spray starting from four weeks after transplantation as the level of thrips infestation crossed economic threshold level. The disease incidence was also recorded at 2 weeks interval by observing 30 randomly selected plants in each replication. The number of GBNV infected and healthy plants were recorded from 30 selected plants to work out per cent disease.

Table 1: Pest management modules evaluated against thrips and Groundnut bud necrosis virus disease on tomato

Modules	Name of the module	Components
M ₁	Bio-intensive module	Installation of blue sticky traps @ 8 traps/Acre at 2 WAT followed by 2 sprays of azadirachtin 10,000 ppm @ 1 ml/l at 4 WAT and 8 WAT and 2 sprays of <i>Lecanicillium lecanii</i> (2×10 ⁸ cfu/g) @ 2 g/l at 6 WAT and 10 WAT
M ₂	Chemi-intensive module	Seedling dip with imidacloprid 200 SL @ 0.5 ml/l for 10 min at the time of transplantation followed by 2 sprays of thiamethoxam 25 WG @ 0.20 g/l at 4 WAT and 8 WAT and diafenthiuron 50 WP @ 1.25 g/l at 6 WAT and 10 WAT
M ₃	Integrated pest management (IPM) module	Sowing of 2 rows of maize at 15 days before transplantation, seedling dip with imidacloprid 200SL @ 0.50 ml/l for 10 min at the time of transplantation, installation of blue sticky traps @ 8 traps/Ac at 2 WAT followed by foliar spray of azadirachtin 10,000 ppm @ 1.00 ml/l at 4 WAT, thiamethoxam 25 WG @ 0.20 g/l at 6 WAT, diafenthiuron 50 WP @ 1.25 g/l at 8 WAT and <i>Lecanicillium lecanii</i> (2×10 ⁸ cfu/g) @ 2 g/l at 10 WAT
M ₄	Recommended plant protection (RPP) module	4 sprays of dimethoate 30 EC @ 1.70 ml/l at 4, 6, 8 and 10 WAT
M ₅	Untreated control	-

Benefit cost ratio (B:C ratio)

The yield of tomato from each module was recorded by adding the total yield of all the harvests and converted to tonnes per hectare. The price of inputs that prevailing at the time of their use was considered for working out the cost of cultivation. Benefit cost analysis was expressed in terms of cost-benefit ratio by using the following formula:

$$\text{Cost-benefit ratio} = \frac{\text{Net return (Rs./ ha)}}{\text{Cost of treatment (Rs./ ha)}}$$

Statistical analysis

Data obtained in respect of thrips population and per cent GBNV disease incidence recorded during experiment were

subjected to square root and arc sine transformation, respectively before analysing the data with one way ANOVA. The treatment means were separated by using DMRT.

Results and Discussion

The results of the field efficacy of different pest management modules against thrips infestation and GBNV disease incidence on tomato are mentioned in the Table 2 and 3, respectively.

Thrips infestation

The minimum thrips population of 0.50 per plant was recorded from chemi-intensive module at five weeks after

transplantation and it was significantly different from all other modules evaluated. The integrated pest management module was found to be next best module by recording the thrips population of 2.00 thrips per plant followed by recommended package of practice module recording 3.75 thrips per plant. Among the modules evaluated, significantly highest thrips per plant of 7.25 was recorded from the bio-intensive module.

At six weeks after transplantation, the lowest thrips infestation of 2.75 per plant was recorded from chemi-intensive module and it was significantly superior over other modules followed by integrated pest management module by recording thrips infestation of 3.75 per plant. The bio-intensive module recorded maximum thrips population of 8.25 per plant, followed by recommended package of practice (7.50 thrips/plant).

Integrated pest management module at seven weeks after transplantation recorded nil population of thrips. Next best module was chemi-intensive module by recording 0.25 thrips per plant followed by recommended package of practice (2.25 thrips/plant). Whereas, the bio-intensive module recorded maximum infestation of 7.25 thrips per plant.

Similar trend was noticed during eight weeks after transplantation, where integrated pest management module again proved to be effective against thrips as compared to all other modules (1.25 thrips/plant), followed by chemi-intensive module which recorded 2.00 thrips per plant. Other than untreated control, the maximum thrips infestation of 8.75 thrips per plant was noticed in Bio-intensive module.

