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Bio-ecology and seasonal incidence of thrips *Scirtothrips dorsalis* Hood in rose

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ABSTRACT: In rose. *Scirtothrips dorsalis* is the dominant insect species causing damage to tender shoots, leaves, buds, flowers and growing tips of rose plants in field and polyhouse. Rose thrips prevailed throughout the flowering period and attained peak during May. Thrips followed an annual pattern in distribution over time. Thrips numbers were more in polyhouse than in open field. Cumulative mean numbers of thrips was more in polyhouse than open fields. Temperature and sunshine hours were found to have positive effect on thrips density. Relative humidity, rainfall and wind velocity had negative effect. Temperature and relative humidity largely influenced seasonal incidence of thrips. In general, the biology was short in field compared to laboratory. Newly emerged adults were yellow with rectangular head. Eyes were very prominent and pink. Total fecundity ranged from 6 to 11 per female. Adult female longevity ranged from 4 to 8 days.

KEY WORDS: *Scirtothrips dorsalis*, rose, bio-ecology, seasonal incidence, field and polyhouse

INTRODUCTION

Rose is being attacked by many insect pests, among which the sucking pest, thrips, *Scirtothrips dorsalis* Hood is one of the serious pests. *Scirtothrips dorsalis* is a major pest of rose (Ananthakrishnan and Jagdish, 1968; Nair *et al*., 1991; Onkarappa and Mallik, 1998). The larvae and adults of *S. dorsalis* caused damage to all the stages of flower (Murugan, 2000). *S. dorsalis* alone can cause 28-95% damage with a population density of 11-33 thrips/flower (Gahukar, 2003). Ayyar *et al*. (1935) reported that thrips population was low in rainy season in Guntur (Andhra Pradesh) and Periyakulam (Tamil Nadu). Dev (1964) reported that *S. dorsalis* occurred almost throughout the year and attained peak during May. Raizada (1965) from Delhi reported thrips peak during spring and early summer. Borah (1987) reported *S. dorsalis* to be active throughout the year. Murugan and Jagadish (2004) reported that the incidence of *S. dorsalis* prevailed throughout the flowering period and attained peak (43.71 thrips per flower) on rose during second fortnight of April. Murugan and Jagadish (2004) also reported that incidence of *S. dorsalis* on rose was significantly positively correlated with maximum temperature and negatively correlated with mean relative humidity. The incidence was positively correlated with minimum temperature and negatively correlated with total rainfall though not significant.

Rao (1929) and Ayyar *et al.* (1935) reported that eggs were laid in the tissues of leaves and shoots.

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Female laid eggs singly in the tissues of buds and young leaves, usually near the mid-rib or in the veins, occasionally in older leaves. Patnaik *et al*. (1986) reported that eggs were laid internally in the leaf lamina and occasionally in the petioles. The ovipositional sites were characterized by light yellow dots with raised cap like structures. Onkarappa and Mallik (1998) observed maximum number of eggs on petals of completely exposed rose flower buds followed by tender leaves. Murugan (2000) reported that the female laid eggs singly in the tissues on the tender leaves, occasionally into the petals of the flower and older leaves.

Rao (1929), Ayyar *et al*. (1935) and Raizada (1965) reported that the incubation period varied from four to six days. Rao (1929) and Ayyar *et al*. (1935) reported that eggs were white and very minute. Murugan (2000) reported that the egg was kidney or oval shaped and glossy white and measured 0.23 to 0.26 mm in length and width ranged from 0.10 to 0.12 mm. Rao (1929) reported that there were two larval instars, duration of which varied from seven to eight days. Ayyar *et al*. (1935) and Patnaik *et al*. (1986) reported that larval period varied from five to six days. Dev (1964) reported that the newly hatched nymphs were almost white and the colour gradually changed to pale yellow. It was 0.29-0.32 mm long and 0.09-0.10 mm broad across the thorax and had a slender body. The antennae were seven segmented but the three distal segments were not distinct. Second stage nymph was orange yellow and was 0.48-0.59 mm long and 0.13-0.18 mm broad at the widest part of the abdomen. The antennal segments were distinct and were pale orange. The average total duration of the two nymphal instars was 6 days in March, 5.3-5.7 days in April, 5 days in May and 4.3 day in June. Murugan (2000) reported that total larval duration was 3.25 to 6.00 days with an average of 4.60 days. Rao (1929) reported that the pre-pupal period varied from 18 to 24 hours. Murugan (2000) reported that pre-pupal period varied from 0.75 to 1.50 days. The pre-pupa measured about 0.59 to 0.6 mm (length) and 0.21 to 0.2 mm (width). Murugan (2000) reported that pupa was dark yellow with pink eyes. The antennae were directed backwards over head and thorax. The pupa was 0.55 to 0.6 mm (length) and 0.21 to 0.25 mm (width). The pupal period ranged from 3.25 to 4.75 days. Ayyar *et al*. (1935) reported that pupation took place mainly in leaf axils, leaf curls, under the calyx of flower and fruits and in other tender parts of the plants. Murugan (2000) reported that the pupation occurred on the curled portion of the flower petals in laboratory condition. In field, it pupated on leaf litter and soil surface.

