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Full Research Article

Population Dynamics of Thrips (*Thrips tabaci* L.) Infesting Tomato (*Lycopersicon esculentum* L.) and their Sustainable Management

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Abstract

Population dynamics of thrips (*Thrips tabaci* L.) in relation to abiotic factors and its botanical management in tomato was assessed by Randomized Block Design for two consecutive seasons (2011–2013) at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India. Minimum number of thrips (0.42−53 leaf^{-1}) population was recorded during 38th to 44th standard week and maximum level of population was observed during 45th to 2nd (1.05−1.89 leaf^{-1}) and again during 6th to 20th (1.00−2.22 leaf^{-1}) standard week. Correlation co-efficient indicates that activity of thrips population decrease with high temperature, high relative humidity and heavy weekly total rainfall but population increase with the rise of temperature difference. Management result shows that acetamiprid was most efficacious against thrips providing 84.15% suppression. However, neem+*Spilanthes* gave satisfactory result providing 72.27% suppression. The individual mean percent suppression of neem pesticides, extracts of *Spilanthes*, *Polygonum*, tobacco, garlic were 60.73%, 53.21%, 50.70%, 42.10% and 41.52% respectively. Highest yield 30.15 t ha^{-1} followed by 27.55 t ha^{-1} was recorded in acetamiprid and neem+*Spilanthes*. Treated plots respectively. Lowest 18.32 t ha^{-1} followed by 23.11 t ha^{-1} was recorded in control and garlic plots respectively. The yield obtained in remaining were 26.67 t ha^{-1} (*Spilanthes)*, 26.32 t ha^{-1} (*Polygonum*), 24.02 t ha^{-1} (tobacco extract), 25.56 t ha^{-1} (neem pesticides).

1. Introduction

Thrips overwinter in the soil but can emerge anytime when it is significantly warm in the winter. It feeds on plant tissue by rasping and sucking sap, resulting in tissue scarification and depletion of the plant's resources (Welter et al., 1990; Shipp et al., 1998). The scarification reduces the photosynthetic capacity of leaves and causes blemishes on fruits. Tomato spotted wilt virus (TSWV) is transmitted exclusively by thrips and especially by western flower thrips and tobacco thrips. The fruits from an infected plant are usually unmarketable and can display irregular ripening symptoms. For this reason, TSWV infected plants are generally not harvested at all (Gitaitis et al., 1998). The direct injury and the virus disease result in discoloration of fruits, thus lowering the quality of the fruits with yield loss of 23.7% (Kagezi et al., 2001). Ovipositor by F. occidentalis has been shown to cause dimpling on tomato fruit, whereas eastern flower thrips, *Frankliniella tritici* (Fitch), has not previously been implicated as a cause of this injury (Navas et al., 1991). Many hazardous insecticides are using for controlling the tomato pests despite of its ill effect on environment. However, the use of chemical pesticides can be minimised by replacing them with botanical and other bio-pesticides for producing healthy and good quality crop. So, bio-pesticides are likely to get a great attention in the insecticide sector (Copping and Menn, 2000). Botanical insecticides are highly effective, safe and ecologically acceptable in general (Nathan et al., 2004). The determination of the efficacy of botanical pesticides has to develop practically for low cost pest control. Hence, the present study was taken to determine the seasonal abundance of pestiferous thrips populations during susceptible stage and to evolve a technically feasible, environmentally sound and economically viable safe pest management strategy of tomato crops.

2. Materials and Methods

Field experiments were conducted in Instructional Farm of Uttar Banga Krishi Viswavidyalaya at Pundibari, Coochbehar, West Bengal, India for two years (2011–12 and 2012–13). The experimental area is situated in the sub-himalayan region of north-east India. To study the population fluctuation and seasonal incidence of thrips and also the influence of prevailing weather conditions on the population dynamics, Pusa Ruby variety was grown round the year except rainy season when tomato cultivation was not possible in open field in this area. The crops were raised following standard agronomic practices of irrigation, weeding, and fertilization. However, no pesticides were used throughout the cropping season for seasonal incidence. The seasonal incidence of pest and important weather parameter (temperature, relative humidity and rainfall) was recorded to find out influence of weather on population fluctuation. Eight treatments were taken to evaluate for its efficacy against thrips viz., T_1 tobacco extract 7.5% (75 ml l^{-1}), T_2 garlic extract 5% (50 ml l^{-1}), T_3 *Polygonum* extract 5% (50 ml l^{-1}), T_4 *Spilanthes* extract 5% (50 ml l^{-1}), T_5 neem pesticide (2.5 ml l^{-1}), T_6 neem+*spilanthes* extract (1.5 ml+40 ml l^{-1}), T_7 acetamiprid (1 g 3 l^{-1}), T_8 untreated control for management trail.