A significant reduction in thrips population was noticed in all modules as against untreated plots at nine weeks after transplantation. Integrated pest management module was found to be significantly superior by recording nil thrips population as compared to other modules. The next best modules in the rank was chemi-intensive module followed by recommended package of practice module recording 0.25 and 4.25 thrips per plant, respectively and these modules

were significantly different from each other. The maximum mean number of 5.50 thrips per plant was recorded from bio-intensive module.

Among the different modules evaluated, the nil thrips infestation was recorded from integrated pest management module at ten weeks after transplantation and it was significantly different from all other modules. Next best modules were chemi-intensive module and recommended package of practice module recording 0.75 and 3.00 thrips per plant, respectively. The highest thrips infestation of 5.50 thrips per plant was noticed with bio-intensive module.

On the eleven weeks after transplantation, the chemi-intensive module was found to be effective in managing thrips and it was significantly different from all other treatments (0.25 thrips/plant). The integrated pest management module and recommended package of practice module were next best modules in order of reducing thrips infestation and these modules were on par with each other (0.75 and 2.00 thrips/plant, respectively). Apart from untreated control, the highest thrips infestation of 3.00 thrips per plant was recorded in bio-intensive module.

The chemi-intensive module was found to be significantly superior over other modules even at twelve weeks after transplantation by recording nil thrips. The integrated pest management module was found to be next best module in reducing the thrips population (0.50 thrips / plant) followed by recommended package of practice module recording thrips infestation of 1.50 per plant. As observed in earlier weeks, again a maximum thrips infestation of 2.50 thrips per plant was recorded with a bio-intensive module.

The per cent reduction of thrips infestation worked based on pooled mean during 12 weeks period after transplantation indicated the superiority of chemi-intensive module by reducing the population of thrips up to 92.05 per cent over untreated control. It was followed by integrated pest management module by reducing thrips up to 90.25 per cent. However, the bio-intensive module recorded the lowest mean per cent reduction over untreated control indicating poor efficacy against thrips (43.18%).

Table 2: Evaluation of different pest management modules against thrips incidence on tomato during Summer season, 2017

Modules	No. of thrips/ plant at different weeks after transplantation								Pooled mean	% reduction over control
	5 WAT	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT	11 WAT	12 WAT		
M ₁ - Bio-Intensive Module	7.25 (2.64) ^{cd}	8.25 (2.84) ^{bc}	7.25 (2.52) ^c	8.75 (2.80) ^{bc}	5.50 (2.21) ^{bc}	5.50 (2.32) ^c	3.00 (1.81) ^{bc}	2.50 (1.70) ^c	6.00	43.18
M ₂ - Chemi-Intensive Module	0.50 (0.97) ^a	2.75 (1.60) ^a	0.25 (0.84) ^{ab}	2.00 (1.48) ^{ab}	0.25 (0.84) ^{ab}	0.75 (1.09) ^{ab}	0.25 (0.84) ^a	0.00 (0.70) ^a	0.84	92.05
M ₃ - Integrated Pest Management Module (IPM)	2.00 (1.47) ^{ab}	3.75 (1.85) ^{ab}	0.00 (0.70) ^a	1.25 (1.26) ^a	0.00 (0.70) ^a	0.00 (0.70) ^a	0.75 (1.05) ^{ab}	0.50 (0.97) ^{ab}	1.03	90.25
M ₄ -Recommended PlantProtection Module (RPP)	3.75 (2.00) ^{bc}	7.50 (2.57) ^{abc}	2.25 (1.61) ^b	6.00 (2.41) ^{abc}	4.25 (2.08) ^{abc}	3.00 (1.74) ^{bc}	2.00 (1.56) ^{ab}	1.50 (1.41) ^{bc}	3.78	64.20
M ₅ - Untreated control	9.75 (3.18) ^d	12.50 (3.51) ^c	13.25 (3.68) ^d	14.25 (3.74) ^c	12.75 (3.45) ^c	10.50 (3.28) ^d	5.75 (2.38) ^c	5.75 (2.40) ^d	10.56	-
S.Em ±	0.313	0.339	0.281	0.446	0.462	0.299	0.262	0.205	-	-
CD (p=0.05)	0.975	1.049	0.866	1.370	1.429	0.914	0.820	0.632	-	-

Figures in parenthesis indicate square root $\sqrt{x+0.5}$ transformed values

Figures in each column followed by same alphabet (s) are not significantly different (P=0.05)

WAT- Weeks after transplantation

Disease incidence

At five weeks after transplantation, the minimum disease incidence of 1.67 per cent was recorded from integrated pest management module and it was significantly superior over

other modules evaluated. The next best module was chemi-intensive module (4.17%), followed by recommended package of practice module recorded 9.17 per cent disease incidence. Whereas, the maximum of 12.50 per cent GBNV

disease incidence was recorded in bio-intensive module.