Dev (1964) reported that in female body length was 1.05 mm, breath was 0.19 mm; head was 0.06 mm long and 0.12 mm broad; antenna was 0.23 mm long; wing was 0.54 mm long. Body colour was orange yellow. Head was more or less rectangular. Eyes were prominent and deep pink. On the dorsal aspect of 2nd and 7th abdominal segments there were arc like pale brownish patches. Male body was 0.71mm long, 0.14 mm broad; head was 0.06 mm long, 0.11mm broad; antenna was 0.16 mm long; Wing was 3.38 mm long. Male was smaller than female and arc- like brown patches were absent on the abdominal tergites.

MATERIALS AND METHODS

The present study was carried out at Gandhi Krishi Vignana Kendra (GKVK), Lalbagh- a botanical garden, farmer field at Agar, Kanakapura Road and polyhouses at GKVK and Karthik Nursery, Ramohally, Bengaluru (12º 56' N and 77º35' E of 930m amsl) from 2008-2010. The seasonal incidence of *S. dorsalis* was studied in GKVK, Lalbagh and polyhouse at Ramohally. Field samples were collected at fortnightly intervals for two years, from January, 2008 to January, 2010. Ten plants were selected randomly on each sampling date. Observations on number of thrips were recorded from three fully matured flowers representing top, middle and bottom regions. The flowers were beaten on the black card board sheet individually and thrips numbers were counted. The average number of thrips per flower was worked out.

Thrips density was correlated with maximum, minimum and mean temperature, maximum, minimum and mean relative humidity, rainfall, sunshine hours and wind velocity. In case of polyhouse, the data on thrips density was correlated

with the maximum, minimum and mean temperature.

Bio-ecology

Studies on bio-ecology of *S. dorsalis* were made in laboratory during three seasons, summer (May, 2009), rainy (August, 2009) and winter (January, 2009). Tender leaves of rose plant were placed in test tubes (10 cmX2.5 cm) and exposed to oviposition by thrips and the eggs laid were identified by the oval shaped raised translucent surface. Leaves having eggs were kept in tubes. Wet cotton was placed at the bottom to maintain the moisture. The leaves were observed daily under stereo-binocular microscope for emergence of the young ones. Newly hatched larvae were released individually in test tube (10 cmX2.5 cm) on rose petals with the help of camel hair brush. The petals were changed once in two days. Daily observation was made on the stages. The data on durations of different stages viz., egg, Incubation period, first instar larva, second instar larva, pre-pupa, pupa and adult were recorded and range, mean and S.D was calculated. Ten experimental sets were made. Out of which, only five were taken for final result in which all the stages resulted with adult.

To study the longevity of adults and fecundity, freshly emerged female thrips were individually placed in tubes (10 cmX2.5 cm) containing tender leaves. New tender leaves were provided every day after removing the old leaves. The egg laying was noted by translucent raised surface on the leaves and such leaves were observed under stereo binocular microscope. Total such counts were made to know the fecundity of female. The leaves with eggs were kept separately in test tube and observed daily to know the incubation period. The females were individually observed to know the longevity. In *S. dorsalis*, males were rare and reproduction was mainly through thelotoky parthenogenesis.

Lactophenol clearing method (Carlson and Hibbs, 1962) was followed to count thrips eggs. Clearing solution was prepared using 85% lactic acid, phenol, distilled water and glycerin (1:1:1:2). This solution was boiled to the boiling point in a beaker. Rose leaves were immersed and boiled for three minutes in the clearing solution. After boiling, the leaves were immersed in cold lactophenol, so that the eggs were being cleared and later the eggs were counted.

To study the oviposition preference, an experiment was conducted during May, 2009 at laboratory with five replications. In a rearing cage, young leaves (5-20 days), matured leaves (>20-45days) and old leaves (>45days), petals and young buds (5 days old) were placed. In the centre, on a petri dish twenty newly emerged females were released and the materials were observed daily for oviposition. The materials were replaced on alternate days for ten days. The number of eggs laid on each part was separately counted under each replication and pooled and averaged.

In the field, ten samplings were conducted on different dates at weekly interval during May, 2009 to know the oviposition preference. In this, ten plants were sampled. In each plant, five random samples of young leaves, matured leaves, old leaves, petals, young buds were collected and they were observed under microscope for oviposition. The number of eggs laid on each part were separately counted on each observation date and pooled and averaged.

Study on morphological characters

To study different morphological characters and to measure the body dimensions, slides were prepared by adopting the method given by Mound and Pitkin (1972). The specimens were mounted on slide (75 mm long, 25 mm wide and 1.3 mm thick) on a drop of Canada balsam and covered with 13 mm cover slip gently to avoid the bubbles. The cover slip was gently tilted and pressed to spread the wings and arrange the specimen. The morphological characters viz., length and width of egg, first and second instar larva, pre-pupa, pupa, adult, antennae length and wing length of adult were recorded. Totally five experimental sets were made. The average was calculated for each stage. By using a calibrated ocular micrometer, the dimensions of the different stages of the thrips viz., egg, larval instars, pre-pupa, pupa and adults were measured.

Field biology of *S. dorsalis* was studied in rose field and polyhouse at GKVK during 2009. A newly emerged female larva was released on the young shoot and was covered with polythene bag (20X26cm) which was punched for aeration. Before releasing female, all the life stages of the thrips were removed from the young shoot. Twenty five experimental set up were made on bio-ecology of thrips to know fecundity, incubation period, duration of larval instars, pre-pupa and pupal stage and adult. Destructive sampling was followed. The data was pooled and averaged. Mean and S.D were calculated.