2.1. Reparation of extract

Polygonum hydropiper and *Spilanthes paniculata* is well known weed in terai agro-climatic region of West Bengal, India. Garlic (*Allium sativum*) is available in India and used as spices for preparation of various delicious foods. Tobacco (*Nicotiana tabacum)* is cultivated in a large scale in the locality where experiment has been done. The washed floral part *Polygonum hydropiper* and *Spilanthes* as well as edible garlic were dried and powdered in a grinder. The powder (50 g) samples of each tested plant were transferred separately to a conical flask (500 ml) and dipped in 250 ml methanol. The washed tobacco leaves was also dried and powdered in a grinder. The powdered sample (100 g) were transferred to a container and dipped in 1 litre water. The material was boiled for about half. All the material was allowed to stand for 72 hours at room temperature with occasional stirring. After 72 hours the extract was filtered through Whatman 42 filter paper. Except in tobacco extract 15 ml liquid soap was added.

2.2. Data recording

The data for seasonal incidence was recorded at seven days interval. Five plants were randomly selected and tagged from each replicated plots for each observation. The number of thrips were counted leaf^{-1} basis. For the evaluation of botanicals extract three sprays at 12 day intervals were made, starting with the initiation of infestation. The population densities were recorded 3, 7 and 11 days after each spraying leaf^{-1} from top, middle and bottom leaves from five randomly selected plants replication^{-1}. The results were expressed as thrips population suppression (%) compared to densities recorded on the control treatment. Percent reduction of thrips population over control was calculated by the following formula (Abbott, 1925):

$$Pt = \frac{Po - Pc}{100 - Pc} \times 100$$

Where, Pt=Corrected mortality, Po=Observed mortality and Pc=Control mortality.

$$\text{Percent reduction over control} = \frac{\text{(Percent reduction–(Percent reduction in treatment) in control)}}{\text{(100\% reduction in control)}} \times 100$$

The tomato fruits were harvested at frequent intervals when they attained marketable size. The yield of marketable produce was calculated in different years separately on the basis of fruit yield plot^{-1} and converted to t ha^{-1}. Data were analyzed by using INDO-STAT-software for analysis in randomized block design (RBD).

3. Results and Discussion

The pooled data on thrips incidence for the two years during 2011 and 2013 (Figure 1), showed that thrips was very active in 43rd standard week of 3rd week of October. The lowest population (0.42−0.53 leaf^{-1}) was recorded during 38th to 44th standard week that was during 3rd week of September to first week of November and highest population was maintained during 45th to 2nd (1.29−1.55 leaf^{-1}) standard week that was during 2nd week of November to 2nd week of January and 6th to 20th (1.00−2.22 leaf^{-1}) standard week that is during 2nd week of February to 3rd week of May. Peak population (2.22 leaf^{-1}) was recorded on 9th and 12th standard week that on last week of February and 3rd week of March when average temperature were 20.93 °C-23.95 °C, 48.83%-62.49% and 0.00 mm-6.05 mm respectively (Nault et al., 2003; Jenser et al., 2003;

