

**Studies on Population Dynamics and Spatial Distribution  
of Insect Pest Complex of Rose with special reference to  
sucking pests**

**Azhan Reyaz**  
(MSH-2018-196)



**Division of Entomology**  
**Faculty of Horticulture**  
**Sher-e-Kashmir University of Agricultural Sciences &  
Technology of Kashmir**

**2021**

**Studies on Population Dynamics and Spatial Distribution  
of Insect Pest Complex of Rose with special reference to  
sucking pests**

**Azhan Reyaz**  
(MSH-2018-196)



**Thesis**

Submitted to

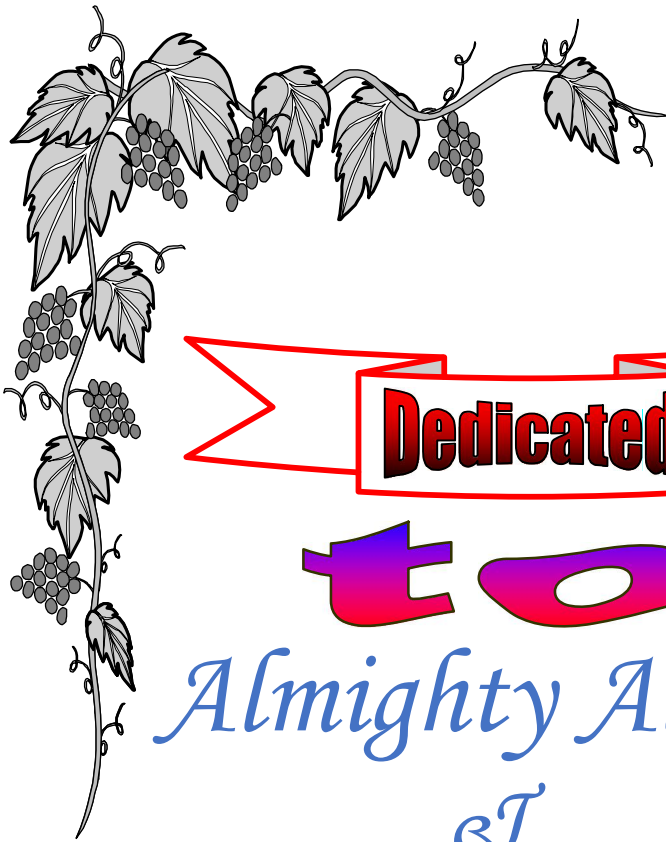
**The Faculty of Horticulture**

**Sher-e-Kashmir**

**University of Agricultural Sciences & Technology of Kashmir  
in partial fulfillment of requirements for the award of the degree of  
Master of Science in Horticulture**

**(Entomology)**

**2021**



**Dedicated**

**to**

*Almighty Allah  
&*

*Beloved Parents*



**Sher-e-Kashmir**  
**University of Agricultural Sciences & Technology of Kashmir**  
**Faculty of Horticulture, Division of Entomology**

**Certificate – I**

This is to certify that the thesis entitled, “**Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests**” submitted in partial fulfilment of the requirements for the award of the degree of **Master of Science in Horticulture (Entomology)**, to the **Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir** is a record of bonafide research work carried out by **Mr. Azhan Reyaz (Regd. No. MSH-2018-196)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that any help or information received during the course of investigation has duly been acknowledged.

**(Dr. Asma Sherwani)**  
Chairperson  
Advisory Committee

Endorsed

**Prof. & Head,**  
Division of Entomology

**Sher-e-Kashmir**  
**University of Agricultural Sciences & Technology of Kashmir**  
**Faculty of Horticulture, Division of Entomology**

**Certificate – II**

We, the members of the Advisory Committee of **Mr. Azhan Reyaz (Regd. No. MSH-2018-196)** a candidate for the degree of **Master of Science in Horticulture (Entomology)** have gone through the manuscript of the thesis entitled, “**Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests**” and recommend that it may be submitted by the student in partial fulfilment of the requirements for the award of the degree.

**Advisory Committee**

**Chairperson**

**Dr. Asma Sherwani**  
Assistant Professor,  
Division of Entomology, SKUAST-Kashmir

**Members**

**Dr. Malik Mukhtar**  
Assistant Professor,  
Division of Entomology, SKUAST-Kashmir

**Dr. Zahoor Ahmad Rather**  
Assistant Professor, Division of Floriculture and  
landscape Architecture, SKUAST-Kashmir

**Dr. M. S. Pukhta**  
Professor,  
Division of Agri-Statistics, SKUAST-Kashmir

**Dean’s Nominee**


**Dr. Zahoor Ahmad Bhat**  
Assistant Professor,  
Division of Plant Pathology, SKUAST-Kashmir

**Sher-e-Kashmir**  
**University of Agricultural Sciences & Technology of Kashmir**  
**Faculty of Horticulture, Division of Entomology**

**Certificate – III**

This is to certify that the thesis entitled, “**Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests**” submitted by **Mr. Azhan Reyaz (Regd. No. MSH-2018-196)** to the **Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir** in partial fulfilment of the requirements for the award of the degree of **Master of Science in Horticulture (Entomology)** was examined and approved by the Advisory Committee and External Examiner on **03-04-2021**

**Chairperson**  
Advisory Committee



**External Examiner**

**Dr. Hafeez Ahmad**  
Professor and Head  
Division of Entomology,  
SKUAST-Jammu

**Prof. & Head,**  
Division of Entomology

**Dean,**  
Faculty of Horticulture  
SKUAST-Kashmir

**Sher-e-Kashmir**  
**University of Agricultural Sciences & Technology of Kashmir**  
**Faculty of Horticulture, Division of Entomology**

Name of the student : **Azhan Reyaz**

Registration No. : MSH-2018-196

Major subject : Entomology

Minor subject : Floriculture

Major advisor : **Dr. Asma Sherwani**  
Assistant Professor,  
Division of Entomology,  
SKUAST-Kashmir

Title of the Thesis : **Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests**

**ABSTRACT**

The present investigation on “**Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests**” was conducted during 2019 at Shalimar and Ganderbal districts of Kashmir. Ten insect pests including one mite pest were recorded on rose. Thrips, aphid and mites were found to be major sucking pests causing huge damage to rose along with gypsy moth (mostly in polyhouse). Sucking pests were found to be severe both in field as well as in polyhouse damaging tender plant parts, reducing flower quality and yield. Matured flower and young shoots were preferred for sampling thrips, while for aphids calyx opened bud and young shoots were preferred by them, similarly for mites fully opened flower and matured shoots were favored by them. Incidence of thrips and aphids was found to be at peak during June to July. Temperature was positively correlated while as relative humidity, rainfall was negatively correlated with seasonal incidence of thrips and aphids. The mite incidence was found to be at peak during May – June. Temperature was positively correlated while as relative humidity, rainfalls were negatively correlated with seasonal incidence of mites. Seasonal incidence of rose thrips was influenced by weather parameters 82 to 93 % in field and 65 to 85 % at polyhouse, for aphids they were influenced by weather parameters 75 to 91 % in field and 77 to 82 at polyhouse. As far as mites are concerned they were influenced by weather parameters 69 to 71% in field and 46 to 57 % at polyhouse.

Rose varieties Virgo, Golden gate, Message, Arthur bell, Kiss of fire and American heritage were found promising. It was also found that varieties of light colored petals were less attractive to thrips, whereas varieties with red, pink and orange petals were found to be more susceptible. Rose varieties Superstar, Virgo, Bijazzo, American heritage, Golden gate and Kiss of fire were found promising against aphids and for mites rose varieties Virgo, Bijazzo, American heritage and Golden gate were found promising. Spiders, Syrphid flies and Lady Bird beetles were found predated on major sucking pest.

**Key words:** sucking pest, rose

Signature of Student

Dated: \_\_\_\_\_

Signature of Major Advisor

Dated: \_\_\_\_\_

## Acknowledgement

*I would like to express my deepest and most sincere gratitude to the Chairman of my Advisory Committee; Dr. Asma Sherwani, Assistant Professor (Entomology), SKAUST-K, who with her expertise, keen assistance, steady encouragement, valuable suggestions along with ardent interest, patient guidance and above all her positive attitude towards my abilities has helped me add significantly to the research plan; its execution and preparation of the manuscript. I feel exceedingly privileged and honoured to have worked under her as she provided me with direction, technical support and went above and beyond her role as my major Advisor to become a cherished friend and mentor.*

*It gives me great pleasure to place on record my profound sense of admiration to Dr. Malik Mukhtar, Assistant Professor, Division of Entomology, SKUAST -K Co-chairman of my Advisory Committee for his helpful suggestions and offered assistance during the entire course of investigation. I am indebted to him for numerous clarifications, valuable discussions and encouragement that helped me bring my work to a satisfying conclusion.*

*I am highly grateful for the constant and conscientious guidance, motivation, helpful suggestions and unremitting efforts of the other members of my Advisory Committee viz; Dr. Zahoor Ahmad Rather (Assistant Professor, Division of Floriculture), Dr. M. S. Pukhta (Professor, Division of Agri-Statistics) and Dr. Zahoor Ahmad Bhat (Assistant Professor, Division of Pathology, SKUAST-K).*

*I also thank Professor and the Head, Division of Entomology, Dr. G. M Lone for his consistent and emboldening support and constructive suggestions during the period of my research.*

*I am also much obliged to Dean, Faculty of Horticulture, SKUAST-K for boosting my morale and encouraging me. The wisdom they so graciously impart and their sustained efforts have helped to create a genial atmosphere for students of the University which proved to be of utmost help to me in executing this research endeavour.*

