

An Insight to Thrips Diversity in Horticulture Ecosystem of Mandya

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ABSTRACT

The study on the seasonal abundance of thrips on various horticultural plant species in Southern dry zone of Karnataka (Mandya) has revealed the diverse species composition of thrips with their hosts and abundance in different months. The correlation studies between thrips population and weather parameters showed that maximum temperature had a positive effect on thrips population inhabiting plant species *viz.*, Chrysanthemum, *Cosmos bipinnatus*, *Ficus benjamina*, *Gaillardia grandiflora* and *Rosa* spp. and negative correlation with thrips inhabiting plant species *viz.*, *Cosmos sulphureus*, Marigold and Hibiscus. Morning relative humidity also had positive effect on the population of thrips associated with plant species *viz.*, *C. bipinnatus*, *F. benjamina*, Hibiscus and Marigold and had a significant negative correlation with thrips species found on Rose. Similarly, windspeed and rainfall had a positive effect on thrips population found on plant species *viz.*, *C. bipinnatus*, *C. sulphureus*, *F. benjamina*, Hibiscus and marigold and had a negative correlation with the thrips inhabiting chrysanthemum, *G. grandiflora* and Rose.

Keywords : Thrips, Flowers, Abundance

THRIPS are very small insects, of order Thysanoptera. Thrips possessing distinct characters from other group of insects. Their wings are fringed, with asymmetrical mouth parts *i.e.*, with well-developed left mandible and vestigial right mandible, presence of a protrusible bladder at the tip of tarsi, a pre pupal stage between larva and pupa is present and body size varies from 0.5 to 15 mm in length with rapid growth and fast breeding potential (Ananthakrishnan, 1969).

Thrips are being polyphagous in nature, they are gaining more importance now a days due to their ability to cause economic losses. Keeping the importance of thrips, the study on seasonal abundance was planned to identify the thrips species associated with different plant species to describe population fluctuation during various months and to correlate the effect of weather parameters.

MATERIAL AND METHODS

Seasonal abundance of thrips population was studied at College of Agriculture, V.C. Farm, Mandya (Latitude 12.523731) Longitude 76.894684). By recording the population of thrips from 32 different

plant species from 17 plant families during 2016-17. Observations were recorded at monthly intervals from March 2016 to April 2017. For each observation five randomly selected flowers (because thrips inhabit only on flowers from the host plants selected for this study) were collected from each host plant. From each flower species thrips were collected and counted. Those cut flowers were immediately placed into a labelled polyethylene bags. Later flowers were tapped against a white sheet of paper to dislodge the thrips. For identification Thrips were sent to NBAIR (National Bureau of Agricultural Insect Resources), Bengaluru. Similarly, on plant species, *Ficus benjamina* (weeping Fig), as this is ornamental foliage plant and thrips inhabit on leaves the observations were recorded on five randomly selected leaves. The mean thrips population per flower / leaf data analysed statistically and correlated with the meteorological variables *viz.*, maximum and minimum temperature, morning and evening relative humidity, wind speed, rainfall and rainy days. The weather parameters recorded during the study period of March 2016 - April 2017 are given in the Table 1. The weather parameters were correlated with thrips populations in selected horticultural plant species *viz.*, *Cosmos*

sulphureus, *Cosmos bipinnatus*, *Dendranthema grandiflora*, *Ficus benjamina*, *Gaillardia grandiflora*, *Hibiscus syriacus*, *Rosa* spp. and *Tagetes patula*.

RESULTS AND DISCUSSION

Seasonal Abundance of Thrips Species

The seasonal abundance of 21 species of thrips were recorded from 32 flowering plants belonging to 17 family of horticultural plants are presented in Tables 2 to 5. The 21 thrips species from different plant species recorded and observed for seasonal occurrence were *viz.*, *Anaphothrips sudanensis* Trybom, *Arorathrips mexicanus* (D. L. Crawford), *Ayyaria chaetophora* Karny, *Exothrips hemavarna* (Ramakrishna and Margabandhu), *Frankliniella schultzei* (Trybom), *Gynaikothrips bengalensis* Ananthakrishnan, *Haplothrips ganglbaueri* Schmutz, *Haplothrips gowdeyi* (Franklin), *Kurtomathrips morrilli* Moulton, *Megalurothrips usitatus* (Bagnall),

Microcephalothrips abdominalis (D. L. Crawford), *Rhipiphorothrips cruentatus* Hood, *Scirtothrips bispinosus* (Bagnall), *S. dorsalis* Hood, *Thrips florum* (Bagnall), *T. flavus* Schrank, *T. hawaiiensis* (Morgan), *T. orientalis* (Bagnall), *T. palmi* Karny, *T. tabaci* Lindeman and *Xylaplothrips ligs* Ananthakrishnan and Jagadish.