Correlation studies were made to find the relationship between the weather parameters and seasonal incidences of thrips, aphids and whitefly. Regression analysis was made to know the effect of abiotic factors on thrips density.

RESULTS

Peak populations of rose thrips (in numbers) were found during May in all the three locations in both the years (Table 1) at Lalbagh. For instance, during 2008-09, 61.8 thrips were recorded per flower during 3rd week of May. In May 1st week, 45.4 thrips were recorded during 2009-10. Similar peak numbers were observed between May1st and 3rd week at GKVK and polyhouse recording the highest thrips numbers viz., 57.8 and 65.4 during 2008-09 and 38.4 and 65.2 during 2009-10, respectively. Thrips density was minimum during 3rd week of November in all locations (8.7 at Lalbagh during 2008-09, 5.4 and 6.4 at GKVK during 2008-09 and 2009-10, respectively and 20.7 at polyhouse during 2008) and all the years except in polyhouse during 2009 where it was during November 1st week. In field as well as in polyhouse, thrips density peaked during May.

In polyhouse, where the environmental conditions are regulated, peak thrips numbers were found during May. The trend in the numbers of thrips was similar throughout the year both in field and polyhouse. These observations suggest that the rose thrips follow an annual pattern in distribution over time. However, when the cumulative mean was worked out and compared, rose thrips number was more in polyhouse (44.30 and 37.93 during 2008-09 and 2009-10 respectively) compared to open field in both the years. When the cumulative mean of Lalbagh (32.10 and 25.96 during 2008-09 and 2009-10 respectively) was compared to GKVK (26.31 and 19.96 during 2008-09 and 2009-10 respectively), it was noticed that the mean number of thrips were more in Lalbagh compared to GKVK.

Correlation coefficients indicated that there was significant positive correlation between maximum temperature (r = 0.722 and 0.802; 0.572 and 0.758; 0.515 and 0.784 for GKVK, Lalbagh and polyhouses during 2008-09 and 2009-10, respectively) and thrips density at all the three locations during both the years. With minimum temperature, there was positive correlation at three locations during both the years (r = 0.008 and 0.347 at GKVK, 0.137 and 0.241 at Lalbagh and 0.076 and 0.317 at polyhouse during 2008-09 and 2009-10, respectively) though they were not significant (Table-2).

Mean temperature was positively correlated with the thrips density in the three locations during both the years. When maximum relative humidity was correlated with thrips density during both years in fields, they were negatively correlated, r value being -0.334 and 0.-0.432 at GKVK, -0.501 and -0.412 at Lalbagh during 2008-09 and 2009-10, respectively. In Lalbagh during 2008, maximum relative humidity was positively and significantly correlated with thrips density (r = -0.501). Rainfall had negative correlation with thrips density at both the locations during both the years, but relation was not significant (r = -0.105 and -0.024 at GKVK, -0.021 and -0.199 at Lalbagh during 2008-09 and 2009-10, respectively). When thrips density was correlated with sunshine hours, they were positively correlated at both the locations during both years, even though the relation was not significant (r = 0.376 and 0.349 at GKVK, 0.232 and 0.360 at Lalbagh during 2008-09 and 2009-10, respectively). Wind velocity and thrips density had negative correlations at both the locations during both the years. In Lalbagh during 2009, they were

Table 1. Seasonal incidence of rose thrips, *Scirtothrips dorsalis* Hood 2008-10

Date/ Month	** Thrips numbers/ flower					
	Lalbagh		GKVK		Polyhouse	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Jan, 1st week	20.4	13.8	11.2	9.0	25.4	30.8
Jan,3rd week	21.0	12.2	19.0	11.2	25.8	32.2
Feb, 1st week	36.2	15.4	28.8	14.2	41.4	40.8
Feb, 3rd week	34.6	17.6	24.8	20.8	43.6	49.0
Mar , 1st week	42.8	38.4	33.6	31.2	54.6	53.4
Mar,3rd week	47.8	31.4	37.2	27.0	56.4	54.0
April, 1st week	39.4	41.2	35.2	39.6	64.0	58.4
April, 3rd week	51.2	39.8	41.0	37.3	57.2	63.2
May, 1st week	54.8	45.4	51.2	38.4	62.6	65.2
May, 3rd week	61.8	39.6	57.8	39.0	65.4	51.2
June, 1st week	30.8	33.2	27.8	29.0	55.2	39.6
June, 3rd week	28.8	*	24.8	27.0	48.6	38.6
July, 1st week	*	*	19.0	21.8	37.4	31.4
July, 3rd week	*	*	15.2	19.2	28.8	29.0
Aug., 1st week	10.8	12.8	10.8	12.8	27.6	25.4
Aug., 3rd week	15.2	18.8	7.6	9.0	37.2	22.4
Sep., 1st week	22.4	20.4	11.8	13.6	57.0	29.0
Sep., 3rd week	20.4	26.6	15.2	15.2	50.8	32.8
Oct., 1st week	42.6	21.9	19.6	14.8	54.4	29.6
Oct., 3rd week	27.8	28.6	20.8	18.8	64.8	33.3
Nov. 1st week	24.4	10.2	6.3	7.3	18.8	20.7
Nov. 3rd week	8.7	*	5.4	6.4	20.8	23.8
Dec. 1st week	*	*	11.4	5.7	36.0	25.6
Dec. 3rd week	*	*	9.6	10.8	29.4	30.8
Total	641.9	467.3	631.5	479.1	1063.2	910.2
Mean	32.10	25.96	26.31	19.96	44.30	37.93

* No flowers on the plant due to pruning. Hence no observation was made on thrips numbers.
** Average of ten plants. In each plant average no.of thrips per three flowers

significantly and negatively correlated (r = -0.168 and -0.259 at GKVK, -0.440 and -0.530 at Lalbagh, respectively).

