Mysore J. Agric. Sci., 51 (2) : 281-286, 2017

Species Diagnosis, Occurrence of Thrips and Bud Necrosis Virus Disease on Tomato

TIMMANNA AND MOHAN I. NAIK
Department of Agricultural Entomology, College of Agriculture, UAS, GKVK, Bengaluru-560 065
E-mail: thimsento@gmail.com

ABSTRACT

The studies were carried out during *kharif* seasons of 2015-16 and 2016-17 at the Indian Institute of Horticultural Research, Hessaraghatta, Bengaluru to understand the role of thrips and impact of insecticide application on thrips and incidence of *Groundnut bud necrosis virus* (GBNV) on tomato var *Arka vikas*. Thrips collected in the experiment were identified as, *Thrips palmi* Karny, *Scirtothrips dorsalis* Hood and *Frankliniella schultei* Trybom and these three species were occurred together in tomato ecosystem. The results indicated that irrespective of thrips numbers, higher level of thrips incidence was observed at the flowering stage, 40 to 60 per cent of GBNV infection was observed from fourth week to till end of the crop.

Keywords :

TOMATO (*Solanum lycopersicum* L.) is one of the major and widely grown staple vegetable crop in both tropics and sub-tropics of the world and ranks second in importance among vegetables. In India tomato can be grown throughout the year. Though, the area under tomato cultivation is high but the productivity (15 t / ha) is low, due to various biotic and abiotic factors (Anonymous, 2016), Among the biotic factors, thrips transmitting tospovirus, *Ground Nut Bud Necrosis Virus* (GBNV) Disease having a greater negative impact on production of tomato.

Thrips are difficult to control due to their small size and ability to develop insecticide resistance and these attributes contribute to the success of this pathosystem and corresponding yield losses in agricultural systems. Thysanoptera is a diverse order includes more than 7700 species, among these 14 thrips species reported as vectors for tospoviruses worldwide, these viruses are exclusively transmitted by thrips in a circulative and propagative manner, and these viruses are not known to be existing in nature in absence of thrips vector. India hosts 700 species of thrips, of these five thrips species, suspected to be the tospovirus vectors *viz., Thrips palmi* Karny, and *Thrips tabaci* Lindeman, *Ceratothripoides claratris* (Shumsher), *Frankliniella schultzei* Trybom and *Scirtothrips dorsalis* Hood. They are transmitting five distinct tospoviruses *viz*., *Groundnut bud necrosis virus* (GBNV), *Watermelon bud necrosis virus* (WBNV), *Capsicum Chlorosis Virus* (CaCV), and *Iris Yellow Spot Virus* (IYSV) and *Peanut Yellow Spot Virus* (PYSV) in different vegetable and pulse crops. The losses due to GBNV disease in tomato depends mainly on the level of infection, stage of the crop, thrips population and severity of the disease. Early stage of the crop, *i.e.* 15-20 days after transplanting, flowering and fruit formation stage is susceptible to this virus. GBNV causes upto 100 per cent losses in tomato, chilli and groundnut and it was suspected to be transmitted by *T. palmi*. (Krishnareddy *et al.,* 2008; Kunkalikar *et al.,* 2011; Mandal *et al.,*2012), but the vector status and the virus transmissibility of all five thrips species need to be studied.

In India, meagre research efforts were made in respect of GBNV infecting tomato. Hence, this study has been formulated to understand the insights of thrips-virus pathosystem and their dynamics in different seasons.

MATERIAL AND METHODS

To study the occurrence of thrips and GBNV, tomato var. *Arka vikas* was planted for two consecutive growing seasons of *kharif* (June 15th 2015-2016 and 2016-2017) in two experimental plots, one without insecticide intervention (Control) and other treated with insecticide, Fipronil 5 SC (1.75ml/l) at 10 days interval till the harvest. In each treatment 15 replications were maintained.

One week after planting thrips number per plant and per cent disease incidence were recorded. Subsequent observations were made at weekly intervals till the end of the crop. During each sampling 15 plants were selected and tagged at randomly. Selected plant shoots were tapped on white paper and number of thrips were counted and recorded and per cent disease incidence was also recorded. During every sampling thrips individuals were collected and preserved in 70 per cent alcohol for taxonomic studies.