The integrated pest management module was recorded minimum per cent disease incidence of 2.50 at seven weeks after transplantation and it was significantly different from other modules, followed by chemi-intensive module (5.00%). The next best module was recommended package of practice module recording 11.67 per cent GBNV disease incidence. Apart from untreated control, the maximum disease incidence of 17.50 per cent was recorded in bio-intensive module.

The minimum disease incidence of 12.50 per cent was recorded from integrated pest management module followed by chemi-intensive module (14.17%) and these modules were on par with each other. The next best module was recommended package of practice by recording 20.00 per cent disease incidence. While, the bio-intensive module recorded highest GBNV disease incidence of 26.67 per cent. Similar trend was noticed during eight weeks after

transplantation also *i.e.*, integrated pest management module proved to be effective against GBNV disease as compared to all other modules (17.50 per cent) and it was on par with chemi-intensive module recording 20.00 per cent disease incidence. The recommended package of practice module was found to be next best module by recording 28.33 per cent disease incidence. Among the modules evaluated, the bio-intensive module recorded maximum disease incidence of 34.17 per cent.

Amongst the four tested pest management modules, the integrated pest management module (M3) was found to be significantly effective in reducing GBNV disease incidence up to 65.62 per cent as that of other modules evaluated, followed by chemi-intensive module (56.60%). The next best treatment in reducing disease incidence was recommended plant protection module by recording 35.97 per cent reduction over control.

Table 3: Evaluation of different pest management modules against GBNV in tomato during Summer season, 2017

Modules	GBNV disease incidence (%)					Pooled Mean	% reduction over control
	5 WAT	7 WAT	9 WAT	11 WAT	13 WAT		
M ₁ - Bio-Intensive Module	12.50 (20.59) ^{cd}	17.50 (24.19) ^{cd}	26.67 (31.07) ^c	34.17 (35.72) ^{bc}	37.50 (37.74) ^{cd}	25.67	18.51
M ₂ - Chemi-Intensive Module	4.17 (11.63) ^{ab}	5.00 (12.50) ^{ab}	14.17 (21.96) ^a	20.00 (26.52) ^a	25.00 (29.94) ^{ab}	13.67	56.60
M ₃ - Integrated Pest Management Module (IPM)	1.67 (5.52) ^a	2.50 (6.64) ^a	12.50 (20.66) ^a	17.50 (24.71) ^a	20.00 (26.52) ^a	10.83	65.62
M ₄ - Recommended Plant Protection Module (RPP)	9.17 (17.20) ^{bc}	11.67 (19.72) ^{bc}	20.00 (26.52) ^b	28.33 (32.15) ^b	31.67 (34.12) ^{bc}	20.17	35.97
M ₅ - Untreated control	18.33 (24.95) ^d	26.67 (30.90) ^d	32.50 (34.73) ^d	37.50 (37.75) ^c	42.50 (40.66) ^d	31.50	-
S.Em ±	2.102	2.404	1.000	1.182	1.488	-	-
CD (p=0.05)	6.475	7.419	3.086	3.646	4.583	-	-

Figures in parenthesis indicate square root $\sqrt{x+0.5}$ transformed values

Figures in each column followed by same alphabet (s) are not significantly different (P=0.05)

WAT- Weeks after transplantation

Integrated pest management module besides its superior efficacy in managing thrips on tomato, this module also registered highest yield of 31.11 t/ha with B:C ratio of 1.01 as compared to other modules. This was followed by chemi-intensive module which recorded 30.37 t/ha with B:C ratio of 0.97. Whereas, lowest yield and B:C ratio of 20.78 t/ha and 0.38 was registered in bio-intensive module, respectively (Table 4).

Results indicated that, the chemi-intensive module was found most effective in keeping the thrips population and GBNV disease incidence under check up to 12 weeks after transplantation. The reduction of thrips infestation and disease incidence was to the tune of 92.05 and 56.60 per cent, respectively. This was followed by integrated pest management module wherein up to 90.25 and 65.62 per cent reduction in thrips infestation and disease incidence was observed, respectively. Whereas, relatively lower level of reduction in the thrips infestation (43.18%) and disease incidence (18.51%) was recorded with bio-intensive module and it was inferior to that of RPP module by recording 64.20 and 35.97 per cent reduction in thrips and disease incidence, respectively (Fig.1).