Temperature and relative humidity largely influenced the seasonal incidence of rose thrips. Correlation values indicated statistically highly significant to significant relationship between temperature, relative humidity and thrips density.

Regression analysis revealed that seasonal incidence of rose thrips was influenced by weather parameters to an extent of 75.2 per cent and 72.2 per cent at GKVK, 55.2 per cent and 65.9 per cent at Lalbagh and 34.7 per cent and 42.3 per cent in polyhouse condition during 2008 and 2009, respectively (Table 3).

Bio-ecology

Egg

Eggs of rose thrips were bean shaped, tapering at end and white in colour. Incubation period ranged from 7 to 9 days in January, 2009 with mean ±S.D of 7.4±0.45, 5 to 6 days in May, 2009 with mean ±S.D of 5.4±0.55 and 6 to 8 days in August, 2009 with mean ±S.D of 7.0±0.71 under laboratory conditions (Table 4). In the field conditions, incubation period ranged from 5 to 7 days in January,

Table 2. Correlation between number of rose thrips, *Scirtothrips dorsalis* Hood and weather parameters, 2008-10

Weather Parameters	Correlation Values (r)					
	GKVK		Lalbagh		Polyhouse	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Maximum Temperature	.722*	.802*	.572**	.758*	.515*	.784*
Minimum Temperature	.008	.347	.137	.241	.076	.317
Mean Temperature	.264	.731*	.455*	.639*	.289	.702*
Maximum Relative Humidity	-.334	-.432*	-.501*	-.412*	-	-
Minimum Relative Humidity	-.345	-.586*	-.426*	-.397	-	-
Mean Relative Humidity	-.379	-.615*	-.488*	-.443*	-	-
Rainfall	-.105	-.024	-.021	.199	-	-
Sunshine hours	.376	.349	.232	.360	.474*	.311
Wind velocity	-.168	-.259	-.440*	-.530*		

*Significant at 5%

Table 3. Multiple Linear Regression Analysis for seasonal incidence of thrips, *Scirtothrips dorsalis* during 2008-10

Locations	Regression Equation	R2
GKVK-2008-09	Y= 40.782 -0.653 X1 +2.143 X2 -0.731 X3 -0.032 X4 +0.030 X5 -1.714 X6 -0.690 X7	0.752
GKVK-2009-10	Y= 11.901- 0.087 X1 +2.329 X2 -0.357 X3 -0.220 X4 +0.338 X5 -0.063 X6 -0.067 X7	0.722
Lalbagh-2008-09	Y= 92.759- 3.072 X1 +5.438 X2 -1.104 X3 -1.141 X4 +0.148 X5 -2.765 X6 -2.228 X7	0.552
Lalbagh-2009-10	Y= -44.008 -0.514 X1 +8.231 X2 -0.350 X3 -0.055 X4 +0.512 X5 -1.773 X6 -1.861 X7	0.659
Polyhouse, Ramohall Y-2008-09	Y= 37.230 – 2.784 X1 +4.389 X2 -0.703 X3 -0.015 X4 +0.015 X5 -1.172 X6 -0.0.446 X7	0.347
Polyhouse, Ramohall Y-2009-10	Y= 64.921+0.477 X1 +1.853 X2 -0.582 X3 -0.482 X4 +0.879 X5 -0.543 X6 -0.0.082 X7	0.423

Y - Number of thrips X1- Maximum Temperature X2 - Minimum Temperature X3 - Maximum Relative Humidity X4 Minimum Relative Humidity X5 – Rainfall X6 - Sunshine hours X7 - Wind velocity

2009 with mean ± S.D of 5.63±0.86, 4-6 days in May, with 2009 mean ±S.D of 5.25±0.66 and 6 to 7 days in August, 2009 with mean ±S.D of 6.25±0.43. In polyhouse, incubation period ranged from 5 to 7 days, 4 to 5 days and 5 to 6 days during January, May and August, 2009, respectively (Table 5). Egg measured 0.22 to 0.25 mm in length with mean ± S.D. of 0.24±0.01 and 0.09 to 0.11 mm in width with mean ±S.D of 0.10±0.01 (Table 6).

Larvae

There were two larval instars. Newly emerged first instar larva was white in colour, later turned to straw yellow colour. Antenna was seven segmented. Larvae had slender body. Eyes were small with pink colour. Abdomen was ten segmented, tapering posteriorly. Duration of the 1st instar larva ranged from 2 to 3 days in January, 2009 with mean ±S.D

of 2.8±0.45, 2 to 3 days in May, 2009 with mean ±S.D of 2.6±0.55 and 2 to 3 days in August, 2009 with mean ±S.D of 2.8±0.45 under laboratory conditions (Table 4). In the field, duration of the 1st instar larva ranged from 3 to 4 days in January, 2009 with mean ±S.D of 3.37 ±0.48, 2 to 3 days in May, 2009 with mean ±S.D of 2.5±0.55 and 2 to 3 days in August, 2009 with mean ±S.D of 2.5±0.5 (Table 5). In polyhouse, duration of 1st instar larva ranged from 3 to 4 days in January with mean ±S.D of 3.25 ±0.43, 2 to 3 days in May with mean ±S.D of 2.25±0.43 and 2 to 3 days in August with mean ±S.D of 2.25±0.43 (Table 5). First instar larvae measured 0.27 to 0.31 mm in length with mean ±S.D of 0.29±0.02 and 0.1 to 0.13 mm in width with mean ±S.D of 0.11±0.01 (Table 6).