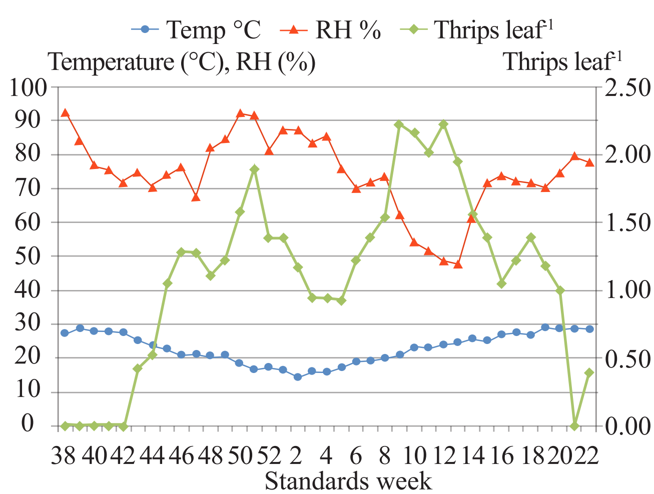

Figure 1: Incidence of thrips as influence by temperature and RH

Shahanawaz and Goud 2005). Correlation coefficient (Table 1) values worked out for thrips incidence and weather parameters revealed that temperature difference had significant positive influence on thrips while significant negative correlation with temperature (minimum and average), relative humidity (minimum, average) and weekly total rainfall. In case of maximum relative humidity and maximum temperature non significant negative influence was observed. (Patel et al., 2009). This shows that activity of thrips population decrease with high temperature, high relative humidity and heavy weekly total rainfall but population increase with the rise of temperature difference.

Table 1: Correlation co-efficient between thrips and environmental parameter

Environmental parameter		Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Temp °C	Max	-0.275	0.075	Y=-1.552X+31.084
	Min	-0.524**	0.275	Y=-4.413X+21.201
	Dif	0.644**	0.415	Y=2.851X+9.900
	Avg	-0.440**	0.193	Y=-3.003X+26.177
Relative humidity (%)	Max	-0.317	0.100	Y=-4.690X+85.803
	Min	-0.566**	0.321	Y=-11.897X+81.424
	Avg	-0.483**	0.233	Y=-8.293X+83.613
Rainfall (mm)	Weekly total	-0.453**	0.205	Y=-29.885X+52.088

Max: Maximum; Min: Minimum; Dif: Difference; Avg: Average

The overall efficacy of different insecticides treatments and their persistence at different days after application varied significantly in their suppression of thrips population (Table 2). Among the seven pesticides evaluated under investigation, the percent thrips control was highest in acetamiprid (84.15%) treated plot closely followed by neem+*Spilanthes* (72.27%) and *garlic* extract stand least effective providing 41.10% suppression. That of neem pesticides, extract of *Spilanthes*, *Polygonum*, tobacco, garlic sow moderate result recording about 60.73%, 53.21%, 50.70%, 42.10% and 41.52% suppression respectively. (Shiberu et al., 2013; Burubai et al., 2011). It was observed that, 3 days after spraying acetamiprid and neem+*Spilanthes* gave significant reduction in thrips infestation as compared to control providing 86.21% and 77.79% suppression respectively. The rest of the treatments such as neem pesticides, *Spilanthes, Polygonum*, tobacco and garlic were found to be moderately effective against thrips providing 68.83%, 60.69%, 60.26%, 46.83%, and 45.01% mortality respectively (Shiberu et al., 2013). A similar trend was also noticed 7 days after spray that acetamiprid was found to be most effective (83.41% suppression) closely followed by neem+*Spilanthes* (73.97%). The remaining treatments viz., neem pesticides, *Spilanthes*, *Polygonum*, tobacco and garlic reveal medium results giving 62.15%, 54.96%, 52.96%, 44.28% and 41.82% suppression respectively. Eleven days after spraying again acetamiprid rank first in thrips prevention (82.82%) followed by neem+*Spilanthes* (65.04%). The other

Table 2: Overall efficacy of plant extracts against thrips (*Thrips tabci Genn.*) on tomato plant (Grand mean of 2011–12 and 2012–13)