For morphological identification studies, the permanent microscopic slide mounts of thrips were prepared by maceration and dehydration protocol (modified protocol from Dr. J. S. Bhatti Delhi University), morphological key characters (Anon., 2012) of thrips were identified by using phase contrast microscope (Olympus BX) at the Department of Entomology, GKVK, Bengaluru.

Observations on mean number of thrips and disease incidence were subjected to statistical analysis using Analysis of variance (ANOVA) after suitable transformation.

Results and Discussion

Pooled data of two years indicated that the significant difference in thrips infestation and GBNV disease incidence was observed between fipronil and control plots (Fig. 1). Thrips infestation was lower in fipronil treatment at third week (1.53) to 6th week (1.67) after planting, and gradually decreases (0.93) as the crop matures. But higher level of thrips infestation was observed at 2nd week (8.07) to 6th week (9.40) after transplanting. Visual GBNV symptoms

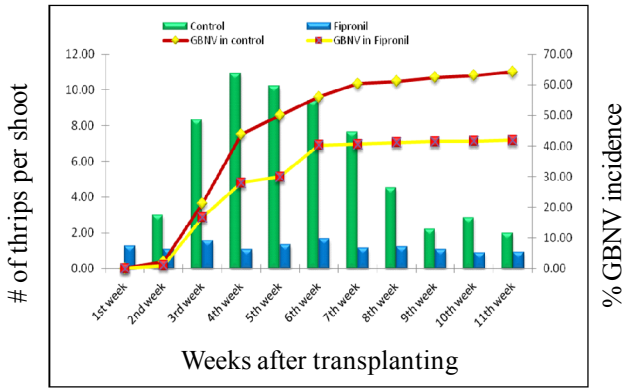
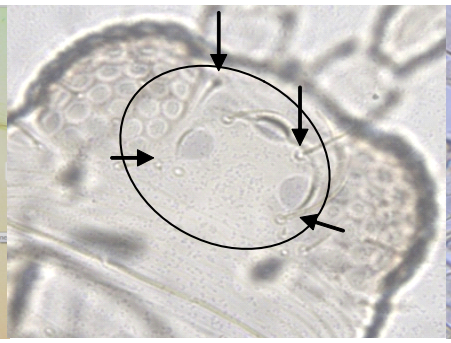
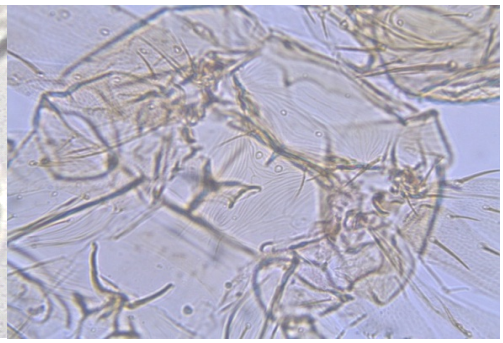


Fig.1: Mean incidence of thrips and GBNV during different weeks after transplanting

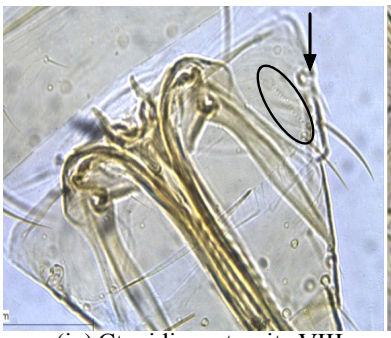
(i) Adult (@&)



(ii) 2 pairs of ocellar setae III pair is smaller



(iii) Campaniform sensillae present



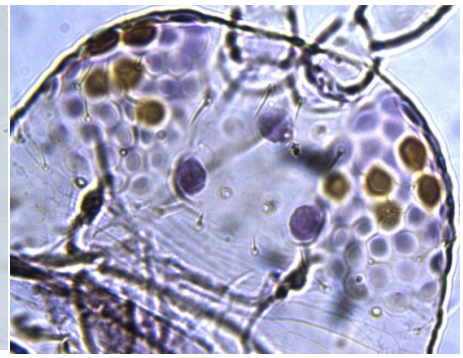
(iv) Ctenidia on tergite VIII is posterior to spiracle