Second instar was orange in colour. Antenna was pale orange with well distinct antennal segments with brown hairs. Duration of second instar larvae ranged from 3 to 4 days in January, 2009 with mean ±S.D of 3.4±0.55, 3 to 4 days in May, 2009 mean ±S.D of 3.2±0.55 and 3 to 4 days in August, 2009 mean ±S.D of 3.4±0.55 under laboratory conditions (Table 4). Second instar larvae measured 0.48-0.55 mm in length with mean ± S.D of 0.51±0.03 and 0.13-0.15 mm in width with mean ± S.D of 0.142 ± 0.008 (Table 6). In the field, duration of the 1st instar larva ranged from 3 to 4 days in January, 2009 with mean ± S.D of 3.37±0.48, 2 to 3 days in May and August with mean ±S.D of 2.5±0.5 (Table 5). In polyhouse, duration of the 1st instar larva ranged from 3 to 4 days in January, 2009 with mean ±S.D of 3.25 ±0.43, 2 to 3 days in May and August with mean ±S.D of 2.25±0.43 (Table 5). Total duration of 1st and 2nd larval instars ranged from 5 to 7 days (Table 4).

In the field, total duration of 1st and 2nd larval instars ranged from 6 to 8 days in January 2009, 5 to 7days in May 2009 and 5 to7 days in August 2009. In polyhouse, total duration of 1st and 2nd larval instars ranged from 6 to 9 days in January, 2009, 5 to 7days in May and August, 2009 (Table 5).

Prepupa and pupa

Both pre-pupa and pupa were non feeding stage of the thrips. Prepupa was yellow in colour with short wing pads reaching 3rd abdominal segment. Prepupal length varied from 0.57-0.59 mm with mean ±S.D of 0.58±0.008 and width ranged from

Table 4. Bio-ecology of *Scirtothrips dorsalis* Hood on rose under laboratory conditions, 2008

Life Stages	January, 2009		May, 2009		Aug, 2009	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Fecundity (Numbers/Female/day)	1-2	1.2±0.45	1-2	1.4±0.55	1-2	1.6 ±0.55
Incubation Period (Days)(IP) 7-8	7.4±0.45	5-6	5.4±0.55	6-8	7±0.71	
I Larval Instar(Days)(IL)	2-3	2.8±0.45	2-3	2.6±0.55	2-3	2.8±0.45
II Larval Instar(Days)(IIL)	3-4	3.4±0.55	3-4	3.2±0.55	3-4	3.4±0.55
Pre-pupa(Days)(Pp)	1-2	1.6±0.55	1-2	1.4±0.55	1-2	1.4±0.55
Pupa(Days)(P)	3-4	3.6±0.55	2-3	2.8±0.45	2-4	3.4±0.89
Adult Female Longevity (Days)	6-7	6.8± 0.45	4-6	5±0.71	6-8	6.8±0.84
Total developmental period (Days) (IP+IL+IIL+Pp+P)		23.41		17.8		18.2
Total Fecundity (Numbers/female)	7-11	9.6±0.54	6-10	7.4±0.63	6-11	7.8± 0.83

Table 5. Field Bio-ecology of *Scirtothrips dorsalis* Hood in rose, 2009

Life Stages	Field, 2009						Polyhouse, 2009					
	January		May		Aug		January		May		Aug	
	Range	Mean± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD
Fecundity (Numbers/Female/day)	2-4	2.87± 0.78	2-4	2.75± 0.66	2-4	2.5± 0.71	3-5	3±1	2-4	2.87± 0.78	2-4	2.62± 0.85
Incubation Period(IP) (Days)	5-7	5.63± 0.86	4-6	5.25± 0.66	6-7	6.25± 0.43	5-7	5.75± 0.66	4-5	4.6± 0.48	5-6	5.37± 0.48
I Larval Instar (IL) (Days)	3-4	3.37± 0.48	2-3	2.5± 0.5	2-3	2.5± 0.5	3-4	3.25± 0.43	2-3	2.25± 0.43	2-3	2.25± 0.43
II Larval Instar (IIL) (Days)	3-4	3.37± 0.48	3-4	3.25± 0.43	3-4	3.5± 0.5	3-5	4± 0.5	3-4	3.25± 0.43	3-4	3.13± 0.33
Pre-pupa(Pp) (Days)	1-2	1.12± 0.33	1-1	1±0	1-2	1.13± 0.33	1-2	1.5±0.5	1-2	1.12± 0.33	1-2	1.37± 0.48
Pupa(P) (Days)	3-4	3.87± 0.33	2-3	2.5±0.5	3-4	3.5±0.5	5-6	5.25± 0.43	2-3	2.38± 0.48	2-4	3±0.5
Adult Female Longevity(Days)	5-7	6.25± 0.66	4-5	4.6± 0.48	5-7	5.75± 0.83	6-7	6.37± 0.48	4-6	5± 0.50	5-7	6.13± 0.78
Total developmental period (Days) (IP+IL+IIL+Pp+P)		17.36		14.85		16.88		19.75		14.09		15.12

0.20-0.21 mm with mean ±S.D of 0.21±0.005 (Table 6). Duration of prepupal period in laboratory, field and polyhouse ranged from 1 to 2 days (Table 5).