*I also wish to extend my earnest appreciation and heartfelt gratitude to all the teachers namely; Prof. Md. Jamal, Prof. A. A. Khan, Dr. S. S. Pathania, Dr. Manzar Ahmad, Dr. Muneer A. Sofi, Dr. Barkat Hussian for their effective*

*and constructive suggestions and constant uplifting encouragement that allowed me to improve my comprehension and has always inspired me to work harder.*

*The aid and assistance provided to me by the staff of Division of Entomology especially Mr. Naseer A. Bhat, Mr. Sajad A. Bakshi and Mr. Zahoor Ahmad is duly acknowledged.*

*With a deep sense of gratitude, I find myself fortunate enough to acknowledge and appreciate the heartfelt help and enthusiastic cooperation offered by my seniors Mr. Waseem, Ms Jasra Bano, Ms Irham and my batch mates: Ms Huzaifah, Ms Sana, Ms Rasheeba, Ms Atufa and Ms Tabeena.*

*I am grateful to mention Mr. Gulzar Ahmad Moti whose guidance and assistance in the experimental field has been unquestionably valuable and helpful.*

*I am undoubtedly indebted to Mr. Haris Wajeeli for his sincere, continued and consistent assistance along with his heartfelt and unwavering support every step of the way. I truly appreciate his presence and words along with the invaluable help he provided me during the course of this venture.*

*I also take this opportunity to convey my profound gratitude to my beloved parents: my father Mr. Reyaz Ahmad Khan—my mother, Mrs. Shaheena Khan, my precious grandparents: my grandfather Mr. G. M Khan—my grandmother, Mrs. Khadija Khan and my lovely sister—Ms Mahpara Khan for their prayers, deep consideration, warm love and care and their ceaseless encouragement and support. I would also like to thank my cousin—Mr. Arif Wani along with Mr. Javed and Mr. Imran for their indispensable and earnest help and sincere motivation.*

*I also acknowledge with thanks the assistance and cooperation extended to me during the study and research work by the staff of Central Library and C. D Room, SKAUST-Kashmir.*

*I am highly thankful to Mr. Shahid Sultan of M/s Shahid Thesis Point for composing this manuscript with utmost care.*

***Azhan Reyaz***

Place: Shalimar, Srinagar

Dated:

## CONTENTS

---

<b>Chapter</b>	<i>Particulars</i>	<b>Page No.</b>
1.	INTRODUCTION	1-5
2.	REVIEW OF LITERATURE	6-27
2.1	Conduct of survey to document the insect pest complex on rose under open and polyhouse conditions	6
2.2	To study the seasonal incidence of sucking pests on rose	12
2.3	To screen various rose cultivars against sucking pest damage under open conditions	21
3.	MATERIALS AND METHODS	28-40
3.1	Conduct of survey to document the insect pest complex on rose under field and polyhouse conditions	28
3.2	To study the seasonal incidence of sucking pests on rose	31
3.3	To screen various rose cultivars against the sucking pest damage under open Conditions	34
3.4	Statistical analysis	40
4.	EXPERIMENTAL FINDINGS	41-101
4.1	Conduct of survey to document the insect pest complex on rose under open and polyhouse conditions	41

4.2	To study the seasonal incidence of sucking pests on rose	70
4.3	To screen various rose cultivars against sucking pest damage under open conditions	96
5.	DISCUSSION	102-115
5.1	Conduct of survey to document the insect pest complex on rose under open and polyhouse conditions	102
5.2	To study the seasonal incidence of sucking pests on rose	108
5.3	To screen various rose cultivars against sucking pest damage under open conditions	113
6.	SUMMARY AND CONCLUSION	116-119
	LITERATURE CITED	<i>i-xiv</i>
	APPENDIX	

---

## LIST OF TABLES

Table No.	Particulars	Page No.
1	Varieties screened at agricultural experimental farm, Shalimar, during 2019	40
2	Insect and mite pests recorded on rose and their nature of damage, during the year 2019	44
3	Natural enemies recorded on different rose cultivars at all the locations under polyhouse and field conditions	45
4	Thrip ( <i>Scirtothrips dorsalis</i> ) density on different aged shoots/ floral group and plant canopy of rose under Standard Meteorological Week polyhouse at Shalimar, 2019	47
5	Aphid <i>Macrosiphum rosae</i> Linn density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar, 2019	49
6	Mite ( <i>Tetranychus urticae</i> (Koch)) density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar, 2019	51
7	Thrip ( <i>Scirtothrips dorsalis</i> ) density on different aged shoots/ floral group and plant canopy of rose under open condition at Shalimar, 2019	53
8	Aphid <i>Macrosiphum rosae</i> density on different aged shoots/ floral group and plant canopy of rose under open condition at Shalimar, 2019	55
9	Mite ( <i>Tetranychus urticae</i> (Koch)) density on different aged shoots/ floral group and plant canopy of rose under open condition at Shalimar, 2019	57
10	Thrip ( <i>Scirtothrips dorsalis</i> ) density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal, 2019	59
11	Aphid <i>Macrosiphum rosae</i> density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal, 2019	61

12	Mite ( <i>Tetranychus urticae</i> (Koch)) density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal, 2019	63
13	Thrip ( <i>Scirtothrips dorsalis</i> ) density on different aged shoots/ floral group and plant canopy of rose under open condition at Ganderbal, 2019	65
14	Aphid <i>Macrosiphum rosae</i> density on different aged shoots/ floral group and plant canopy of rose under open condition at Ganderbal, 2019	67
15	Mite ( <i>Tetranychus urticae</i> (Koch)) density on different aged shoots/ floral group and plant canopy of rose under open condition at Ganderbal, 2019	69
16	Seasonal Incidence of sucking pests on rose under polyhouse at Shalimar, 2019	73
17	Relationship between population of sucking pests and weather parameters under protected conditions in Shalimar, 2019	74
18	Seasonal Incidence of sucking pests on rose under field at Shalimar, 2019	78
19	Relationship between population of sucking pests and weather parameters under open conditions in Shalimar, 2019	79
20	Incidence and Severity index of Thrips under polyhouse and open conditions at Shalimar, 2019	80
21	Incidence and Severity index of aphids under polyhouse and open conditions at Shalimar, 2019	81
22	Incidence and Severity index of Mites under polyhouse and open conditions at Shalimar, 2019	82
23	Seasonal Incidence of sucking pests on rose under polyhouse at Ganderbal, 2019	86
24	Relationship between population of sucking pests and weather parameters under protected conditions in Ganderbal, 2019	87

25	Seasonal Incidence of sucking pests on rose under field at Ganderbal, 2019	91
26	Relationship between population of sucking pests and weather parameters under open conditions in Ganderbal, 2019	92
27	Incidence and Severity index of Thrips under polyhouse and open conditions at Ganderbal, 2019	93
28	Incidence and Severity index of Aphid under polyhouse and open conditions at Ganderbal, 2019	94
29	Incidence and Severity index of Mite under polyhouse and open conditions at Ganderbal, 2019	95
30	Varietal screening of rose cultivars against Thrip ( <i>Scirtothrips dorsalis</i> ) infestation during the year 2019	97
31	Varietal screening of rose cultivars against Aphid infestation during the year 2019	99
32	Varietal screening of rose cultivars against Mite ( <i>Tetranychus urticae</i> (Koch)) infestation during the year 2019	101

.....

## LIST OF FIGURES

---

<b>Fig. No.</b>	<b>Particulars</b>	<b>After page No.</b>
1	Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar	47
2	Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar	49
3	Relation between total mites and different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar	51
4	Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under field at Shalimar	53
5	Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under field at Shalimar	55
6	Relation between total mites and different aged shoots/ floral group and plant canopy of rose under field at Shalimar	57
7	Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal	59
8	Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal	61
9	Relation between total mites and different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal	63

---

10	Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under field at Ganderbal	65
11	Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under field at Ganderbal	67
12	Relation between total mites and different aged shoots/ floral group and plant canopy of rose under field at Ganderbal	69
13	Seasonal incidence of major sucking pests on rose under protected condition at Shalimar during the year 2019	74
14	Seasonal incidence of major sucking pests on rose under open condition at Shalimar during the year 2019	79
15	Seasonal incidence of major sucking pests on rose under protected condition at Ganderbal during the year 2019	87
16	Seasonal incidence of major sucking pests on rose under open condition at Ganderbal during the year 2019	92

---

## LIST OF PLATES

---

Plate No.	Particulars	After page No.
1	General view of experimental field	30
2	Collection of insects using light traps	30
3	Thrip damage on different parts of rose plant	33
4	<i>Macrosiphum rosae</i> (Pink morph) on different parts of rose plant	33
5	<i>Macrosiphum rosae</i> (Green morph) on different parts of rose plant	36
6	<i>Tetranychus urticae</i> on different parts of rose plant	36
7	Gypsy Moth on rose Plant	37
8	Slug sawfly and crane fly on rose Plant	37
9	Weevil and flea beetle recorded on rose plant	38
10	White fly and butterfly (Entomofauna) on rose plant	38
11	Natural enemies recorded on rose Plant	40

---

## Chapter-1

### INTRODUCTION

Rose (*Rosa hybrida* L), a member of family rosaceae is considered one of the important flower shrubs in India and other countries. Admired for their exquisite beauty and aromatic blooms, roses have been fostered for centuries in gardens as vines, shrubs, and specimen plants. The etymology suggests that the name *rose* is derived from “Eros”—the Roman God of Love. The importance of rose is also evident from its mention in Sanskrit literature, where it has been addressed by different names such as “Tarunipushpa”, “Atimanjula” and “Simantika”.