(v) 3 distal setae with gap on forewing

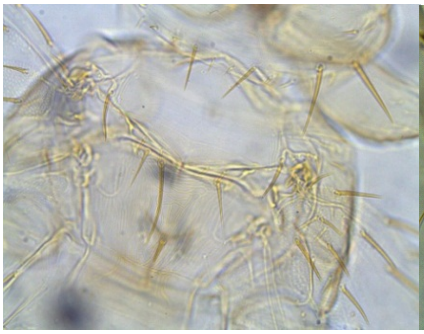
Fig. A

(i) Adult (♀)

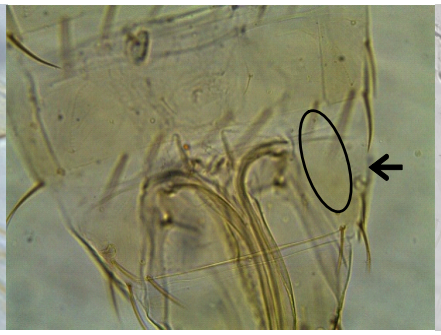
(ii) Antenna 7-8 segmented



(iii) 3 pairs of ocellar setae



(iv) Campaniform sensilla absent



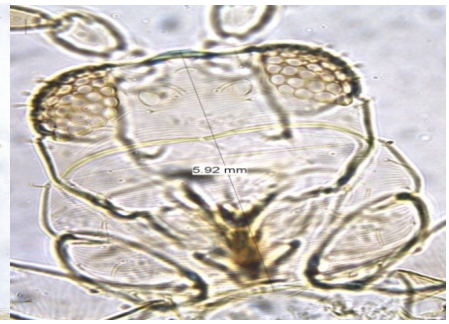
(v) Ctenidia on tergite VIII anterolateral to spiracle

(vi) Continuous 2 rows of setae on forewing

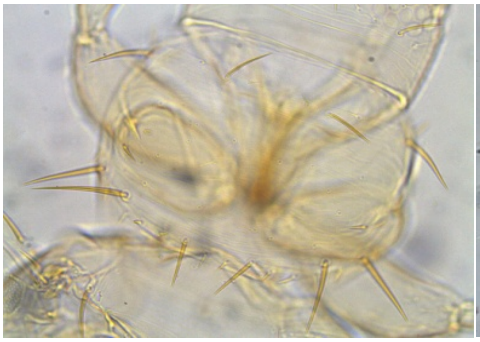
Fig. B

(i) Adult (♀) with dark brown patches anticostal ridges

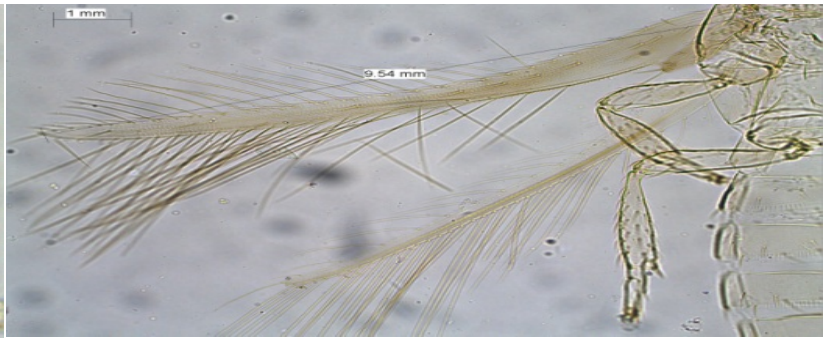
(ii) Antenna 8 segmented



(iii) Closely spaced sculpture lines on pronotum



(iv) 4 pairs of posterior pronotal setae



(v) Long setae on both wings

Fig.C

TABLE I

Thrips and bud necrosis virus disease during different weeks after transplanting

Treatments	Thrips infestation and bud necrosis virus disease incidence in different weeks after transplanting (WAT)											
	1st WAT		2nd WAT		3rd WAT		4th WAT		5th WAT		6th WAT	
	No. Thrips	% GBNV	No. Thrips	% GBNV	No. Thrips	% GBNV	No. Thrips	% BNV	No. Thrips	% GBNV	No. Thrips	% GBNV
Fipronil 5 SC(1ml/l)	0.00	0.00	1.07	1.00	1.53	16.73	1.07	28.00	1.33	40.20	1.67	40.27
			(1.23)	(8.37)	(1.41)	(24.04)	(1.25)	(38.15)	(1.34)	(39.32)	(1.46)	(39.36)
Control	0.00	0.00	8.07	2.13	8.33	21.27	10.93	43.87	10.20	50.00	9.40	56.00
			(2.97)	(5.74)	(2.97)	(27.40)	(3.38)	(41.44)	(3.27)	(44.98)	(3.14)	(48.46)
SEM±	-	-	**0.29**	**0.06**	**0.14**	**0.73**	**0.18**	**1.29**	**0.22**	**1.23**	**0.19**	**1.12**
CD (0.05)	-	-	**0.89**	**0.19**	**0.43**	**2.22**	**0.55**	**3.92**	**0.66**	**3.75**	**0.57**	**3.38**

TABLE I (CONTD.)