Pupa was yellow in colour with pink eyes with antennae directed backwards over the head. Wing pads were reaching eighth abdominal segment. Pupal length varied from 0.55-0.56 mm and width from 0.20-0.23 mm (Table 6). Pupal period ranged from 3 to 4 days in January, 2009 with mean ±S.D of 3.6±0.55, 2 to 3 days in May, 2009 with mean ±S.D of 2.8±0.45 and 2 to 4 days in August, 2009 with mean ±S.D of 3.4±0.89 under laboratory (Table 4). In the field, pupal period ranged from 3 to 4 days in January with mean ±S.D of 3.87±0.33, 2 to 3 days in May with mean ±S.D of 2.5 ±0.5 and 3 to 4 days in August with mean ±S.D of 3.5±0.5 and in polyhouse it ranged from 5 to 6 days in January with mean ±S.D of 5.25±0.43, 2 to 3 days in May with mean ±S.D of 2.38± 0.48 and 2 to 4 days in August with mean ±S.D of 3 ±0.5 (Table 5). Total of pre-pupal and pupal period ranged from 3 to 6 days (Table 4).

Total developmental period from the time of hatching of egg till the adult emergence varied from 23.41 days in January and 17.8 days in May and 18.2 in August under laboratory condition (Table 4). Under field, total developmental period ranged from17.36 days in January, 14.85 days during May and 16. 88 days during August in field conditions and in polyhouse it was 19.75day, 14.09 days and 15.12 days during January, May and August, respectively (Table 5).

Adult

Under field conditions, reproduction was by thelytokous parthenogenesis. Males were very rare. Newly emerged adults were yellow in colour with head rectangular shape. Eyes were very prominent and pink in colour. Adult had three ocelli placed in triangle on the vertex. Antenna was 8 segmented and filiform.

Antenna measured 0.21 to 0.22 mm in length. Abdominal segments are provided with hairs and bristles. On the dorsal side of 2nd to 7th abdominal

Table 6. Morphometric parameters of *Scirtothrips dorsalis* life stages in laboratory (April-May, 2009)

Life Stages	Length(mm)		Width(mm)	
	Range	Mean ± SD	Range	Mean
Female				
Egg	0.22-0.25	0.24 ± 0.01	0.09-0.11	0.10±0.01
1st Instar larva	0.27-0.31	0.29±0.02	0.1-0.13	0.11±0.01
2nd Instar larva	0.48-0.55	0.51±0.03	0.13-0.15	0.14±0.008
Pre-pupa	0.57-0.59	0.58±0.008	0.20-0.21	0.21±0.005
Pupa	0.55-0.56	0.57±0.005	0.20-0.23	0.21±0.01
Adult body	0.9-1.02	0.97±0.06	0.18-0.19	0.19±0.004
Adult Head	0.04-0.05	0.05±0.004	0.10-0.12	0.11±0.007
Antennae	0.21-0.22	0.21±0.005		
Wing	0.52-0.53	0.52±0.005		
Male				
Adult body	0.5-0.6	0.58±0.044	0.12-0.14	0.13±0.008
Adult Head	0.04-0.05	0.05±0.005	0.1-0.1	0.1±0.00
Antennae	0.14-0.15	0.04±0.001		
Wing	3.34 -3.36	03.35±0.54		

segments arc like brownish patches are there. Adult female measured 0.9 to 1.02 mm in length and 0.18 to 0.19 mm in width. The length and width of head ranged from 0.04 to 0.05 mm and 0.10 to 0.12mm, respectively. Adult wing measured 0.52 to 0.53 mm in length (Table 6). Under laboratory, adult female longevity ranged from 6 to 7 days in January with mean ±S.D of 6.8±0.45, 4 to 6 days in May with mean ±S.D of 5 ± 0.71 and 6 to 8 days in August with mean ±S.D of 6.8±0.0.84 (Table 4).

Fecundity per female per day was tested in the laboratory, field and polyhouse conditions during 2009. Numbers ranged from 1 to 2 days in January, May and August with mean ±S.D of 1.2±0.45, 1.4 ± 0.55 and 1.6 ±0.55, respectively (Table 4). Under field, fecundity per female per day ranged from 2-4 days in January, May and August with mean ±S.D of 2.87 ± 0.78, 2.75±0.66 and 2.5±0.71, respectively. In polyhouse, fecundity per female ranged from 3 to 5 days in January with mean ±S.D of 3±1, 2 to 4 days in May and August with mean ±S.D of 2.87±0.78 and 2.6±0.85, respectively (Table 5).

Adult female longevity ranged from 5 to 7 days in January and August, 2009 with mean ±S.D of 6.25±0.66 and 5.75±0.0.83, 4 to 5 days in May with mean ±S.D of 4.6±0.48 days under field conditions. In polyhouse longevity ranged from 6 to 7 days in January with mean ±S.D of 6.37 ±0, 48, 4 to 6 days in May, 2009 with mean ±S.D of 5±0.5 and 5 to 7 days in August, 2009 with mean ±S.D of 6.13±0.0.78 (Table 6).