Treatment	Spray conc.	% Suppression of thrips population on different days after treatment (DAT)				
		Season-I (2011–2012) and season II (2012–13)				
		Pre treatment conc.	Days after treatment			
			3	7	11	Mean
T_1 (tobacco extract)	7.5% (75 ml l^{-1})	7.12	46.83 (43.18)	44.28 (41.70)	35.18 (63.28)	42.10 (49.39)
T_2 (garlic extract)	5% (50 ml l^{-1})	7.02	45.01 (42.13)	41.82 (40.26)	37.72 (36.06)	41.52 (39.48)
T_3 (*Polygonum* extract)	5% (50 m l^{-1})	7.04	60.26 (51.00)	52.96 (46.9)	38.89 (38.56)	50.70 (45.49)
T_4 (*Spilanthes* extract)	(5% 50 ml l^{-1})	6.80	60.69 (51.10)	54.96 (47.86)	43.97 (41.53)	53.21 (46.83)
T_5 (neem+*pesticides*)	2.5 ml l^{-1}	6.83	68.83 (55.98)	62.15 (52.10)	51.21 (44.14)	60.73 (50.06)
T_6 (neem+*Spilanthes*)	(1.5 ml+40 ml) l^{-1}	6.80	77.79 (62.14)	73.97 (59.65)	65.04 (53.79)	72.27 (58.53)
T_7 (acetamiprid)	1 g 3 l^{-1}	7.04	86.21 (68.28)	83.41 (66.42)	82.82 (66.10)	84.15 (66.93)
T_8 (untreated control)	-	6.89	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
SEm±	-	-	2.18 (6.46)	2.03 (5.73)	2.19 (6.50)	2.12 (6.23)
CD (p=0.05)	-	NS				

Figure in the parenthesis are angular transformed values; DAT: Days after treatment; NS: Not significant treatments namely neem pesticides, *Spilanthes*, *Polygonum*, garlic and tobacco were found to be moderately effective against thrips providing 51.21%, 43.97%, 38.89%, 37.72% and 35.18% suppression respectively.

Result based on 3, 7 and 11 days revealed that acetamiprid was superior insecticides providing more than 80% suppression. However combination of neem and *Spilanthes* extract gave satisfactorily results i.e. more than 70% control. Neem pesticides also gave fair results i.e. 60% suppression (Mandi and Senapati, 2009). Yield was the ultimate output to the farmer which makes them content. In this view comparison has done for yield in order find out effectiveness of botanical pesticide over tomato pests (Table 3). Here overall yield was taken for evaluation. The lowest yield was recorded from control plot i.e. 18.32 t ha^{-1} and highest yield, 30.15 t ha^{-1} were recorded from acetamiprid treated plot followed by neem+*Spilanthes* (27.55 t ha^{-1}), *Spilanthes* (26.67 t ha^{-1}) and *Polygonum* (26.32 t ha^{-1}), tobacco (24.02 t ha^{-1}) which are significantly different from yield of other treated plots. Other than control plot the lowest yield were recorded from garlic treated (23.11 t ha^{-1}) plot (Burubai et al., 2011; Mandi and Senapati, 2009).

Table 3: Yield potentiality in different treatments (2011–12 and 2012–13)

Treatment	Yield t ha^{-1}			
	Spray conc.	2011–12	2012–13	Mean
T_1 (tobacco extract)	7.5% (75 ml l^{-1})	24.52	23.52	24.02
T_2 (garlic extract)	5% (50 ml l^{-1})	22.24	23.98	23.11
T_3 (Polygonum extract)	5% (50 m l^{-1})	25.07	27.57	26.32
T_4 (*Spilanthes* extract)	5% (50 ml l^{-1})	29.29	24.05	26.67
T_5 (Neem pesticides)	2.5 ml l^{-1}	26.79	24.33	25.56
T_6 (Neem+*Spilanthes*)	(1.5 ml+40 ml) l^{-1}	27.99	27.11	27.55
T_7 (Acetamiprid)	1 g 3 l^{-1}	28.15	32.15	30.15
T_8 (Untreated control)	-	16.46	20.18	18.32
SEm±	-	1.57	1.64	1.49
CD (p=0.05)	-	4.76	5.01	4.53

4. Conclusion

Acetamiprid and neem+*spilenthes* was more effective but acetamiprid was a highly toxic synthetic insecticide, so there was every possibility to contaminate tomato fruits with the toxic chemicals, as tomato fruits are eaten by human beings. In spite of using toxic acetmiprid, application of neem+*spilanthes* mixture was best as it was cost effective and environment friendly. So, it may be incorporated in IPM programmed against thrips in tomato cultivation. So, it is advisable to use neem+*Spilanthes* as a safety measure.

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