In some of the hosts plant species, the abundance of thrips species was associated with more than one species which are taken as single mean populations of the associated thrips species per plant are described here.

The thrips species, *F. schultzei* and *H. gowdeyi* were recorded on flowers of *Crossandra infundibuliformis* only during April and June months, 2016 (0.2 and 1.0 thrips / flower, respectively). On flowers of *Impatiens balsamina*, *F. schultzei* was recorded during the months of May-2016 (0.60 thrips / flower), September-2016 (0.20 thrips / flower), December-2016

TABLE 1
Weather parameters recorded during the study period (March 2016- April 2017)

Month	Temperature (°C)		Relative Humidity (%)		Wind speed (Km/h)	Rainfall (mm)	Rainy days
	Max.	Min.	Morning	Evening			
Mar-16	35.84	15.03	79.71	65.39	1.94	0.00	0
Apr-16	37.00	16.35	83.00	65.67	2.93	0.00	0
May-16	36.85	16.55	83.26	66.19	4.48	34.40	2
Jun-16	32.70	19.98	85.53	77.67	6.77	102.0	8
Jul-16	30.92	20.66	87.00	62.97	7.10	65.6	6
Aug-16	32.19	20.25	92.26	55.68	7.39	104.1	3
Sep-16	33.27	19.08	91.77	60.53	5.53	68.20	3
Oct-16	34.55	17.27	86.13	54.71	2.55	65.00	2
Nov-16	31.95	15.82	88.93	42.77	1.73	4.40	1
Dec-16	30.42	12.32	93.60	38.50	2.03	41.9	3
Jan-17	31.30	13.90	90.50	46.20	2.40	6.50	1
Feb-17	33.50	10.97	72.69	61.04	2.80	0.00	0
Mar-17	35.20	18.50	84.70	36.30	3.30	0.30	0
Apr-17	36.40	21.80	89.80	37.00	4.10	12.2	0
Max.	37	21.80	93.60	77.67	7.39	104.1	8
Min.	30.42	10.97	72.68	36.3	1.73	0	0
Mean	33.72	17.03	86.34	55.04	3.93	36.04	2

TABLE 2
 Seasonal abundance of thrips per flower on plant families, Acanthaceae, Balsaminaceae, Bignoniaceae, Combretaceae, Euphorbiaceae, Malvaceae, Moringaceae and Portulacaceae during, March 2016 - April 2017

Plant family	Acanthaceae	Balsaminaceae	Bignoniaceae	Combretaceae	Euphorbiaceae	Malvaceae	Moringaceae	Portulacaceae
Plant species	<i>C. infundibuliformis</i>	<i>I. balsamina</i>	<i>Tabebuia</i> spp.	<i>Q. indica</i>	<i>Jatropha</i> spp.	<i>H. syriacus</i>	<i>M. oleifera</i>	<i>P. grandiflora</i>
Associated thrips species	<i>H. gowdeyi</i> , <i>F. schultzei</i>	<i>F. schultzei</i>	<i>F. schultzei</i> , <i>T. florum</i>	<i>T. tabaci</i> , <i>T. awaiensis</i>	<i>R. cruentatus</i>	<i>F. schultzei</i> , <i>T. florum</i>	<i>S. bispinosus</i>	<i>T. palmi</i>
Mar-16	0.00	0.00	1.80	1.40	0.00	4.60	0.00	0.00
Apr-16	0.20	0.00	2.00	0.80	0.00	2.40	0.00	0.00
May-16	0.00	0.60	3.80	0.00	0.40	2.40	0.00	0.40
Jun-16	1.00	0.00	NF	0.20	0.00	0.40	4.40	0.00
Jul-16	0.00	0.00	NF	0.60	0.00	0.00	9.60	0.00
Aug-16	0.00	0.00	NF	NF	0.00	10.80	0.00	0.00
Sep-16	0.00	0.20	NF	NF	0.00	0.60	0.00	0.60
Oct-16	0.00	0.00	NF	NF	0.00	3.80	0.00	0.00
Nov-16	0.00	0.00	NF	NF	0.00	2.60	0.00	0.00
Dec-16	0.00	0.80	NF	NF	0.00	0.60	0.00	0.00
Jan-17	0.00	0.00	NF	NF	0.00	2.60	0.00	0.00
Feb-17	0.00	0.60	1.20	NF	0.20	2.20	0.00	0.00
Mar-17	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.00
Apr-17	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00
Mean	0.08	0.15	0.65	0.32	0.04	2.35	1.00	0.07
SD	0.26	0.28	1.15	0.48	0.11	2.84	2.73	0.18