When total fecundity was studied under laboratory, the numbers ranged from 7-11 days in January with mean ±S.D of 9.6±0.54, 6-10 days in May, 2009 with mean ±S.D of 7.4±0.63 and 6-11 days in August, 2009 with mean ±S.D of 7.8±0.83 (Table 4).

Adult male was smaller than female measured 0.5 to 0.6 mm in length with mean ± S.D of 0.58± 0.04 and 0.12 to 0.14 mm in width with mean ± S.D of 0.13± 0.008. Head length was 0.04 to 0.05 mm with mean ± S.D of 0.05 ± 0.005 and width was 0.1mm. Antenna length was 0.14 to 0.15 mm with mean ± S.D of 0.04±0.001. Adult fore wing measured 3.34 to 3.36 mm in length with mean ±S.D. of 3.35 ± 0.54 (Table 6).

DISCUSSION

Seasonal incidence

Observations on seasonal incidence revealed that thrips occurred throughout the year, except during pruning time, when there were no flowers on plant. Thrips density started developing from December-January, reached peak in April-May, and then started declining during rainy period both in field and polyhouse. After rainy season, again thrips density started developing. It can be concluded that high temperature in April-May favoured the development and multiplication of the thrips. Rains would have washed the thrips to little extent during rainy season. Hence the density count was low during rainy season. These are in confirmatory with Ayyar *et al*. (1935) who reported that thrips population was low in rainy season. Dev (1964) reported that *S. dorsalis* occurred almost throughout the year, attained peak during May. Raizada (1965) reported thrips peak during spring and early summer. Murugan and Jagadish (2004) reported that severe infestation occurred from February-May.

The trend in the number of thrips was similar throughout the year both in open and polyhouse. These observations suggested that rose thrips follow an annual pattern in their distribution over time. However when the cumulative mean was worked out and compared, thrips number was more in polyhouse (43.43 and 37.93 during 2008-09 and 2009-10 respectively) (Table-1 and Figure-1) compared to open field both the years. For the thrips to be higher in number in polyhouse, may due to regulated temperature and humidity that favoured thrips density on rose plant. When the cumulative mean of Lalbagh (32.10 and 25.76 during 2008-09 and 2009-10, respectively) was compared to GKVK (22.71 and 19.98 during 2008-09 and 2009-10, respectively), it was noticed that cumulative mean was more in Lalbagh compared to GKVK. It may be due to the fact that in Lalbagh due to urbanization, the environmental conditions are changed and favoured thrips development compared to GKVK where it is undisturbed from urbanization.

Maximum, minimum and mean relative humidity, rainfall and wind velocity had negative correlations with thrips density. In Lalbagh during 2008, there was significant negative correlation with maximum relative humidity (r = -0.501). This is because of high rains which washed away the thrips. Thrips density was positively correlated with sunshine hours. They were positively correlated at all locations during both the years, even though correlation was not significant. These finding are confirmatory with Patnaik *et al*. (1986) who reported that rainfall and relative humidity were negatively correlated with thrips population but diurnal temperature variation was positively correlated. Murugan and Jagadish (2002) reported that incidence of *S. dorsalis* on rose was significantly and positively correlated with maximum and minimum temperature and negatively correlated with mean relative humidity and total rainfall. Hence, it can be concluded that both temperature and relative humidity largely influence seasonal incidence of rose thrips. Correlation values indicated statistical highly significant to significant relationship between temperature, relative humidity and thrips density.

Regression analysis revealed that seasonal incidence of rose thrips was influenced by weather parameters to 75.2 per cent and 72.2 per cent at GKVK, 52.2 per cent and 65.9 per cent at Lalbagh and 34.7 per cent and 42.3 per cent at polyhouse during 2008 and 2009, respectively. In polyhouse, regression analysis showed less influence of weather parameters (34 to 42%) compared to field (55 to 75%). This may be due to the fact that in polyhouse controlled environmental conditions would have influenced thrips density.

Rainfall, sunshine hours and wind velocity had no direct relationship with thrips incidence. Nevertheless, these factors may indirectly influence seasonal incidence of rose thrips. The correlation and regression analyses indicated that more than one parameter together influenced thrips incidence on rose. Rainfall, sunshine hours and wind velocity may not directly influence, but may have indirect impact via other weather parameters, crop phenology, natural enemies, biotic and abiotic components in rose cultivated ecosystem.

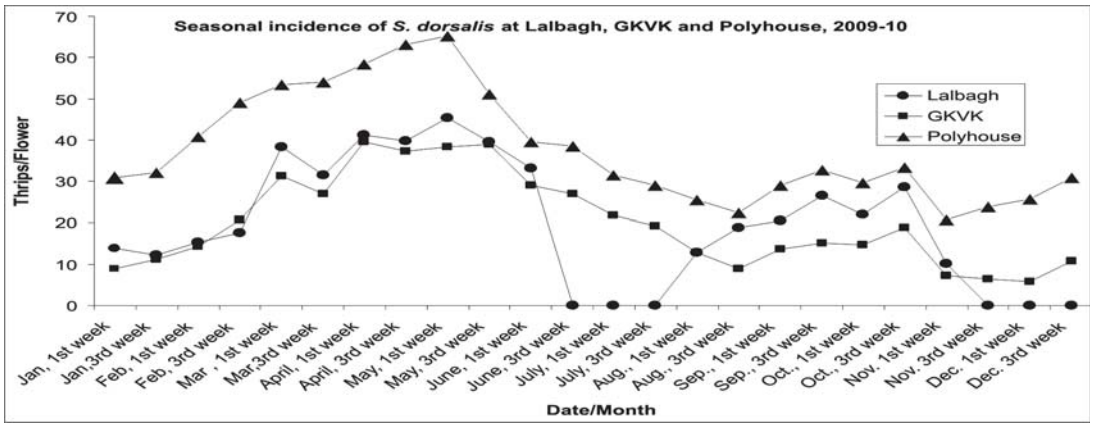

Figure 1. Seasonal incidence of *Scirtothrips dorsalis* at Lalbagh, GKVK and Polyhouse, 2009-10