Present findings are in agreement with that of Ambika (2011) who also reported superiority of integrated pest management module in terms of management of thrips and

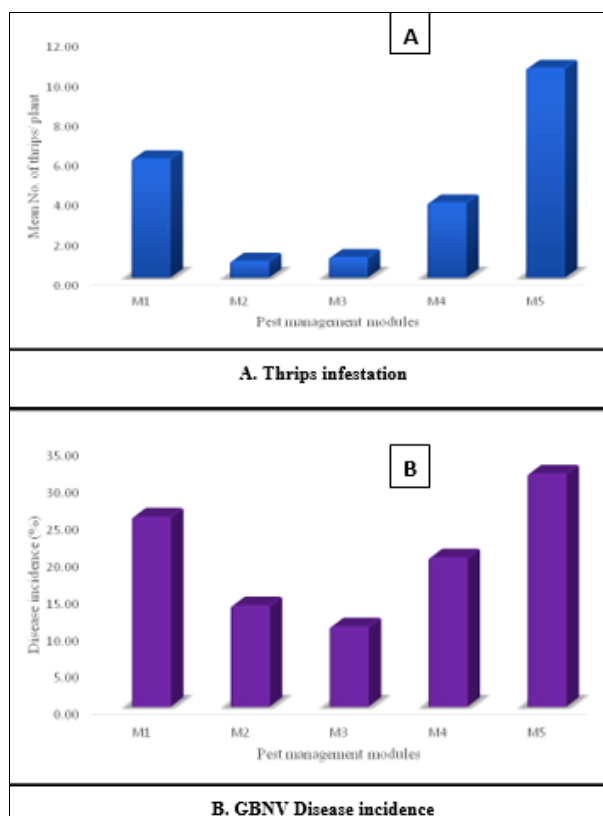
GBNV disease incidence on tomato wherein the total number of thrips observed upto 12th weeks after planting was 12.50 in *rabi* and 27.50 in *summer* 2011 as compared to control plots which recorded number of thrips of 33.50 and 53.50 in *rabi* 2010 and *summer* 2011, respectively. The IPM module comprises seedlings grown under nylon net, maize grown as a border crop, seedlings were dipped in diafenthurion solution (0.05%) for 5 mins, installed yellow/blue sticky trap and a chemical spray of dimethoate (0.2%) at 15 days after transplanting (DAP) followed by imidacloprid (0.05%) at 30 DAP and spray of diafenthurion (0.1%) at 45DAP, removal of weeds and infected plants after the insecticide spray. In respect of disease incidence, the lowest per cent disease incidence of 16.60 and 18.66 per cent was observed during *rabi* 2010 and *summer* seasons of 2010, respectively where integrated practices followed as against 39.33 and 47.33 Per cent disease incidence in *rabi* 2010 and *summer* 2011, respectively in control (untreated check plot) plots.

The findings of the present investigation are in the line with the outcomes of the field trial carried out by Kurbett *et al.* (2018) who evaluated different IPM modules for the management of pest complex in chilli (Cv. Byadgi dabbi). The M-III was most effective against thrips as that of other modules evaluated. Higher chilli yield 12.36 q/ha with

36.57% increase over untreated control was observed in M-III (Root dip with imidacloprid 17.8 SL @ 0.5 ml/l for 30 min. at the time of transplanting + Acetamiprid 20 SP @ 0.2 g/l + Fenpropathrin 30 EC @ 0.5 ml/l + Diafenthiuron 50 WP @ 1.0 g/l + Spiromesifen 240 SC @ 1ml/l + Spinosad 45 SC @ 0.2 ml/l + Rynaxypyr 18.5 SC @ 0.2 ml/l) followed by M-II (Application of neem cake @ 2.5 q/ha at the time of sowing + Growing one row of marigold as a trap crop and two rows of maize as barrier crop + Root dip with imidacloprid 17.8 SL @ 0.5 ml/l for 30 min. at the time of transplanting + Azadirachtin 10,000 ppm @ 1.0 ml/l + *Lecanicillium lecanii* (1x10⁸ CFU/g) @ 5 g/l + Diafenthiuron 50 WP @ 1.0 g/l @ 0.5 ml/l + Rynaxypyr 18.5 SC @ 0.2 ml/l) was equally effective in recording the yield of 11.84 q/ha with 33.78% increase in yield over control. Considering the result, M-I in comparison with M-III and M-II however appeared to be a quite promising strategy.