There are almost 120 (one-hundred and twenty) species, in genus *Rosa* among which only eight are cultivated which can be stated as follows: *Rosa damascena*, *R. foetida*, *R. chinensis*, *R. gallica*, *R. gigantea*, *R. moschata*, *R. multiflora* and *R. wichuraiana*. Garden Roses are usually categorized as: Hybrid Teas, Floribundas, Gladiator, Grandifloras, Polyanthas, Miniatures, Climbers, Ramblers, etc. Grand gala, Sweet Heart, Super Star, First Red, Vivaldi, etc., are the most popular and widely grown varieties in India (Pal, 1972). Rose, mostly native to Asia is unanimously acclaimed as the Queen of flowers and is undoubtedly one of the most stunning of nature’s creations. Since the ancient times, rose has symbolized love, adoration, innocence and several other passionate expressions and has a number of origin myths and legends to its credit from Greek legends to Hindu Mythology. Of all the cut flowers, it is by far the most famous and acclaimed cut flower throughout the world. It occupies the first position in the International market of cut flowers. Rose cultivation is becoming more and more favoured in India because of the boost in its demand as cut flower and consequently higher commercial gains. There are about 150 recognized species which were identified and are all indigenous to the temperate regions of the Northern hemisphere. In India, there are eleven species reportedly found to be

growing in the wild viz, *Rosa brunonii* (Himalayan Musk Rose), *R. eglanteria* (Austrian Rose), *R. involucrate* (*R. sempervirens*), *R. leschenaultiana* (*R. sempervirens*), *R. longicuspis*, *R. macrophylla*, *R. moschata* (Musk Rose), *R. rubiginosa* (Sweet Briar), *R. walpoleana*, *R. sericea* (Ladakh Rose) and *R. multiflora*. The climatic conditions of Jammu and Kashmir are quite affable for its “off season” flower production. The major producers of cut rose flowers are Netherlands (70% share in the world export market), followed by Colombia (12%), Israel (6%) and Italy (8%) (Manjula, 2005). In India, Rose ranks first in the export trade worth 178.60 million dollars in international market.

The great demand for Rose cut flowers is predominantly from the Western market during winter months. European countries, Japan, Australia, South East Asian countries are major importers from India. Much of the area under cut flower production in Northern India is concentrated around Delhi and they produce cut flowers in winter from November to March. In the South, rose flowers are expansively grown for domestic purpose and export market in and around Bangalore. In Karnataka, rose is fostered in about 1815 hectares. In the Western region, extensive export oriented cut flower cultivation is taken up in Pune, Nasik and Sangli districts of Maharashtra. The demand for roses in the local market is attributed to their utility for the purpose of worship, garland making, floral arrangement and bouquets. Gulab oil extracted from the roses has both aromatic and medicinal value. As such it is used in ayurvedic medicine, perfumery, cosmetics, carbonated drinks and beverages. Rose water also finds its application in medicine and confectionery for the reason it is used in flavouring wines, jams, jellies and syrups (Bose and Yadav, 1989).

In India, protected cultivation of Rose was taken up on a commercial scale in the early 1990s when the government of India realized its commercial potential. India has, in view of its good soil, water availability, favourable weather in many places like Bangalore, Pune and others, encouraged the production of Roses in polyhouses/greenhouses for export by announcing several subsidies/incentives

(Reddy and Nagaraju, 2004). Rose is attributed for having a great commercial value as a cut flower due to its superb keeping quality, flower shape, flower fragrance, steady opening of buds wide array of colours and forms. The cumulative fruit of Rose is a berry- like structure called rose hip which is rich in vitamin C.

The demand for flowers in the market has up surged due to the awareness of the use of cut flowers for various occasions. Due to the improvement in the standard of living and quality of life, the production of cut flowers has gone up from 2,071 million stems (Anonymous, 2007) to 6,667 million stems (Anonymous, 2011) and that gradually influences the increase in the growth of domestic and export markets (Naqvi, 2011). An area of 2.48 lakh hectares is used for growing traditional flowers from where a production of 16.58 lakh tonnes is observed for loose flowers and a yield of 4.84 lakh tonnes is observed for cut flowers (Anonymous, 2015) in India (Janakiram, 2018). The area under Rose production in India is 29.41 thousand hectare (Anonymous, 2015-16) with total production of rose being 301.95 thousand MT (Anonymous, 2015-16). The export from India to various countries was 0.03 thousand MT, worth about 141.45 lakh rupees (Anonymous, 2016-17). Rose cultivation in protected conditions has gained prominence in recent years owing to its high export value. In polyhouses, Rose is highly affected by sucking pests. Among them, the spider mites, *Tetranychus* spp. takes the major share in reducing the flower yield. These mites expansively web the top, fresh growth of leaves and unopened flower buds. The infested leaves exhibit a burnt appearance and high leaf-fall. The severe infestation of mites causes partial opening of flower buds and infested flower petals lose their brightness resulting in a direct loss to the grower. Mites cause about 53 per-cent damage on rose plants with webbed top canopy (Dhooria, 1999). Different parts of rose plant are vulnerable to a large number of insects at varied stages of growth. Thrips are the most recurring pests of rose. Most of the aforementioned pests are found round the year which ruins the rose plants and

decline the overall yield. Furthermore the sucking pests namely thrips, aphids, whitefly and mites are regarded as the key pests of rose. They are found in clusters and in large numbers under leaf surface, stems, flowers and buds throughout the year in field and polyhouse (Ayyar, 1963).

Of all the sucking pests, thrips are among the crucial pests of roses. Twelve species of thrips have been recorded from polyhouse. *Scirtothrips dorsalis*, Hood is a major pest of rose (Ananthkrishnan and Jagdish, 1968; Nair *et al.*, 1991; Onkarappa and Malik, 1998). *Rhipiphorothrips cruentatus* Hood, *Scirtothrips dorsalis* Hood, *Retithrips syriacus* (Mayet), *Thrips flavus* Schrank, *Frankliniella schultzei* (Trybom) and *Thrips tabaci* Lindeman are the thrips recorded infesting the leaves and flowers of rose (Dash and Naik, 1998). The larvae and adults of *S. dorsalis* cause havoc to the flower at all stages of its growth and development (Murugan, 2000). *S. dorsalis* has a capacity to cause deterioration ranging from 28 - 95 percent if found above economic threshold level (11-33 thrips/flower). (Gahukar, 2003). Rose Aphid *Macrosiphum Rosae* (Aphididae: Hemiptera) likely found on new shoots and buds, they are most active during the season of spring and summer when they reproduce at unexceptionally high rate by feeding on the sap of the plant through a proboscis. Rose mites *Tetranychus* Spp. (Tetranychidae: Acari), usually appear on the underside of leaves but move to the upper side as population increases and may cause leaves to dry up and fall off (Thanlass *et al.*, 2017). Due to the extensive demand and use of rose by humans, the crop needs to be managed with less pollutant chemicals. It is imperative to know the different insect pest complex of rose both in open field and polyhouse; no systematic research has been done on these aspects. Also the thrips especially *S. dorsalis* are gaining importance both in open field and polyhouse. The strategic importance of Kashmir for nurturing of off-season rose blooms for national and international market and the rising significance being attached to flower production in the state require production of quality blooms able to compete in national and global market. Since pest infestation diminish the

quality of blooms and scanty information on pest fauna of rose in Kashmir is available, studies have been conducted to assess the rose both in open field and polyhouse conditions. Keeping in view the above facts, the present investigation on “Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests” was undertaken with the following objectives:

1. Conduct of survey to document the insect pest complex on rose under open and polyhouse conditions.
2. To study the seasonal incidence of sucking pests on rose.
3. To screen various Rose cultivars against sucking pest damage under open conditions.

## Chapter -2

### REVIEW OF LITERATURE

The current status and future prospects for raising rose flower production necessitate an in-depth study on the insect pest complex of rose. Therefore, a study with the purpose to review and record insect pest complex, seasonal incidence of sucking pests both in polyhouse and field and varietal screening in field conditions was taken into consideration. The available literature about the previously mentioned aspects on rose and related crops has been appraised and is included in this chapter.

#### **2.1 Conduct of survey to document the insect pest complex on rose under open and polyhouse conditions**

##### **2.1.1 Insect pests of Rose**

Tussock caterpillars, *Euproctis fraterna* Moore; *Euproctis scintillans* Walker; slug caterpillar, *Latoia lepida* Cramer; Castor semilooper, *Achoea janata* Linnaeus; crab caterpillar, *Stauropus alternus* Walker; grape vine thrips, *Rhipiphorothrips cruentatus* Hood, orange scale, *Aonidiella aurantii* Maskell, rose chaffer beetles, *Oxycetonia versicolor* Fabricius, *Adoretus versutus* Har., Leaf cutter bee, *Megachile anthracina* Walker; rose aphid, *Macrosiphum rosaeiformis* Linnaeus and stem girdler, *Sthenias grissator* Fabricius have been observed to damage the rose during different stages of the plant growth (Ayyar, 1963).

Dev (1964) observed that thrips caused damage to buds, young leaves, tender stems and intermittently to older leaves. The insect pierced by driving the stylets into the tender tissues and sucked up the sap escaping through the wound. It then moved a little and repeated the operation. The injurious tissues harden and turn brownish. Due to recurring feeding, more or less unbroken lines and wound marks appeared on the buds as 'sand papery lines' lying on the epidermis of the leaves.

Ananthkrishnan (1971); Patnaik and Mohapatra (1997); Jaganmohan *et al.* (1980) detailed that *S. dorsalis* (Thysanoptera: Thripidae) was a serious pest of chilli, brinjal, groundnut, rose and other economically important crops in India.