NF- No flowers were present

(0.80 thrips / flower) and February-2017 (0.60 thrips / flower). The thrips species, *F. schultzei* and *T. florum* were observed on plant species, *Tabebuia* spp. from March-2016 (1.80 thrips / flower), April-2016 (2.00 thrips / flower) and May-2016 (3.80 thrips / flower) and during February-2017 (1.20 thrips / flower) and March-2017 (0.40 thrips / flower). The thrips species, *T. tabaci* and *T. hawaiiensis* were recorded on flowers of *Quisqualis indica* during March-2016 (1.40 thrips / flower), April-2016 (0.80 thrips / flower), June-2016 (0.20 thrips / flower), July-2016 (0.60 thrips / flower), March-2017 (0.40 thrips / flower) and April-2017 (1.20 thrips / flower) during the flowering season. The occurrence of thrips, *R. cruentatus* on the flowers of *Jatropha* spp. was recorded during May-2016 (0.40 thrips / flower) and February-2017 (0.20 thrips / flower). On the flowers of *Hibiscus syriacus*, highest number of thrips *F. schultzei* and *T. florum* was recorded during August-2016 (10.80 thrips / flower) and no thrips were recorded during July-2016, March and April 2017, respectively. On flowers of *Moringa oleifera*, thrips *S. bispinosus* was recorded only during the months of June-2016 (4.40 thrips / flower) and July-2016 (9.60 thrips / flower). The occurrence of thrips, *T. palmi* on flowers of *Portulaca grandiflora* was recorded only during May-2016 (0.40 thrips / flower) and September-2016 (0.60 thrips / flower) (Table 2).

On flowers of *Rosa* spp., thrips *M. abdominalis* and *S. dorsalis* was recorded highest number during March-2016 (8.60 thrips / flower) and were absent during July and September-2016, respectively. The occurrence of thrips species, *H. ganglbaueri* was recorded on flowers of *Pentas lanceolata*, only during July-2016 (0.40 thrips / flower), November-2016 (0.80 thrips / flower), December-2016 (1.60 thrips / flower) and January-2017 (0.60 thrips / flower). On the flowers of *Allamanda cathartica*, thrips species *T. hawaiiensis* was recorded during March (0.80 thrips / flower), May (0.20 thrips / flower), July (2.20 thrips / flower), August (0.20 thrips / flower) 2016 and February-2017 (0.40 thrips / flower). On the flowers of *Catharanthus roseus*, thrips species recorded were *T. hawaiiensis* and *T. orientalis* and were observed

only during April-2016 (0.60 thrips / flower). The occurrence of thrips, *T. florum* and *T. hawaiiensis* on the flowers of *Tabernaemontana* spp. was recorded during 2016 April (2.20 thrips / flower), May (0.20 thrips / flower), July (0.60 thrips / flower), August (1.00 thrips / flower) and during 2017, January (4.80 thrips / flower), February (1.20 thrips / flower), March (1.20 thrips / flower) and April (1.80 thrips / flower), respectively. Thrips species, *H. ganglbaueri* and *T. flavus* observed on flowers of *Celosia argentea* during only May (2.40 thrips / flower), June (4.60 thrips / flower), September (6.60 thrips / flower), October (4.80 thrips / flower) 2016, respectively. On flowers of *Gomphrena serrata*, the occurrence of thrips, *M. abdominalis* and *Xylaplothrips ligs* was recorded during only April-2016 (0.40 thrips / flower) (Table 3).