Treatments	Thrips infestation and bud necrosis virus disease incidence in different weeks after transplanting (WAT)									
	7th WAT		8th WAT		9th WAT		10th WAT		11th WAT	
	No. Thrips	% GBNV	No. Thrips	% GBNV	No. Thrips	% GBNV	No. Thrips	% GBNV	No. Thrips	% GBNV
Fipronil 5 SC (1ml/l)	1.13	40.53	1.20	41.07	1.07	41.40	0.87	41.60	0.93	41.93
	(1.25)	(39.52)	(1.30)	(39.83)	(1.25)	(40.02)	(1.16)	(40.14)	(1.19)	(40.33)
Control	7.67	60.27	4.53	61.07	2.20	62.33	2.87	63.07	2.00	64.27
	(2.86)	(50.95)	(2.24)	(51.43)	(1.69)	(52.19)	(1.83)	(52.61)	(1.58)	(53.32)
SEM±	**0.17**	**1.06**	**0.11**	**1.12**	**0.06**	**1.22**	**0.07**	**1.13**	**0.05**	**0.99**
CD (0.05)	**0.51**	**3.23**	**0.34**	**3.40**	**0.19**	**3.71**	**0.21**	**3.44**	**0.14**	**2.99**

were not observed up to two weeks after planting. In contrast to thrips number the per cent disease incidence was higher in fipronil treatment, it increases from 3rd week (16.73%) after planting to the harvest (41.93%). The results indicated that more than the presence of thrips on tomato, there may be migrating adult thrips appear important in the spread of GBNV. It has been reported that inoculation access period for Western flower thrips, a vector of TSWV (Tomato spotted wilt virus) is few seconds to minutes (Ullman, 1997). It is likely that thrips successfully transmits the GBNV in a very short period possibly within few seconds to minutes. Thus, the fluctuating thrips population on tomato at any point of time may be less important compared to migrating adults. Further, our results indicated that the insecticide spray against thrips vectors to limit the spread the GBNV

Significant reduction of thrips numbers was observed in fipronil treated plot. In contrast to reduction in thrips number (following insecticide application), there was no significant reduction in GBNV infection (Table 4 and Figure D). GBNV incidence was higher in both the fipronil treated (41.40%) and control plots (64.27%). These results indicated that chemical control of thrips may not be an effective answer for management of GBNV, increased incidence of groundnut bud necrosis virus (GBNV) was observed due to the application of insecticide in groundnut (Amin *et al.,* 1980*)* as it facilitated higher dispersion of vector thrips.

The present study results are in conformity with the findings of Ullman *et al.* (1997) and Krishna Kumar *et al.*(2006), who reported that control of thrips transmitted plant pathogens can rarely be achieved using insecticides for several reasons. First, relatively a small number of vector thrips can result in high rate of pathogen spread. Second, many thrips species are intensely resistant to insecticides, so their populations are not well controlled. Third, inoculation of plant pathogen transmitted by thrips occurs quickly and the insects are not killed by the insecticide until after they have transmitted the pathogen. Finally, many epidemics are caused by dispersing thrips that are transient in the affected crop. Insecticides do not control this transient population unless applied at an unacceptable frequency. Our results fully support these findings.

Morphological identification of thrips species associated with tomato crop

During the present study, three thrips species were identified by morphological diagnostic key characters, which were prepared by using available resources (Mound and Kibby 1998; Thrips California website). Of these *Scirtothrips dorsalis* Hood was the predominant (60%) species followed by *Thrips palmi* Karny (30%) and *Frankliniella schultzei* Trybom (10%), these results are in agreement with the earlier reports, which stated that five thrips species were suspected to be the vectors of tospoviruses in India. but there was no particular study was carried out for the species specific thrips vector-virus interactions (Mandal *et al.,* 2012).