Nair (1975) reported white fly, *Aleurocanthus rosae* Singh and *A.spiniferus* Q. damaged the rose by sucking the sap.

Puttarudriah (1977) reported rose leafhopper, *Typhlocyba rosea* Moore; termite, *Odentotermes obesus* (Rambur); whitefly, *Trialeurodes vaporariorum* (Westwood) and spider mite, *Tetranychus telarius* Linneaus to be damaging different parts of rose plant.

Bene and Garnai (1990) reported that the thrips, *Frankliniella occidentalis* Pergande damaged the rose plant by sucking the sap from tender shoots and flowers.

Nair *et al.* (1991) observed that thrip feeding on the sap of tender leaves, flower buds and growing tips which resulted in elongated brownish lesions. In severe infestations, marginal upward curling and severe crinkling of the leaves could be seen which led to brittleness of the leaves. Buds when infected with thrips failed to open and in case of severe infestations, buds and calyx exhibited dark coloured lesions. While in mature buds brownish patches were seen on the outer petals and the flower which bloomed after the feeding of the thrips showed distorted petals.

Reddy (1997) recorded twenty-nine species of pests on rose which included eleven sucking pests of the order Hemiptera and Thysanoptera, two flower feeders of Coleoptera, three foliage feeders of Coleoptera and Lepidoptera, two stem borers of Hymenoptera, one bark feeder of Isoptera and a mite pest of Acarina. The majority of the insects were found to be present on rose from August to November. The main pests were aphids, thrips, scales, chafer beetles and lepidopteran caterpillars. The thrip, *S. dorsalis* damaged both flower buds and leaves resulting in crinkled, malformed and brittle leaves and deformation of

petals. It was extreme during the months of February to May 1996. The scale insect, *Aonidiella aurantii* Mask was found to be stationary but sucked plant sap resulting in yellowing and drying of infested portions. They were present in large numbers during summer. The two spotted spider mite *Tetranychus urticae* Koch was severe during December.

Reddy (1997) also observed that the foliage feeders, *Mylocerus discolor* Boh. and *Megachile* sp. was seen during September-October 1996. The rose chafer beetle, *Adoretus* sp. and *Oxycetonia versicolor* F. were abundant from June-August. The caterpillars of *Euproctis* sp. *Achaea janata* L. and *Helicoverpa armigera* (Hubner) spoiled leaves and flowers. The stem borer wasp, *Ceratina hieroglyphica* Smith pressed into the cut ends of rose branches. Its infestation was very extreme after pruning. The aphid population was found to be fluctuating throughout the year and the population was less during summer and higher during autumn.

Reddy (1997) found *S. dorsalis* infestation on both flower buds and leaves which resulted in crinkled, malformed, brittle leaves and deformed petals. It was high from Feb to May 1996.

Hole and Salunkhe (1997) reported that the pest upsurge of rose aphid, *Macrosiphum rosae* L. started in the third week of January, enlarged steadily reaching its peak (149.2 aphids per shoot) in the fourth week of February and declined subsequently in Maharashtra, India.

Wenjer (1997) recorded five species of thrips viz, *Frankliniella intonsa* (Trybom), *Scirtothrips dorsalis*, *Haplothrips chinensis* (*chinensis*), *Thrips hawaiiensis* (Morgan) and *Rhipiphorothrips cruentatus* Hood on the Rose in mid west part of Taiwan.

Onkarappa and Malik (1998) observed that *S. dorsalis* was one of the major pests of chilli, grapes and rose in India. The serious malformation of the rose leaves and flowers due to the attack of *S. dorsalis* reduced its market value.

Gahukar (1999) reported that two species of thrips, *S. dorsalis* and *Thrips flavus* Schrank were recorded for the first time as major pests on rose in central India.

Jhansi-Rani and Reddy (2001) reported that the rose grown under polyhouse, chiefly for export, was damaged by a number of pests. Chilli thrips, *S. dorsalis* Hood (Thysanoptera: Thripidae) was one of the destructive pests of rose under this setting.

Gahukar (2003) reported that influx of *S. dorsalis* at bud, half opened and fully opened flower, resulted in poor quality flowers, distressing its market value. It was reported to cause 28-95% damage with a density of 11-33 thrips/ flower.

Rajkumar *et al.* (2004) observed *Frankliniella schultzei* (Trybone) (80% on flowers), *Scirtothrips dorsalis* (80% on leaves), *Haplothrips ganglabaueri* (Schmutz) (15% in flowers) and *Thrips palmi* (5% in flowers and 20% in leaves) infesting roses.

Murugan and Jagadish (2004) worked between the three strategies looked at for performing percent efficiency estimates, better adequacy was measured for the liquid detergent method (84.13, 85.47 and 85.04%), trailed by beating method (82.08, 80.68 and 80.94%) for eradication of adults, larvae and overall population of thrips from rose flowers. The percentage of effectiveness for elimination of adult, larvae and total population of thrips at the sampling time was high on harvestable blossoms (79.44, 79.32 and 79.21%) and fully opened flowers (77.0, 75.73 and 75.78%). A progressed effectiveness of extraction of thrips for beating and liquid detergent methods for harvestable and fully opened flowers was observed due to the interaction effect between the technique for extraction and the phases of blossoms. Thus, the study disclosed that the ideal bloom stage for thrip sampling is that of harvestable bloom. As far as the extraction of the thrips is concerned, the liquid detergent and beating methods were at a similar level. However, as far as ease of use and swifter outcomes were concerned, beating

strategy was suggested as the idyllic technique for determination of thrips inside the rose flowers.

Matsui *et al.* (2006) reported *Heliocoverpa armigera* (Hubner) as a pest of rose. The larva attacked the roses from calyx and diminished the ornamental worth of the flowers.

Guihong *et al.* (2007) reported thrip species on five types of flowers: carnation, rose, gypsophila, lily and calla in Dounan, Chenggong county of Yunnan province, China. A total of 384 thrips specimens were collected and prepared on slide, and 6 thrips species were identified. *Aeolothrips fasciatus* (Linnaeus), *Frankliniella occidentalis* (Pergande), *Frankliniella intonsa* (Trybom), *Thrips flavus* Schrank, *T. hawaiiensis* Hackman and *T. tabaci* Lindeman, *F. occidentalis* and *F. intonsa* were the predominant thrips species on the flowers. These thrips were observed in every greenhouse when the harm was serious. The results of field investigation pointed that thrips arose around all seasons a year and the occurrence period ranged from April to July but the thrip population decreased from August.

Kmiec (2007) conducted studies on various kinds of roses and reported the occurrence of *M. rosae* from distinct utility groups. Among all the groups, *M. rosae* was recorded annually on the roses of each group and at each site. In April, the first individuals emerged on the inspected shrubs and colonies were observed on the plants even in the month of December. The summer vanishing of the colonies in each year of the examinations was monitored on the species of wild roses (salt sprays and multi-flowered ones) whereas aphids were observed to remain round the year on noble roses (particularly the park rose).

Bhuyan *et al.* (2008) recorded that three species of scarab beetles, *Amorites dorsalis* Fabricius, *Apogonia ferruginea* Fabricius and *Adoretus pallens* Blanchard attacked and damaged rose plants in Assam; the grubs struck the root system of the plant. The beetles were positively phototactic and emerged at night

and feed on the leaves of rose plant by making some holes and the brutal infestation lead to complete plant defoliation.

Mehrpavar *et al.* (2008) recorded that rose aphid; *M. rosae* was the most central pest of rose that caused major economic damage annually. For rose aphid, the seasonal fluctuations demonstrated two peaks in a year corresponding to the months of May and December and the activity of the rose aphid in spring was seen relative to the rapid growth and tenderness of the rose foliage.

Sredkov (2008) reported that rose chafer (*Cetonia aurata* L.) is a pest on fruit crops, mainly cherries, pears, grapes and roses.

Suris and Gonzalez (2008) reported that in a sample collection on various crops, the highest numbers of thrip species were found to be present on rose and cajigal crops.

ZhiMin *et al.* (2009) examined population amount of western flower thrips on rose, the amount of *F. occidentalis* had obvious inconsistencies in different times. The cumulative indices and Iwao regression method were used to test the spatial pattern of *F. occidentalis* in the field. Each index showed that the spatial pattern of *F. occidentalis* in rose fields was aggregate. The reason for this was their own behaviour or the effect of the combination of the behaviour and environmentally incongruent natures.

Sood (2010) worked on the survey of insect pests under protected conditions in India and recorded about 20 insect species. During the Study aphids (*Myzus persicae* and *Aphis gossypii*) were found more prevalent over other recorded insect pests.

Vashisth *et al.* (2013) conducted study in four districts of Himachal Pradesh, covering 82 poly-houses to ascertain the insect-pest problems associated with capsicum, tomato, cucumber, pea, Cole crops, carnation, rose, etc. Eight species of insects, *i.e.* *Trialeurodes vaporariorum* (Westwood), *Myzus persicae* (Sulzer), *Spodoptera litura* (F.), *Helicoverpa armigera* (Hübner), *Plutella*

*xylostella* (L.), *Liriomyza rifolii* (Burgess), *Thrips tabaci* (Lindeman) and *Frankliniella* sp. were commonly observed in poly-houses but their population remained low.

Onkara-Naik and Sridhar (2015), revised and analysed distinct colour sticky traps for observing chilli thrips, *Scirtothrips dorsalis* Hood on rose under open and protected conditions. Amongst the colour traps used, blue attracted highest number of *S. Dorsalis* adults which was followed by yellow and pink.