On the flowers of *Caesalpinia pulcherrima*, thrips species, *T. florum* was recorded only during 2016 June (0.20 thrips / flower), July (0.20 thrips / flower) and October (2.20 thrips / flower). The thrips species, *F. schultzei* and *M. usitatus* were recorded on flowers of *Phaseolus vulgaris* only during the flower bearing months of March-2016 (3.20 thrips / flower), June-2016 (1.60 thrips / flower), March-2017 (4.20 thrips / flower) and April-2017 (5.60 thrips / flower). Thrips species, *F. schultzei*, *H. ganglbaueri*, *M. abdominalis* and *T. florum* on Chrysanthemum plants were recorded during the all months of study period. The highest populations were during February-2017 (20.20 thrips/flower) and lowest number of 1.40 thrips/flower were recorded in August-2016. On the flowers of *Cosmos sulphureus*, the peak population of the thrips species, *H. ganglbaueri* was recorded during August-2016 (17.40 thrips / flower) while absent during April-2017. Three thrips species viz., *F. schultzei*, *H. ganglbaueri*, *M. abdominalis* on the flowers of *Cosmos bipinnatus* were recorded at peak during August-2016 (11.60 thrips / flower) while absent during April-2017. The flowers of *Gaillardia grandiflora*, showed the presence of *F. schultzei* and *H. ganglbaueri* and the peak population was during May-2016 (7.20 thrips / flower) while absent during the months of September-2016, January, March and April-2017, respectively. The occurrence of thrips

TABLE 3
Seasonal abundance of thrips per flower on plant families, Rosaceae, Rubiaceae, Apocynaceae and Amaranthaceae during, March 2016 - April 2017

Plant family	Rosaceae	Rubiaceae	Apocynaceae	Apocynaceae	Apocynaceae	Amaranthaceae	Amaranthaceae
Plant species	<i>Rosa</i> spp.	<i>P. lanceolata</i>	<i>A. cathartica</i>	<i>C. roseus</i>	<i>Tabernaemontana</i> spp.	<i>C. argentea</i>	<i>G. serrata</i>
Associated thrips species	<i>M. abdominalis</i> <i>S. dorsalis</i>	<i>H. ganglbaueri</i>	<i>T. hawaiiensis</i>	<i>T. hawaiiensis</i> <i>T. orientalis</i>	<i>T. florum</i> <i>T. hawaiiensis</i>	<i>H. ganglbaueri</i> <i>T. flavus</i>	<i>M. abdominalis</i> <i>X. ligs</i>
Mar-16	8.60	0.00	0.80	0.00	0.00	0.00	0.00
Apr-16	2.60	0.00	0.00	0.60	2.20	0.00	0.40
May-16	2.20	0.00	0.20	0.00	0.20	2.40	0.00
Jun-16	2.80	0.00	0.00	0.00	0.00	4.60	0.00
Jul-16	0.00	0.40	2.20	0.00	0.60	0.00	0.00
Aug-16	3.00	0.00	0.20	0.00	1.00	0.00	0.00
Sep-16	0.00	0.00	0.00	0.00	0.00	6.60	0.00
Oct-16	1.40	0.00	0.00	0.00	0.00	4.80	0.00
Nov-16	1.20	0.80	0.00	0.00	0.00	0.00	0.00
Dec-16	1.60	1.60	0.00	0.00	0.00	0.00	0.00
Jan-17	2.80	0.60	0.00	0.00	4.80	0.00	0.00
Feb-17	3.60	0.00	0.40	0.00	1.20	0.00	0.00
Mar-17	2.60	0.00	0.00	0.00	1.20	0.00	0.00
Apr-17	1.20	0.00	0.00	0.00	1.80	0.00	0.00
Mean	2.40	0.24	0.27	0.04	0.93	1.31	0.03
SD	2.08	0.47	0.60	0.16	1.34	2.31	0.11

K. morrilli and *T. orientalis* on plant species, *Parthenium hysterophorus* were observed during April (0.40 thrips / flower), May (0.60 thrips / flower), September (1.00 thrips / flower), October (1.00 thrips / flower), November (0.80 thrips / flower), December (0.60 thrips / flower) 2016. On the flowers of *Tagetes* spp., two thrips species viz., *H. ganglbaueri* and *M. abdominalis* were recorded throughout the year. The highest population was during September-2016 (11.40 thrips / flower) and lowest (0.60 thrips / flower) during January-2017 (Table 4).

The flowers of *Tridax procumbens* showed the presence of thrips species, *H. ganglbaueri* during April-2016 to December-2016 and February-2017 to

April-2017. Peak population of thrips were recorded during April-2016 (2.40 thrips / flower) and were absent during March-2016 and January-2017 respectively. On the flowers of *Wedelia chinensis*, thrips species *H. gowdeyi* was recorded during 2016 in the months of September (3.40 thrips / flower), October (19.60 thrips / flower), November (14.60 thrips / flower), December (12.40 thrips / flower) and during 2017 in the months of January (3.20 thrips / flower), March (1.20 thrips / flower) and April (2.60 thrips / flower), respectively. The thrips species, *T. florum* was recorded on the flowers of *Jasminum grandiflorum* during June (0.20 thrips / flower), July (2.20 thrips / flower), August (0.60 thrips / flower), September (1.40 thrips / flower), October (3.60 thrips