Key morphological diagnostic characters for identification of thrips

1. Terminal abdominal segment tubular, forewing (when present) without longitudinal veins, ovipositor represented by a small sclerotised eversible tube like opening on IX abdominal segment.....2 (Tubulifera).

2. Terminal abdominal segment tubular, Forewing (when present) with longitudinal veins, ovipositor curved and serrated blades on IX abdominal segment .....3 (Terebrantia).

3. (2) Antennal segments III and IV with simple or forked sensory cones.....4(Thripidae)

4. (3) Legs covered with transverse rows of microtrichia.....Sericothripinae
   Legs covered without transverse rows of microtrichia.....5

5. (4) Metathoracic endofurca elongated extending into mesothorax, terminal antennal segment not long and acute..... Dendrothripinae
   Metathoracic endofurca not elongated and usually not extending into mesothorax, terminal antennal segment variously shaped.....6

6. (5) Head and legs usually with reticulate sculpture often body with heavy sculpture, terminal antennal segments long and acute..... Panchaetothripinae
   Head and legs are not reticulate but many have transverse lines of sculpture, terminal antennal segments not acute.....7 (Thripinae)

7. (6) Abdominal tergites with rows of fine microtrichia S1 setae of abdominal sternites VII on posterior margin, ocellar setae III between posterior ocelli, posterior marginal cilia of fore wing straight ; lateral microtrichial fields of abdominal tergites with 3 discal setae; abdominal tergites usually with dark antero-medial shading.....*Scirtothrips dorsalis* (Hood)
   Abdominal tergites with rows of fine microtrichia other characters are various.....8

8. (7) Head with 3 pairs of ocellar setae(1 present), ctenidia of abdominal tergites VIII antero-lateral to the spiracle, forewing with two complete rows of vienal setae, antenna usually with 8 segments, pronotum usually with long setae on the anterior and posterior margin..... 9
   Head with 3 pairs of ocellar setae (1 absent), ctenidia of abdominal tergites VIII medial to the spiracle, forewing with gap in first row of vienal setae, antenna usually with 7 segments, pronotum usually with long setae only on the posterior margin.....13

9. (8) Pedicel antennal segment III simple (nearly parallel sided).....10
   Pedicel antennal segment III laterally expanded .....other *Frankliniella* spp.

10. (9) Head prolonged anterior of compound eyes.....other *Frankliniella* spp.
    Head not prolonged anterior of compound eyes.....11.

11. (10) Compound eyes with 2-4 antero-lateral facets twice the diameter of other facets..... other *Frankliniella* spp.
    Compound eyes with antero-lateral facets not elongated.....12

12. (11) Ocellar setae III with in ocellar triangle and anterior of posterior ocelli, comb complete present on tergite VIII but short, metanotal companiform sensilla present.....*Frankliniella occidentalis* (Pergande)
    Ocellar setae III between the posterior ocelli, comb absent on tergite VIII, metanotal companiform sensilla absent..... *Frankliniella schultzei* (Trybom)

13. (12) Abdominal sternites and pleurotergites without discal setae, comb on tergite VIII complete with long tines .....14.
    Abdominal sternites and pleurotergites with discal setae, comb various.....other *Thrips* spp

14. (13) Tergite II with 3 lateral setae, abdominal pleurotergites with rows of microtrichia; metanotal companiform sensilla absent..... *Thrips tabaci* (Lindemann)
    Tergite II with 4 lateral setae, abdominal pleurotergites without rows of microtrichia; metanotal companiform sensilla present..... *Thrips palmi* (Karny).

In conclusion, the present study indicated higher level of thrips incidence at the flowering stage and it reduces gradually after fruit setting. Insecticide fipronil was effective in reducing thrips load on tomato, but not effective in reducing GBNV infection. *T. palmi* was suspected to be the major vector of GBNV in groundnut, chilli and other vegetable crops, in our studies along with *T. palmi,* other species like *S. dorsalis* and *F. scultzie* were also observed and suspected to be the transmitters of GBNV. More basic research on virus-vector interactions and thrips migration, quick thrips identification techniques, screening of resistance sources are the needs of the hour for formulating the ecologically and economically viable management strategies for thrips and tospoviruses.

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(*Received :* May, 2017 *Accepted :* June, 2017)