Hegde *et al.* (2017) reported that amongst the distinctive plant factors viz. young shoot, matured shoot, old shoot, unopened bud, calyx opened bud, matured flower, fully opened flower examined to sample thrip population in upper, middle and lower canopies, matured flower and young shoot ( $r = 0.96$  and  $0.90$ , respectively) were the plant parts that were ideal for sampling of thrips. In polyhouse, fully opened flowers had greatest positive relationship ( $r = 0.94$ ) as opposed to mature flower ( $r=0.92$ ).it was also indicated by the regression analysis that matured flower and young shoot were the best model of the thrip density and were a trustworthy sampling unit. In this way while sampling for thrips, matured flowers are the most predictable parameter. However, during non-flowering time, young shoots can be taken for counting thrips effectively.

## **2.2 To study the seasonal incidence of sucking pests on rose**

### **2.2.1 Seasonal Incidence of thrips on rose**

Ayyar *et al.* (1935) observed that thrip population was low in rainy season in Guntur (Andhra Pradesh) and Periyakulam (Tamil Nadu).

Dev (1964) noticed that *S. dorsalis* occurred almost throughout the year and reached the peak during May. With the onset of Monsoon, thrip population reached the lowest level and the pest survived in smallest numbers from August to October; the thrips practically disappeared during cold weather.

Raizada (1965) observed that thrips peak during spring and early summer; however, the damage was low in July-September with the beginning of rains. But the action started again in October causing critical damage.

Vevai (1969) reported that *S. dorsalis* was seen to occur more during October in Andhra Pradesh, February to March in Bihar, August to November in Delhi, Mysore and Madhya Pradesh and all through the year in Tamil Nadu and Maharashtra.

In Karnataka, the pest was seen to be present almost all the way through the year on chilli. The population reached its zenith during October and subsequently declined from November upto May (Ningappa, 1972).

Rangarajan *et al.* (1975) also observed that the thrips appeared in summer and winter in Tamil Nadu.

Senapati and Mohanty (1980) noticed *S. dorsalis* throughout the year in Orissa with higher populations during January- March with a peak in the first week of March.

Lee and Wen (1982) observed increased population of *S. dorsalis* in dry season in Taiwan.

Okada and Kudo (1982) observed minimum adult activity from the middle of December to mid March in Kenya (Japan) but some adults were active on tea grown all through the winter.

Borthakur (1984) observed peak incidence of the pest from July to August on tea in the North-eastern states of India.

Sanap *et al.* (1985) reported that population of the thrips in the first week of August in Maharashtra rose steadily till September and declined thereafter.

Velayudhan *et al.* (1985) reported that the temperature and rainfall had a significant impact not only on numerical strength of thrips but also on

reproductive ability and population. Higher temperature and rainfall caused dramatic decline in population during May-June and November- December.

Patnaik *et al.* (1986) reported that thrip population remained very low from August to December on chilli and a steady rise in the pest population was recorded from December with its peak during January, after which the population declined. Studies on the influence of climate revealed that temperature, precipitation and relative humidity were found to have a negative correlation with population of thrips, however, diurnal temperature difference was found to have a positive correlation.

Borah (1987) reported *S. dorsalis* to be active throughout the year.

Sakakibara and Nishigaki (1988) reported that larvae of *S. dorsalis* occurred from May to mid November, and adults were most abundant in July when the total young leaves in the orchard were the highest.

Reddy (1997) reported that the population of *S. dorsalis* on rose was very severe during the summer season and reached peak during April.

Park-Jong-Dae *et al.* (2002) reported that the occurrence of *F. occidentalis* was first observed in polyhouse initially in April which climbed till May with greatest densities during June.

loyd (2003) while studying the seasonal population dynamics of western flower thrips (*Frankliniella occidentalis*) by using blue coloured sticky traps on cut carnation in greenhouse condition recorded the highest population of pest from May to September and lowest from November to March.

Gahukar (2003) reported that rose thrips, *S. dorsalis* and *Thrips flavus* Schrank were found high during January to March and were low during May to July. The infested flowers were in the order of 14-88, 28-95 and 37-52 per cent during 1996, 1997 and 1998, respectively under field condition.

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. The severe infestation occurred from February-May. The increase in temperature during summer season favored the development and multiplication of the pest. The population declined from June with the onset of rains, but the activity was resumed in November.

Murugan and Jagadish (2004) also reported that incidence having maximum temperature was significantly and positively correlated with the incidence of *S. dorsalis* on rose and the incidence was found to have a negative correlation with mean relative humidity. It was also observed that the incidence had a positive correlation with minimum temperature and negative correlation with overall precipitation, though it was non-significant.

Guihong *et al.* (2007) reported that occurrence period of different thrip species ranged from April to July on rose and other flowers. Thrip population decreased from August along with the decline of temperature.

Yamaguchi (2007) reported that *Scirtothrips dorsalis* was regularly found on flower buds, inflorescence and young fruits of mango plants cultivated in greenhouses in Amami- Oshima Island in Japan.

Kumar *et al.* (2012) provided 0-9 damage score for sucking pests as per the Standard Evaluation Score (SES) and reported the maximum incidence of thrips was in first fortnight of August in Mysore mallige; while minimum in Ratnachudi during October first fortnight.

Gupta (2016) studied the seasonal incidence of insect pest complex on capsicum and observed the pest incidence of thrips (*Scirtothrips dorsalis*) during last week of April as 6.93 thrips/3 leaves.

Chauhan *et al.* (2017) studied the seasonal incidence of sucking pests of BT cotton and observed that the sucking pest thrips invaded the crop between the third weeks of July to second week of August and continued throughout the crop season.

Sathyan *et al.* (2017) studied the seasonal incidence of thrips and recorded peak population of thrips during January to March. They also found that the thrips population was negatively correlated with rainfall and morning relative humidity whereas, positively correlated with sunshine hours. They further attributed rainfall as the deciding factor in lowering the population of thrips.

Kiran *et al.* (2017) reported the occurrence of crucial pests of crop jasmine and found that thirteen species of pests were causing harm to it. From India, the first report infesting jasmine was Banana flower thrips (*Thrips florum*) amongst these insect pests.

Thanlass-Norboo *et al.* (2017) examined the seasonal incidence of *Scirtothrips dorsalis* on rose and observed the maximum number of thrips in the 48<sup>th</sup> standard week to be 13.98 thrips/leaf/plant. It was also revealed that the thrips population was found out to be in negative correlation with the mean maximum temperature and relative humidity ( $r = -0.112$  and  $-0.046$ ).

Moanaro and Choudhary (2018) considered the seasonal incidence of thrips in capsicum. The pest incidence started from second to third week of September and attained the peak in the month of October. Further, the correlation analysis between thrips population and weather parameters was investigated which revealed that there was a negative correlation between the rainfall and the number of thrips.

Suman Sanjta *et al.* (2018) surveyed for the occurrence of various species of thrips in different ornamentals under mid-hill conditions of Himachal Pradesh and reported nearly twenty six species of thrips. Out of those species, *Thrips tabaci* and *Thrips flavus* dominated all other species by contributing 10 and 18.33 per cent, respectively.

### **2.2.2 Seasonal incidence of aphids on rose**

Hole and Salunkhe (1997) reported that the pest build up of rose aphid, *Macrosiphum rosae* L. started in the third week of January in Pune, increased

gradually reaching its peak (149.2 aphids per shoot) in the fourth week of February and declined thereafter in Maharashtra, India.

Dattatraya (2007) surveyed the insect pests correlated with five major flower crops specifically; chrysanthemum, gaillardia, gerbera, rose and spider lily and revealed that the incidence of aphids was the principal in all the five major flower crops. They also observed the main activity period of aphid (*Macrosiphoniella sanborni*), period from November to March and peak throughout January month.

Pal and Sarkar (2009) appraised the diversity of sucking pests infesting the ornamental plants and observed number of aphid species associated with different ornamental plants causing severe damage to carnation, gerbera and chrysanthemum during dry summer months.

Pal and Sarkar (2010) evaluated the reaction of ten different germplasm of carnation against the main pests and recognized eight different pests attacking the crop during various growth stages. Surrounded by the pests, green peach aphid (*Myzus Persicae*) was found as key pest causing serious damage to the crop mainly during April-May. They also found that the germplasm tested displayed great variation in their reaction to different pests of carnation. The germplasm lines i.e. Acc. No. 19, Danubio, Athletic Schubert and Lolita were found least liable to green peach aphid, *Myzus Persicae* (<3 aphids/apical twig).

Pritesh-Patel (2015) studied the seasonal incidence of aphid in gerbera and the population was found all through the year and attained peak during the month of December.

Gupta (2016) studied the seasonal incidence of insect pest complex on capsicum and observed that the aphid (*Aphis gossypi*) incidence was at peak during the last week of April and first week of May (3.07 aphids/3 leaves).

Chauhan *et al.* (2017) studied the seasonal incidence of sucking pests of BT cotton. Among the sucking pests aphid attacked from the third week of July to second week of August and continued right way through the crop season.

Yadav *et al.* (2017) Studied on the seasonal incidence of aphid, *Myzus persicae* (Sulzer) on cumin (*Cuminum cyminum*). Towards the end of December the frequency of aphid began and increased to reach its top in the end of January and gradually declined thereafter. Further, they found the correlation analysis between aphid and weather parameters which revealed that significant negative correlation between infestation of aphid with maximum temperature whereas, morning relative humidity showed positive significant correlation.

Dhandge *et al.* (2018) studied the seasonal incidence of sucking pests on okra. The peak population of aphid (17.8 aphids/3 leaves) was observed at 16th standard meteorological week. There was positive correlation between pest population with maximum temperature, minimum temperature, morning relative humidity and bright sunshine. Only evening relative humidity was negatively correlated.