TABLE 4
Seasonal abundance of thrips per flower on plant families, Fabaceae and Asteraceae during, March 2016 - April 2017

Plant family	Fabaceae	Fabaceae	Asteraceae	Asteraceae	Asteraceae	Asteraceae	Asteraceae	Asteraceae	Asteraceae
Plant species	<i>C. pulcherrima</i>	<i>P. vulgaris</i>	Chrysanthemum	<i>C. sulphureus</i>	<i>C. bipinnatus</i>	<i>G. grandiflora</i>	<i>P. hysterothorus</i>	<i>P.</i>	<i>Tagetes</i> spp.
Associated thrips species	<i>T. florum</i>	<i>F. schultzei</i> , <i>H. anglbaueri</i> , <i>M. abdominalis</i>	<i>F. schultzei</i> , <i>H. anglbaueri</i> , <i>M. abdominalis</i> , <i>T. florum</i>	<i>H. ganglbaueri</i>	<i>F. schultzei</i> , <i>H. ganglbaueri</i> , <i>M. abdominalis</i>	<i>F. schultzei</i> , <i>H. ganglbaueri</i> , <i>M. abdominalis</i>	<i>K. morrilli</i> , <i>T. orientalis</i>	<i>H. ganglbaueri</i> , <i>M. abdominalis</i>	
Mar-16	0.00	3.20	19.2	7.60	6.40	1.20	0.00	0.80	
Apr-16	0.00	NF	12.4	8.20	9.60	1.80	0.40	1.80	
May-16	0.00	NF	5.40	8.80	10.4	7.20	0.60	3.20	
Jun-16	0.20	1.60	3.80	4.60	5.20	0.20	0.00	4.60	
Jul-16	0.20	NF	2.20	12.4	5.80	0.60	0.00	3.60	
Aug-16	0.00	NF	1.40	17.4	11.6	1.00	0.00	6.40	
Sep-16	0.00	NF	7.60	1.80	2.80	0.00	1.00	11.4	
Oct-16	2.20	NF	5.20	2.40	3.20	1.60	1.00	6.80	
Nov-16	0.00	NF	10.6	4.20	3.80	1.00	0.80	4.40	
Dec-16	0.00	NF	17.6	5.60	4.20	0.80	0.60	2.20	
Jan-17	0.00	NF	18.4	5.60	6.40	0.00	0.00	0.60	
Feb-17	0.00	NF	20.2	6.80	2.40	1.80	0.00	3.60	
Mar-17	0.00	4.20	17.4	1.60	2.20	0.00	0.00	2.40	
Apr-17	0.00	5.60	11.6	0.00	0.00	0.00	0.00	1.20	
Mean	0.18	1.04	10.9	6.21	5.29	1.23	0.31	3.37	
SD	0.58	1.89	6.74	4.62	3.36	1.84	0.41	3.24	

NF- No flowers were present

/ flower), November (1.40 thrips / flower) months of 2016, respectively. On the flowers of *Jasminum multiflorum*, thrips *A. chaetophora* and *T. florum* were recorded highest during September (6.20 thrips / flower) and lowest (0.60 thrips / flower) in the month of June-2016. The flowers of *Jasminum sambac* had *H. gowdeyi* and *F. schultzei* during March-2016 (1.60 thrips / flower), June-2016 (0.20 thrips / flower), March-2017 (7.60 thrips / flower) and April-2017 (10.60 thrips / flower). The flowers of *Chloris barbata* recorded thrips *E. hemavarna* during March (6.60 thrips / flower), April (1.40 thrips / flower), August (0.20 thrips / flower) and September (0.40 thrips / flower). The thrips species, *A. mexicanus*, *A. sudanensis* and *H. ganglbaueri* were observed on the plants of *D. aegyptium* during April (2.20 thrips / flower), May (2.00 thrips / flower), June (0.80 thrips / flower), July (0.20 thrips / flower), August (3.80 thrips / flower) and September (0.80 thrips / flower) 2016, respectively. Thrips species, *H. ganglbaueri* were recorded on *Eleusine indica* during April-2016 (0.80 thrips / flower), May-2016 (1.20 thrips / flower), March-2017 (1.60 thrips / flower) and April-2017 (2.20 thrips / flower). On the leaves of *Ficus benjamina* showed the presence of thrips *G. bengalensis* throughout the year except during June-2016. Maximum population of the thrips was observed during August-2016 (75.60 thrips / leaf) and the lowest number of 0.80 thrips / leaf were recorded during January-2017 (Table 5).