Bio-ecology

In the field thrips laid eggs singly on young and matured leaves but in laboratory they preferred young leaves and buds. In laboratory, thrips got narrow choice unlike field that made them to prefer young buds. Hence it can be concluded that rose thrips preferred young and matured leaves for oviposition recording maximum egg numbers .Also, it was noticed that it laid more eggs on leaf veins and toward leaf margins. It was in confirmatory with the reports of Dev (1964), Raizada (1965), and Lewis (1973). Murugan (2000) reported that the female laid eggs singly in the tissues on the tender leaves, occasionally into the petals of the flower and older leaves. Number of eggs laid per female ranged from 6 to 11 in laboratory. Eggs of rose thrips were bean shaped, tapering at end and white in colour. Eggs measured 0.22 to0.25 mm length and 0.09 to 0.11 mm in width. Incubation period ranged from 7 to 8 days in January, 2009, 5 to 6days in May, 2009 and 6 to 8 days in August, 2009 in laboratory. In the field condition, incubation period ranged from 5 to 7 days in January, 4 to 6 days in May and 6 to 7 days in August. Dev (1964) reported that incubation period ranged from 7 to 8 days in March, 6 to 8 days in April and 6 to 7 days in May and June. Murugan (2000) reported that incubation period was 3.55 days.

Newly emerged first instar larva was white, later turned straw yellow. First instar larvae measured 0.27 to 0.31 mm in length and 0.1 to 0.13 mm in width. Antenna was seven segmented. Larvae had slender body. Eyes were small with pink colour. Abdomen was ten segmented, tapering posteriorly. Duration of the 1st instar larva ranged from 2 to 4 days. This is comparable with Dev (1964) and Patnaik *et al*. (1986). Murugan (2000) reported that total larval duration was 3.25 to 6.00 days with an average of 4.60 days. Second instar was orange in colour and measured 0.48-0.55 mm in length and 0.13-0.15 mm in breath with well distinct antennal segments with pale orange colour and with brown hairs. Duration of second instar larvae ranged from 3 to 4 days. Total duration of 1st and 2nd larval instars ranged from 5 to 8 days. This is comparable with Dev (1964) and Patnaik *et al*. (1986). Murugan (2000) reported that total larval duration was 3.25 to 6.00 days with an average of 4.60 days. Prepupa was yellow with short wing pads reaching 3rd abdominal segment. Prepupal length was 0.57-0.59 mm in length and 0.20-0.21 mm in width. Duration of prepupal period ranged from 1 to 2 days in laboratory, field and polyhouse.

Pupa was yellow with pink eyes with antennae directed backwards over the head. Wing pad was reaching eighth abdominal segment. Pupal length varied from 0.55-0.56 mm and width from 0.20-0.23 mm. Pupal period ranged from 5 to 6 days in January, 2 to 3 days in May and 2 to 4 days in August in laboratory. In the field conditions, pupal period ranged from 3 to 4 days in January, 2 to 3 days in May and 3 to 4 days in August, 2009. In polyhouse, pupal duration ranged from 5 to 6 days

in January 2 to 3 days in May and 2 to 4 days in August. Larvae preferred to pupate in leaf litter both in field and laboratory.

Total developmental period from the time of hatching of egg till the adult emergence varied from 18.2 to 23.41 days in laboratory, from 14.85 to 17.36 days in field. These findings are comparable with Ayyar *et al*. (1935), Dev (1964), Patnaik *et al.* (1986) and Murugan (2000). Newly emerged adults were yellow with rectangular shaped head. Eyes were very prominent and pink. Adult has three ocelli placed in triangle on the vertex. Antennae were filiform of type with 8 segments. Antennae measured 0.21 to 0.22 mm in length. On the dorsal side of 2nd to 7th abdominal segments arc like brownish patches were present. Adult of female measured 0.9 to 1.02 mm in length and 0.18 to 0.19 mm in width. The length and width of head was 0.04 to 0.05 mm and 0.10 to 0.12 mm, respectively. Adult wing measured 0.52 to 0.53 mm in length. Adult female longevity ranged from 4 to 8 days in laboratory, from 4 to 7 days in field and polyhouse. Fecundity per female per day ranged from 1to 2 in laboratory and 2 to 4 in field. Total fecundity in laboratory ranged from 6 to 11 per female.

It can be concluded that high temperature in April-May favoured the development and multiplication of the thrips. Rains would have washed the thrips to little extent during rainy season. Hence the density count was low during rainy season. These are in confirmatory with Ayyar *et al*. (1935) who reported that thrips population was low in rainy season. Murugan and Jagadish (2004) reported that severe infestation occurred from February-May. Rainfall, sunshine hours and wind velocity had no direct relationship with thrips incidence. Nevertheless, these factors may indirectly influence seasonal incidence of rose thrips. Correlation and regression analyses indicated that more than one parameters together might influence the incidence of thrips on rose.

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