### **2.2.3 Seasonal incidence of mites on rose**

Butani (1974) reported the incidence of *Tetranychus urticae* (Koch) on rose and observed September to January as the active period for mites on rose which later started declining till April due to excess heat.

Shereef *et al.* (1980) noticed that rose was overrun mainly by *Oligonychus mangiferus* and *Tetranychus urticae*, of which the *T. urticae* was outweighed and had its summit in September.

Sudharma *et al.* (1995) recorded severe influx of *T. urticae* on rose which was found along with *T. ludeni*. They noticed two peaks of *T. urticae* in a year with the first peak during October to November and the other throughout February to May. The highest population of 45-60 mites per leaf was recorded during peak population.

Hole and Salunkhe (1997) observed that the population of *T. urticae* increased gradually from February and reached peak in March (69.65 mites/plant) and went down subsequently. They also observed that population trend was found certainly and considerably correlated with maximum temperature and relative humidity.

Dhooria (1999) recorded that infestation of mites *T. urticae*, *T. cinnabarinus*, *Brevipalpus phoenicis* Geijskes and *Oligonychus* spp. was noticed on field roses during April to June, March to November, February to June and May to June, respectively in minor proportions.

Rajkumar (2003) studied the seasonal incidence of red spider mite, *Tetranychus urticae* on jasmine and reported that the higher incidence of mites was observed from March to May due to absence of rain with continuous dry weather. No population was noticed in 32<sup>nd</sup>, 38<sup>th</sup> and 42<sup>nd</sup> weeks due to occurrence of heavy rain.

Dhananjaya (2007) observed population of mite, *Tetranychus urticae* building up from first fortnight of September and increased its peak during December-January in rose under polyhouse condition. Again increased from April and reached a peak during second fortnight of May due to high temperature. During June-August, the incidence of mite population was low due to low temperature.

Pal and Sarkar (2009) studied the diversity of sucking pests infesting ornamental plants and observed the non-insect pests like red spider mite and *Tetranychus urticae* reported to cause havoc to carnation, gerbera and chrysanthemum during dry summer months.

Pal and Sarkar (2010) observed the pests infesting spray type carnation and evaluated the reaction of ten different germplasm against main pests and recognized the two spotted spider mite (*Tetranychus urticae* Koch) as major pest inflicting serious damage to the crop especially during warm summer months of

April-May coinciding with the flowering stage. More number of mites were observed on buds/flowers as compared to the leaves. The germplasm Acc. No. 19 and Athletic Schubert were found to have the lowest propensity to red spider mite infestation.

Gupta (2016) studied the seasonal incidence of insect pest complex on capsicum and observed that the mite (*Polypaghotarsonemus latus*) was present throughout the year and peak during third week of May (11.8 mites/3 leaves).

Sathyan *et al.* (2017) observed the seasonal incidence of red spider mite and recorded peak population during March to April. It was also observed that there exhibited a negative correlation between the mite population with that of the rainfall and morning relative humidity whereas, a positive correlation of the mite population with sunshine hours was also reported. Minimum temperature was found to influence the mite incidence positively.

Kiran *et al.* (2017) studied the seasonal incidence of mites on jasmine and observed that red spider mite (*Tetranychus* sp.) suck the sap from jasmine leaves.

Thanlass *et al.* (2017) observed that in the 14<sup>th</sup> standard week, the incidence of red spider mite was reported to be 14.40 mites/leaf/plant which reached to its maximum of 27.50 mites/leaf/plant during the 12<sup>th</sup> standard week. There was a positive and highly significant effect on thrips population with the mean maximum and minimum temperatures ( $r = 0.721$  and  $r = 0.768$ ). On the other hand, rainfall, minimum temperature and relative humidity (evening) were found to be negatively and highly significantly correlated with the mite population.

Moanaro and Choudhary (2018) reviewed the seasonal incidence of mites in capsicum. Mite incidence became evident from second to third week of September and attained its peak in the month of October. Further, they investigated those mites manifested a positively significant correlation with temperature and relative humidity ( $P > 0.01$ ), yet exhibited a non-significant negative correlation with rainfall.

#### **2.2.4 Seasonal incidence of whitefly on rose**

Kedar *et al.* (2015) studied the seasonal incidence of white fly on some cultivated host crops and found that level of activity of *B. tabaci* was recorded in August on *Vigna umbellata*, *Laslas purpureus*, *Cyamopsis tetragonoloba*, *Seasamum indicum*, *Glycm max*, *Cucucubita moschata*, *Capiscum annum*, *V. unguiculata*, *V. mungo*, *V. radiata* and *Abelmoschus esculentus*. In October, peak *B. tabaci* population was observed on *Solarium melongena* and during November on *Solarium tuberosum* and *Brassica napus* respectively.

Kumar *et al.* (2016) studied the weather parameters against white fly on brinjal and found that they attained their high population level during end of February to middle of March and 3<sup>rd</sup> to 4th week of March respectively.

Sharma *et al.* (2017) studied the seasonal incidence of white fly on tomato (*Solanum esculentum* var. *Pusa Ruby*). A positive correlation was observed between adult population and abiotic factors that is; temperature (maximum and minimum) and sunshine hours, whereas humidity (maximum and minimum) and rainfall showed a negative correlation with it. Taken together, the key weather parameters studied, caused 89.00 per cent variation in whitefly population (R2 value).

Dhandge *et al.* (2018) appraised the seasonal incidence of sucking pests on okra with white fly having (15.7 whitefly/3 leaves) at 16th and 17th standard meteorological week of summer 2016, respectively. There was positive correlation between pest population with maximum temperature, minimum temperature, morning relative humidity and bright sunshine. Only evening relative humidity was negatively correlated.

### **2.3 To screen various rose cultivars against sucking pest damage under open conditions**

#### **2.3.1 Varietal screening of rose against thrips**

Bergh and Blanc (1997) studied the performance of western flower thrips, *Frankliniella occidentalis* on miniature rose cultivars and they reported that larval

development time was prolonged on cultivars with red and orange flowers and shortest on white and yellow flowered cultivars and among the cultivars, red and orange flowered cultivars were least preferred by female thrips for oviposition.

Herrin and Warnock (2002) used 0 to 9 rating based on the number of leaves expressing feeding damage while recording western flower thrips (WFT), *Frankliniella occidentalis* (Pergande) damage, on impatiens germplasm in greenhouse. This scale was based on the damaged leaves per plant (1:0, 2:1-5, 3: 6-10, 4:11-15, 5: 16-20, 6: 21-25, 7: 26-30, 8: 31- 35, 9: >35).

Rani and Sridhar (2003) recorded that none of the tested rose cultivars viz., First Red, Grand Gala, Starlite, Konfeti, Versilia, Lambada and Vivaldi were free from thrip infestation (*S. dorsalis*) in polyhouse, although Versilia was the most resistant in terms of its response to the attack by the pest. Thrips preferred young leaves.

Gahukar (2003) studied the reaction of three rose varieties against thrips under field condition and reported that over 50 per cent infestation was observed in Gladiator; 40-42% infestation in Folklore and 24-25% infestation in Landora during 1996 and 1997.

Jhansi-Rani and Sridhar (2003) screened seven polyhouse grown rose varieties like First Red, Grand Gala, Starlite, Konfeti, Versilla, Lambada and Vivaldi for their resistance to thrips and reported that none of the tested cultivars were free from the infestation of thrips even though the variety Versilla was found to be most resistant with regards to response to the attack by thrips. They also observed that varieties which have red and orange coloured petals seemed to have more number of thrips than yellow coloured petals.

Murugan and Jagadish (2006) reported that, among the three varieties namely; local red, local yellow and local white screened against *S. dorsalis* under field conditions, local red rose flower was the most vulnerable and the incidence

occurred throughout the flowering period. The peak level was reached during second fortnight of April.

Hegde *et al.* (2016) studied that varieties “Bianca”, “Talea”, “Chandrama”, and “White Master Piece”, scored less number of thrips (<9 per flower) bearing white flowers. “Diamond Jubilee” and “Paddy Stephen” supported <14 thrips per flower were of yellow colour. “Mmelod Mauve” and “Navile Gibson” harboured >17 thrips per flower were of orange colour. “Bordeaux”, “Gladiator”, “Black Lady”, “Grand Gala”, “Grand Prix”, “First Red”, which scored >20-25 thrips per flower were of red and pink colours. Varieties with red and pink colour flowers were more at risk and white flower bearing varieties were found promising. The varieties of roses which were found to be promising were “Bianca”, “Talea”, “Australian Gold”, “Chandrama”, “Cascade Red” and “White Master Piece”. The thrips were less attracted to flowers with light petals. Varieties with red, pink and orange petals were not susceptible.

Thanlass *et al.* (2017) studied two Varieties namely “Rose Local” and “Arjun” were found low resistant to thrips. “Pusa Mohit”, “First Red”, “Sonika” and “Sughandha” were the varieties which were found low susceptible to thrips. While as “Jaya” and “Angelica” were found moderately liable against thrips.

### **2.3.2 Varietal screening of rose against mites**

Grzeszkiewicz and Witaszek (1994) appraised 26 rose cultivars for cut flower yield and quality and for resistance against *T. urticae* and reported that Parfait, Lady Rose and Hidalgo cultivars were found most resistant to *T. urticae*.

Dhooria (1999) studied the mite damage on 7 rose varieties under polyhouse condition. Maximum mite damage was noticed on variety Prophyta (53 percent) followed by Saphire (23 percent), first Red (17 percent), Mercedes Long (15 percent) and Vivaldi (13 percent) and negligible mite damage was recorded in varieties ‘Golden Time’ and ‘Pavarotti’.