Under the population fluctuation of thrips, it was observed that number of species and species composition of thrips varied with respect to the hosts during the study period. Similar to the present studies, several investigations showed the presence or absence of the thrips species on horticultural plants during the different months of the year. The studies by (Submok and Uraichuen, 2015) showed population of *F. schultzei* was not found in January and February months and the population gradually increased to its peak in the March and then sharply declined in the April on lettuce cultivars. Dahiya and Lakra (2001) were observed that *R. cruentatus* thrips were active on grapevine, mango, guava and jamun host plants round the year. Sanjta (2014)

recorded *T. palmi* on cucumber in which thrips were not found till second fortnight of May in leaves and till second fortnight of June in flowers. Gahukar (2003) found that rose thrips, *S. dorsalis* and *T. flavus* were highest during January to March and lowest during May to July. The findings of Kulshrestha *et al.* (1984) recorded population of thrips species, *H. ganglbaueri* was peaked during September and October on plant species, *Oryza sativa* and during March on *Triticum vulgare*. Mascarenhas *et al.* (2016) who studied the abundance of *Gynaikothrips uzeli* in galls of *Ficus benjamina* using seasonal sampling (summer and winter) and recorded that the thrips species showed greater abundance (22,725 thrips / 400 galls) in summer compared to winter (6238 thrips / 400 galls). However, the parallel studies on seasonal abundance of thrips species inhabiting flowers of plants *viz.*, *C. infundibuliformis*, *Tabebuia* spp., *Q. indica*, *H. syriacus*, *M. oleifera*, *A. cathartica*, *C. roseus*, *Tabernaemontana* spp., *G. serrate*, *C. pulcherrima*, *P. vulgaris*, *W. chinensis*, *J. grandiflorum*, *J. multiflorum*, *J. sambac*, *C. barbata* were not found, but the present study has revealed the seasonal abundance of thrips species on these plants during the various months of the year.

Correlation of Weather Parameters with Thrips Populations

The weather parameters with thrips populations in selected horticultural plant species *viz.*, *Cosmos sulphureus*, *Cosmos bipinnatus*, *Dendranthema grandiflora*, *Ficus benjamina*, *Gaillardia grandiflora*, *Hibiscus syriacus*, *Rosa* spp., and *Tagetes patula* are presented in Table 6. The mean number of thrips on the flowers of *Cosmos sulphureus* had positive relationship with minimum temperature ($r=0.029$), evening relative humidity ($r=0.391$), wind speed ($r=0.467$), rainfall ($r=0.358$) and rainy days ($r=0.25$). However, maximum temperature ($r=-0.243$) and morning relative humidity ($r=-0.028$) showed negative association with population of thrips (Table 10). Similarly, on *Cosmos bipinnatus*, the mean number of thrips had positive relationship with maximum temperature ($r=0.064$), morning relative

TABLE 5
Seasonal abundance of thrips on the flowers belonging to the plant family, Asteraceae, Oleaceae, Poaceae and leaves of Moraceae during, March 2016 - April 2017

Plant family	Asteraceae	Asteraceae	Oleaceae	Oleaceae	Oleaceae	Poaceae	Poaceae	Poaceae	Poaceae	Moraceae
Plant family	T. procumbens	W. chinensis	J. grandiflorum	J. multiflorum	J. sambac	C. barbata	D. aegyptium	E. indica	F. benjamina	
Associated thrips species	H. ganglbaueri	H. gowdeyi	T. florum	A. chaetophora T. florum	H. gowdeyi, F. schultzei	E. hemavarna	A. mexicanus, A. sudanensis, H.ganglbaueri	H. A. mexicanus, A. sudanensis, H.ganglbaueri	*G bengalensis	
Mar-16	0.00	NF	NF	1.40	1.60	6.60	0.00	0.00	0.00	34.6
Apr-16	2.40	NF	NF	1.40	NF	1.40	2.20	0.80	0.80	12.4
May-16	0.80	NF	NF	NF	NF	0.00	2.00	1.20	1.20	2.00
Jun-16	0.60	NF	0.20	0.60	0.20	0.00	0.80	0.00	0.00	0.00
Jul-16	0.80	NF	2.20	3.40	NF	0.00	0.20	0.00	0.00	1.20
Aug-16	0.40	NF	0.60	NF	NF	0.20	3.80	0.00	0.00	75.6
Sep-16	0.80	3.40	1.40	6.20	NF	0.40	0.80	0.00	0.00	41.0
Oct-16	2.20	19.6	3.60	1.80	NF	0.00	0.00	0.00	0.00	13.0
Nov-16	1.80	14.6	1.40	2.20	NF	0.00	0.00	0.00	0.00	10.4
Dec-16	1.20	12.4	NF	2.60	NF	0.00	0.00	0.00	0.00	9.80
Jan-17	0.00	3.20	NF	3.80	NF	0.00	0.00	0.00	0.00	0.80
Feb-17	0.80	NF	NF	1.60	NF	0.00	0.00	0.00	0.00	2.40
Mar-17	0.80	1.20	NF	NF	7.60	0.00	0.00	1.60	1.60	14.4
Apr-17	0.40	2.60	NF	NF	10.6	0.00	0.00	2.20	2.20	17.2
Mean	0.93	4.07	0.67	1.78	1.42	0.61	0.70	0.41	0.41	16.7
SD	0.74	6.50	1.10	1.78	3.33	1.76	1.16	0.73	0.73	20.9