Table 4: Economics of management of thrips and Groundnut bud necrosis virus disease incidence on tomato during Summer, 2017

Treatments	Cost of cultivation (Rs./ha)			Yield (t/ha)	Gross return (Rs./ha)	Net returns (Rs./ha)	B:C ratio
	General cost	Crop protection cost	Total				
M ₁ - Bio-Intensive Module	1,32,218	3,500	1,35,718	20.78	1,87,020	51,302	0.38
M ₂ - Chemi-Intensive Module	1,32,218	6,750	1,38,968	30.37	2,73,330	1,34,362	0.97
M ₃ - Integrated Pest Management Module (IPM)	1,32,218	6,775	1,38,993	31.11	2,79,990	1,40,997	1.01
M ₄ - Recommended Plant Protection Module (RPP)	1,32,218	2,148	1,34,366	25.93	2,33,370	99,004	0.74
M ₅ - Untreated control	1,32,218	-	1,32,218	15.85	1,42,650	10,432	0.08



M₁- Bio-intensive module
M₄- Recommended plant protection module
M₂- Chemi-intensive module
M₅- Untreated control
M₃- Integrated pest management module

Fig 1: Efficacy of different pest management modules against thrips infestation and Groundnut bud necrosis virus disease on tomato during Summer season, 2017

Benefit cost ratio

Integrated pest management module registered highest yield of 31.11 t/ha and B:C ratio of 1.01 as compared to other modules tested. Next best modules was chemi-intensive module where in 30.37 t/ha of yield was registered and B:C ratio of 0.97, Whereas, the efficacy and B:C ratio of RPP and bio-intensive module was inferior to above mentioned modules.

Ambika (2011) also obtained the higher level of tomato fruit yield to the extent of 40.77 t/ha in *rabi* 2010 and 32.37 t/ha in summer 2011 where an integrated management practices were followed as compared to 24.31 t/ha in *rabi* 2010 and 22.68 t/ha in the control plots. The cost: benefit ratio obtained in case of IPM practices followed plot was 1:2.2 compared to 1:0.9 in case of control plot in *rabi* 2010. Whereas, in summer 2011, the C: B ratio was 1:1.8 in IPM plot compared to 1: 0.87 in control.

Conclusion

Results of Summer season trial indicated the superiority of chemi-intensive module where thrips population and GBNV disease incidence was kept under check up to 12 weeks after transplantation, followed by integrated pest management module. Whereas, relatively lower level of reduction in the thrips infestation and disease incidence was recorded with bio-intensive module and it was inferior to that of RPP module. Integrated pest management module registered highest yield and B:C ratio as compared to other modules tested, followed by chemi-intensive module. Hence, IPM module can be suggested to farmers for effective management of thrips and GBNV disease in tomato.

References

- Ananthakrishnan TN, Sen S. Taxonomy of Indian Thysanoptera. Handbook Series No. 1. Zoological Survey of India; 1980. p. 1-234.
- Anonymous. National Horticulture Board Database (NHBD). 2018. www.nhb.gov.in/database
- Bhatti JS. Catalogue of insects of the order Terebrantia from the Indian subregion. Zoology. 1990;2(4):205-352.
- Chattopadhyay A, Chakraborty, Siddique W. Characterization of determinate tomato hybrids: Search for better processing qualities. African Journal of Food Science. 2013;4(6):398-402.
- Krishna Reddy M, Gopal K, Akelavani, Singh SJ. Immunological detection and serological comparison of tospovirus isolates using polyclonal and monoclonal antibodies. In: Proceedings of the International Conference on Integrated Plant Disease Management for Sustainable Agriculture, IPS Golden Jubilee; 1997

Nov 10-15; New Delhi. p.36.

6. Mound LA, Palmer JM. Identification, distribution and host plants of the pest species of Scirtothrips (Thysanoptera: Thripidae). Bulletin of Entomological Research. 1981;71(3):467-479.
7. Reddy DVR, Buiel AAM, Satyanarayana T, Dwivedi SL, Reddy AS, Ratna AS, *et al.* Peanut bud necrosis disease: An overview. In: Recent studies on peanut bud necrosis disease. Proceedings of a meeting. ICRISAT Asia Centre, Patancheru, Andhra Pradesh; 1995.
8. Rugman-Jones PF, Hoddle MS, Mound LA, Stouthamer R. Molecular identification key for pest species of Scirtothrips (Thysanoptera: Thripidae). Journal of Economic Entomology. 2006;99(5):1813-1819.