Hole and Solunkhe (2005) screened thirty rose cultivars for their relative

resistance against two spotted spider mite, *T.urticae* and reported that the cultivar Rajhans recorded the lowest mite population followed by Apsara and Rose Evening.

Rinkikumari and Shukla\* (2017) undertook an experiment to screen twelve French bean varieties against two spotted spider mite, *T. urticae* under open field condition. Among the twelve cultivars screened for their reaction to spider mite *T. urticae*, the descending order of these French bean varieties were as Gujarat Rajmah>Arka Komal> HUR-137 > IPR-98-5 >Suvidha>Arka Bold >ArkaAroop> IVFB-1 > HUR-203 > PDR-14 > HUR-15 > IPR-98-31.

Ganai *et al.* (2018) screened eight varieties/genotypes of marigold for their resistance/tolerance to *Tetranychus urticae Koch*. The results divulged that none of the varieties/genotypes were found to be resistant. Varieties namely Desi Gutta and Garland Orange were found to be low resistant with a score of 0.61-0.90. Pusa Narangi Gainda and Garland Yellow were found to be moderately resistant. Pusa Arpita and Pusa Basanti were found moderately susceptible with a score of 1.21-1.50, while as Jafri and Crack jack mix were categorized as low susceptible.

Thanlass *et al.* (2018) studied that varieties “Glory” and “Golden” were found to be low resistant against mites. The varieties “Rose Local”, “Sonika”, “First Red”, “Dr.B.P.Pal”, “Pusa”, “Mohit”, “Naveen”, “Angelica”, “Taj-Mahal”, “Shanti”, “Pusa Muskan”, “Black Beauty”, “Arjun”, “Australian Gold”, “Rakhtima”, “Sugandha”, “Jaya” and “Superstar” were found to be low susceptible with a score of 0.91-1.20, while as only one variety “Girija” was found moderately vulnerable against the pest.

### **2.3.3 Varietal screening of rose against aphids**

Amjad Farooq and Zahida Tasawar (2007) screened twenty three cultivars of Brassica for their vulnerability to aphids. *Brassica napus (var. Bulbul-98)* was found to be most liable with maximum population of aphids 70.66 aphids.

*Brassica campestris* (var. *Peeli sarson*) was found to be tolerant with minimum population of 41.74 aphids per 10 cm inflorescence. Amongst aphids, *Lipaphis erysimi* was found dominant over *Brevicoryne brassicae*.

Mohammad-Munib *et al.* (2015) studied the survey and screening of different cultivars of roses for their resistance and susceptibility against rose aphid (*Macrosiphum rosae*) on three different locations and observed the per cent incidence and number of aphids/ twig were high in Srinagar district at all the five locations surveyed, while these were lower in Baramulla district at all the locations except Pattan. They also found that screening of rose cultivars for their resistance against aphid revealed that Grand Gala and Noblesse harboured maximum mean aphid infestation index (MAII), i.e., 1.33 and 1.10 respectively, whereas Golden Gate and Naranga exhibited moderate mean (0.88 and 0.99). The minimum mean aphid infestation index was 0.55 in Konfeti.

Thanlass *et al.* (2017) observed that variety “Superstar” was found to be highly resistant against aphid. Two Varieties namely “Rose Local” and “Arjun” were found low resistant to aphids. “Pusa Mohit”, “First Red”, “Sonika” and “Sughandha” were the varieties which were noticed to be less prone to the aphids. While as “Jaya” and “Angelica” were found moderately at risk against aphids.

Maurya *et al.* (2018) studied the screening of rapeseed-mustard varieties *Brassica spp*, the aim of screening to find out most tolerant variety against mustard aphid *Lipaphis erysimi* under field condition. The screening was carried out based on the strictures of aphid infestation index and aphid population count. The result revealed that differential reaction among varieties ranged from highly vulnerable to highly tolerant. Among the twenty varieties tested, Pusa Jagnath and RLM-619 possessed highly tolerant and susceptible to mustard aphid.

Abdullah-Al-Rahad *et al.* (2018) conducted an experiment against sucking pest aphid (*Aphis gossypii*) on mung bean. For the study, different mungbean varieties were used as treatment. These were BARI Mung-1, BARI Mung-2,

BARI Mung-3, BARI Mung-4, BARI Mung-5 and BARI Mung-6. Data on different parameter were recorded and statistically significant variation was observed for different varieties. BARI Mung – 6 indicated the least population of aphid and most elevated resistance against aphid invasions at different stages in comparison to all other varieties. The highest seed yield (1.82 t ha<sup>-1</sup>) was recorded from BARI Mung-6, while the lowest (1.30 tha<sup>-1</sup>) was recorded from BARI Mung-4. It means that BARI Mung-6 were superior to other varieties in terms of lowest aphid infestation and maximum yield.

#### **2.3.4 Varietal screening of rose against whitefly**

Reddy and Aswath (2008) carried out an experiment to examine the resistance of 16 exotic collections of gerbera (*Gerbera jamesonii* Bolus ex. Hooker F.) against whitefly (*Bemisia tabaci* Genn.) under polyhouse conditions at Bangalore. Out of the 16 collections screened 2 varieties 'Eva' and 'Carocci' showed combined resistance to whitefly while 3 varieties 'Alberino' Dil, and 'Cassiona' were highly liable to the pest.

Mastoi *et al.* (2013) carried out varietal resistance of okra against whitefly (*Bemisia tabaci*), Seeds of six varieties namely, Sabzpari, Super green, Noori-786, Sharmeeli, Pusa sawani, and Ambak were used. The results revealed that the population of whitefly varied significantly ( $P < 0.05$ ) on different dates and varieties. Okra variety Sabzpari harboured the minimum pest (3.17 insects/leaf) population, while Noori-786 harboured the maximum (4.46 insects/leaf) population. Therefore, it could be considered as the least most resistant variety.

Hafeez *et al.* (2017) carried the study to monitor four okra varieties (Sabz Pari, Sada Bahar, Pusa Sawani, and Arka Anamika) against whitefly. It was deduced that these varieties showed some level of resistance against sucking insect pests Okra variety Sada Bahar was less overrun with whitefly (5.36/leaf) in comparison to other tested varieties and resulted in maximum yield (1529.62 kgha<sup>-1</sup>).

Jamuna *et al.* (2017) conducted a study to screen different tomato cultivars against whitefly under field conditions. It was observed that PTR 4 and PTR 6 recorded the maximum per cent disease incidence of 27.14 and 28.58 per cent respectively and were on par with each other, while least preference was observed in Vybhav, Arka Samrat, Arka Rakshaka and Arka Ananya.

Abdullah-Al-Rahad *et al.* (2018) executed an experiment against sucking pest whitefly (*Bemisia tabaci*) and of mung bean. For the study, different mungbean varieties were used as treatment. These were BARI Mung-1, BARI Mung-2, BARI Mung-3, BARI Mung-4, BARI Mung-5 and BARI Mung-6. Data on different factors were observed and statistically significant variation was noticed for different varieties. BARI Mung-6 showed the least whitefly population and highest resistance against whitefly infestations at different stages than all other varieties. The highest seed yield (1.82 t ha<sup>-1</sup>) was recorded from BARI Mung-6, while the lowest (1.30 tha<sup>-1</sup>) was recorded from BARI Mung-4. It signifies that BARI Mung-6 was better than the other varieties in terms of lowest whitefly invasion and maximum yield.

## **Chapter-3**

### **MATERIAL AND METHODS**

The existing study was conducted in the Division of Entomology, experimental field Division of Floriculture and Landscaping Architecture, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences & Technology - Kashmir, Shalimar and in the experimental field Department of Agriculture, Ganderbal during 2019. The materials used and methods applied for different investigations have been presented in the following chapter.

#### **3.1 Conduct of survey to document the insect pest complex on rose under field and polyhouse conditions**

To record the various insect pest complexes on rose, different investigations were conducted between April to October 2019 both in polyhouse and field conditions. The investigations were carried out at fortnightly intervals at the experimental field, Division of Floriculture and Landscaping Architecture, Faculty of Horticulture as well as in the experimental field Department of Agriculture, Ganderbal. Ten plants were arbitrarily selected on each sampling date per location. During the investigation, the incidence of pests with their nature of damage was recorded. The natural enemies on these pests were also observed during the study.

##### **3.1.1 Sampling procedures**

A number of different insect pests were counted on rose using standardized sampling procedure.

The beating method was employed to estimate the thrip population. A young shoot (15 days old) and flower were tapped five times against a white cardboard sheet (30 cm X 25 cm) and the number of thrips that fell on the white sheet was calculated and averaged. Thrip densities (both on young shoot and matured flowers) with and without natural enemies were counted and averaged.

The thrip density was correlated with plant parameters like age of shoots, age of floral groups and plant canopy. The regression analysis was also done to know the effect of these plant parameters on thrips density.

The Aphid counts were made on growing shoot and flower bud. The number of aphids present on 10 cm length growing shoot, one each from top, middle and bottom canopy levels was calculated and averaged. Aphid densities (both on young shoot and flower bud) with and without natural enemies were counted and averaged. The aphid density was correlated with plant parameters like age of shoots, age of floral groups and plant canopy. The regression analysis was also done to know the effect of these plant parameters on aphid density.

In order to estimate the density of whitefly, three matured leaves (>20-45 days old) were chosen, one each from top, middle and bottom, and the counts were made; the average density per plant was counted as well. Seasonal incidence was also studied through the investigation period. The population densities of these pests were correlated with maximum, minimum and mean temperature including relative humidity, rainfall, sunshine hours and wind velocity. The regression analysis was done to know the effect of abiotic factors on whitefly density.