NF- No flowers were present, *Thrips per leaf

TABLE 6
Correlation coefficients between thrips population and meteorological variables on ornamental plants

Plant species	Cosmos sulphureus	Cosmos bipinnatus	Dendranthema grandiflora	Ficus bengalensis	Giillardia grandiflora	Hibiscus syriacus	Rosa spp.	Tagetes patula
Thrips species	<i>H. ganglbaueri</i>	<i>H. ganglbaueri</i> , <i>M. abdominalis</i> , <i>F. schultzei</i>	<i>H. ganglbaueri</i> , <i>M. abdominalis</i> , <i>F. schultzei</i> , <i>T. florum</i>	<i>G. bengalensis</i>	<i>F. schultzei</i> , <i>H. ganglbaueri</i>	<i>F. schultzei</i> , <i>T. florum</i>	<i>F. schultzei</i> , <i>S. dorsalis</i>	<i>H. ganglbaueri</i> , <i>M. abdominalis</i>
Meteorological variables								
Max. Temp	-0.243	0.064	0.090	0.012	0.444	-0.027	0.316	-0.199
Min. Temp	0.029	0.00	-0.720 **	0.321	-0.215	-0.012	-0.363	0.307
Morning RH %	-0.028	0.026	-0.350	0.324	-0.347	0.057	-0.529 *	0.266
Evening RH %	0.391	0.478	-0.410	-0.021	0.344	0.139	0.260	0.245
Wind speed (Km/h)	0.467	0.300	-0.779 **	0.331	-0.048	0.143	-0.325	0.440
Rainfall (mm)	0.358	0.262	-0.810 **	0.368	-0.072	0.280	-0.325	0.633 *
Rainy days	0.25	0.145	-0.674 **	-0.089	-0.115	-0.134	-0.341	0.363

** = Significant at P = 0.01 or 1 % * = Significant at P = 0.05 or 5 %

humidity ($r = 0.026$), evening relative humidity ($r = 0.478$), wind speed ($r = 0.300$), rainfall ($r = 0.262$) and rainy days ($r = 0.145$). On *Dendranthema grandiflora*, the mean number of thrips had positive relationship with maximum temperature ($r = 0.090$) and negatively associated with morning relative humidity ($r = -0.350$) and evening relative humidity ($r = -0.410$). However significant negative association was found with minimum temperature ($r = -0.720^{**}$), wind speed ($r = -0.779^{**}$), rainfall ($r = -0.810^{**}$) and rainy days ($r = -0.674^{**}$). Positive correlation was recorded between incidence of thrips on *Gaillardia grandiflora* with maximum temperature ($r = 0.444$) and evening relative humidity ($r = 0.344$). There was negative association found with minimum temperature ($r = -0.215$), morning relative humidity ($r = -0.347$), wind speed ($r = -0.048$), rainfall ($r = -0.072$) and rainy days ($r = -0.115$). On *Hibiscus syriacus*, the mean number of thrips had positive relationship with morning relative humidity ($r = 0.057$), evening relative humidity ($r = 0.139$), wind speed ($r = 0.143$) and rainfall ($r = 0.280$). There was negative association found with maximum temperature ($r = -0.027$), minimum temperature ($r = -0.012$) and rainy days ($r = -0.134$). Population of thrips on *Rosa* spp. showed a positive correlation with maximum temperature ($r = 0.316$) and evening relative humidity ($r = 0.260$). There was a negative association with minimum temperature ($r = -0.363$), wind speed ($r = -0.325$), rainfall ($r = -0.325$) and rainy days ($r = -0.341$). However significant negative association found with morning relative humidity ($r = -0.529^*$). On *Tagetes patula*, mean number of thrips had positive relationship with minimum temperature ($r = 0.307$), morning relative humidity ($r = 0.266$), evening relative humidity ($r = 0.245$), wind speed ($r = 0.44$), rainy days ($r = 0.363$) and significant positive relationship with rainfall ($r = 0.633^*$). Negative association was found with maximum temperature ($r = -0.199$). On leaves of *Ficus benjamina*, the mean number of thrips had positive relationship with maximum temperature ($r = 0.012$), minimum temperature ($r = 0.321$), morning relative humidity ($r = 0.324$), wind speed ($r = 0.331$) and rainfall ($r = 0.368$). However, there was negative association

found with evening relative humidity ($r = -0.021$) and rainfall ($r = -0.089$).

Similarly, the correlation results are in line with the findings of Kulshrestha *et al.* (1984) who reported that the population of *H. ganglbaueri* was negatively correlated with temperature ($r = -0.12$), relative humidity ($r = -0.39$) and rainfall ($r = -0.70$) on *T. vulgare* and positively correlated with relative humidity ($r = 0.47$) and rainfall ($r = 0.28$) on *O. sativa*. The findings of Charan (2014) on chrysanthemum, found that species of thrips *viz.*, *Frankliniella occidentalis* (Pergande), *Frankliniella schultzei* (Trybom) and *Thrips palmi* Karny were positively correlated with Maximum temperature ($r = 0.52$), minimum temperature ($r = 0.81$) and sunshine hours ($r = 0.49$). Maximum relative humidity ($r = -0.16$) and rainfall ($r = -0.31$) showed negatively non-significant correlation, whereas minimum relative humidity ($r = -0.56$) and evaporation ($r = -0.58$) showed negatively significant impact on thrips population. Similarly, the findings of Mohanlal (2006) observed that *Scirtothrips dorsalis* on rose had positive correlation with maximum temperature ($r = 0.57$), minimum temperature ($r = 0.04$) and sunshine hours ($r = 0.62$) and negative correlation with morning relative humidity ($r = -0.23$), evening relative humidity ($r = -0.30$), rainfall ($r = -0.72$), rainy days ($r = -0.69$) and wind speed ($r = -0.14$). In a similar way, Muraleedharan *et al.* (1982) found gall thrips, *G. bengalensis* had highly significant positive correlation with temperature ($r = 0.69^*$), maximum relative humidity ($r = 0.31$) and minimum relative humidity ($r = 0.47$).

The study on the seasonal abundance of thrips during March-2016 to April-2017 on various plant species from Southern dry zone (Mandya) of Karnataka has revealed the diverse species composition of thrips with their hosts and their abundance in different months throughout the study period. This study also revealed that few species of thrips were not present though their hosts plants were present in certain months. From this study it is observed that the peak population of thrips in certain months was favourable for their multiplication and in certain months there was

sudden fall in their number with unfavourable weather conditions. The thrips species *F. schultzei*, *G. bengalensis*, *H. ganglbaueri*, *H. gowdeyi*, *M. usitatus*, *M. abdominalis*, *S. dorsalis*, *T. florum* and *T. palmi* which are considered as commonly occurring pests whose infestation is said to be severe were observed maximum in number during summer which was in positive correlation with temperature. Hence the control measures to be taken mainly during high temperature to minimize the population and further spread of these thrips species to control the damage.

Additionally, under the correlation studies between thrips population and weather parameters, maximum temperature showed a positive effect on thrips population inhabiting plant species *viz.*, Chrysanthemum, *C. bipinnatus*, *F. benjamina*, *G. grandiflora* and Rose and negative correlation with thrips inhabiting plant species *viz.*, *C. sulphureus*, Marigold and Hibiscus. Morning relative humidity also had positive effect on the population of thrips associated with plant species *viz.*, *C. bipinnatus*, *F. benjamina*, Hibiscus and Marigold and had a significant negative correlation with thrips species found on Rose. Similarly, wind speed and rainfall had a positive effect on thrips population found on plant species *viz.*, *C. bipinnatus*, *C. sulphureus*, *F. benjamina*, Hibiscus and marigold and had a negative correlation with the thrips inhabiting chrysanthemum, *G. grandiflora* and Rose. These weather parameters can be kept in mind for the management of thrips populations on plants.

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