To estimate the density of two spotted mites on leaves including young shoots and flowers, along with three leaves infested by total number of mites each from different canopy levels (topmost, intermediate and lowest) were counted with the help of hand lens and averaged. The density was correlated with plant parameters like age of shoots, age of floral groups and plant canopy. The regression analysis was done to observe the effect of these plant parameters on mite density.

To estimate the densities of hemipteran, coleopteran, orthopteran, lepidopteran insects, the actual insect counts (both adults and immature) per ten plant were recorded and averaged.

### **3.1.2 Pest species on rose**

In order to identify the different species of thrips, aphids, white fly and mites on rose, the samples were collected from April to October in field and polyhouse during 2019 on Grand gala, Naomi and Himachal red correspondingly. On each sampling date, the samples were gathered by beating a young shoot and a matured flower on white card board sheet including three matured leaves, one each from top, middle and bottom. Then thrip and aphids were collected and stored in a vial with 90% alcohol and the mites were stored in oudmans fluid. The samples were originally identified with the help of a taxonomist and the counting of different species was done under stereo microscope to observe the composition of species on each observation date.

### **3.1.3 Pest distribution on shoots**

In order to estimate the insect pest density on rose, the differently aged shoots were included ranging from young (with 5 to 20 day old), matured (having 20 to 45 days old) and old matured (with more than 45 days old) for determining three leaves with 10 cm length on each of these shoots which include young, matured and old vegetation having been sampled both in field as well as polyhouse. The observations were taken at fortnightly intervals during April to October, 2019 and ten plants were taken at random on the day of survey. To calculate the insect pest population a white cardboard sheet was used having dimension 30 cm X 25 cm by shaking the shoots of different age groups five times against it & insect pests were recorded individually which fell on the sheet. After calculating the data by averaging in each pre determined day for each age group consisting of ten plants it was statistically analyzed by correlation.

### **3.1.4 Pest distribution on flowers**

In order to evaluate the insect pest density on rose, the differently aged floral groups were included ranging from buds (young unopened bud about 2 to 5 days old and calyx opened bud about 6 to 10 days old), matured flowers (about 1



Shalimar

Ganderbal

**Plate 1: General view of experimental field**



**Plate 2: Collection of insects using light traps**

to 5 days old) and fully matured flowers (more than 5 days old) were selected both in field as well as polyhouse for sampling insect pests during April to October, 2019. Observations were taken at fortnight intervals, also ten plants were taken at random on the day of survey. To calculate the insect pest population a white card board sheet with dimensions 25 cm X 25 cm was used by shaking the flower of different aged floral group five times against it and insect pest which fell were recorded individually. After calculating the data by averaging in each predetermined day for each age group consisting of ten plants it was statistically analyzed by correlation.

### **3.1.5 Pest distribution on plant canopy**

In order to evaluate insect pest density on rose in field as well as polyhouse at varying canopy levels which include young shoots being cut into three canopies ranging from lowest (bottom soil level with 0 to 50 cm), intermediate (bottom soil level from <50 to 100 cm) and topmost (bottom soil level from >100cm). The observations were recorded fortnightly through April to October, 2019. Ten plants were taken randomly on the day of survey. To calculate insect pest population a white card board sheet was used having dimensions 30 cm X 25 cm by shaking the three young shoots from each canopy level against it and record individually. After calculating the data, on each pre determined day for each canopy level consisting of ten plants, it was statistically analyzed by correlation.

## **3.2 To study the seasonal incidence of sucking pests on rose**

### **3.2.1 Seasonal incidence of sucking pests**

The seasonal incidence of sucking pests was studied in experimental field, Division of Floriculture and Landscaping Architecture, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences & Technology - Kashmir, Shalimar and in the experimental field Department of Agriculture, Ganderbal.

The sucking pests consist of thrip, aphids, mites and white fly; the field

samples were gathered at fortnightly intervals from April to October, 2019. Ten plants were chosen randomly on each sampling date. The 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 separately and thrip numbers were counted. The observations on number of aphids were recorded from three young shoots at three canopy levels of the plant. The young shoots were beaten on the white cardboard individually five times and numbers of aphids were counted. The average number of aphids per shoot was worked out as well. In case of observations on the number of whitefly; it was recorded from three leaves at three canopy levels of the plant i.e., top, middle and bottom. The leaves were beaten on the white cardboard separately five times and numbers of whitefly were counted. The average number of whitefly per leaves was worked out. The observation on number of mites was recorded from three leaves from top, middle and bottom part of the canopy. The leaves were beaten on the white cardboard individually five times and numbers of mites were recorded. The average number of mites per leaf was worked out.

### **3.2.2 For identification of thrips, aphids, mites and whitefly.**

The specimen of thrips, aphids and whitefly on rose were collected and preserved in a solution (with 10% ethanol (9 parts) glacial acetic acid (1 part) and triton X-100, one ml in 1000 ml of the mixture), mite specimens were presented in oudmans solution. The specimens of aphids, thrips and white fly were mounted for identification in a glass slide with DPX mountant. While as specimen of mites were mounted on glass slide in Hoyer's medium for identification.

The Insect pest density was correlated with maximum, minimum, mean temperature, relative humidity and rainfall. In case of polyhouse, the data on insect pest density was correlated with the maximum, minimum, mean temperature and relative humidity.

## Assessment of Incidence and Infestation of Aphids, Thrips and Mites

### Aphid

The assessment of infestation by aphids on various crops was observed as per the scale given by Nagrare *et al.* (2009)

#### 1-4 Scale infestation for recording infestation of aphids

<b>Grade-1</b>	Scattered appearance of few aphids on the plant.
<b>Grade-2</b>	Severe infestation of aphids on any one branch of the plant.
<b>Grade-3</b>	Severe infestation of aphids on more than one branch or half portion of the plant.
<b>Grade-4</b>	Severe infestation of aphids on whole plant.

The percent incidence was calculated by following formulae

$$\text{Percent Incidence (PI)} = \frac{\text{Number of infested shoots}}{\text{Total no. of shoots examined}} \times 100$$

$$\text{Percent Incidence (PI)} = \frac{\text{Number of infested shoots}}{\text{Total no. of shoots examined}} \times 100$$

$$\text{Severity Index (SI)} = \frac{\text{Sum of total grade points (1-4 infestation grade respectively) of the infested plants}}{\text{Total no. of infested plants observed}}$$

### Thrips

The assessment of infestation by thrips on various crops was observed as per the scale given by Thanlass *et al.* (2017).

#### 1-4 Scale infestation for recording infestation of thrips

<b>Grade-1</b>	Scattered appearance of few thrips on the plant.
<b>Grade-2</b>	Severe infestation of thrips on any one part of the plant.
<b>Grade-3</b>	Severe infestation of thrips on more than one part of the plant.
<b>Grade-4</b>	Severe infestation of thrips on whole plant.



**Plate 3: Thrip damage on different parts of rose plant**



**Plate 4: *Macrosiphum rosae* (Pink morph) on different parts of rose plant**

The percent incidence was calculated by following formulae

$$\text{Percent Incidence (PI)} = \frac{\text{Number of infested flowers}}{\text{Total no. of flowers examined}} \times 100$$

$$\text{Severity Index (SI)} = \frac{\text{Sum of total grade points (1-4 infestation grade respectively) of the infested plants}}{\text{Total no. of infested plants observed}}$$

### Mites

The assessment of infestation by mites on various crops was observed as per the scale given by Thanlass *et al.*, 2017

#### 1-4 Scale infestation for recording infestation of mites

<b>Grade-1</b>	Scattered appearance of few mites on the plant.
<b>Grade-2</b>	Severe infestation of mites on any one part of the plant.
<b>Grade-3</b>	Severe infestation of mites on more than one part of the plant.
<b>Grade-4</b>	Severe infestation of mites on whole plant.

he percent incidence was calculated by following formulae:

$$\text{Percent Incidence (PI)} = \frac{\text{Number of infested leaves}}{\text{Total no. of leaves examined}} \times 100$$

$$\text{Severity Index (SI)} = \frac{\text{Sum of total grade points (1-4 infestation grade respectively) of the infested plants}}{\text{Total no. of infested plants observed}}$$

### 3.3 To screen various rose cultivars against the sucking pest damage under open Conditions

The experiment on varietal screening were undertaken in the fields by means of randomized block design with three replications (RCBD) to screen the rose varieties at Shalimar bagh, Kashmir. Ten accessions grown at Shalimar bagh, Kashmir were screened during 2019. A total of seven observations were taken at fort-nightly intervals during the peak growth and flowering period of the plant i.e. during May to July, because the maximum sucking pest density will overlap with the maximum growth stage. During each observation, thrip numbers were counted

from three matured flowers per plant in each replication and averaged. The thrips were gathered by tapping the matured flowers against white board sheet. While screening the varieties, colour variation was also noted and related to thrip density. The data on number of thrips recorded on different varieties on each observation data per flower was averaged.

During each observation, aphid numbers were counted from three young shoots per plant in each replication and averaged. The aphids were gathered by tapping the young shoots individually against white board sheet. While screening the varieties, colour variation was also noted and related to aphid density. The data on number of aphids noted on different varieties on each observation data per shoot were averaged.

During each observation, mite numbers were calculated from three leaves at three canopy levels per plant in each replication and averaged. The mites were taken by using hand lens on Petri plates. While screening the varieties, colour variation was also noted and related to mite density. Data on number of mites recorded on different varieties on each observation data per leaf were averaged. During each observation, white fly numbers were counted from three leaves at three canopy levels per plant in each replication and averaged. The white fly was gathered by rapping the leaves against white board sheet. While checking the varieties, colour variation was also observed and related to white fly density. Data on number of white fly noticed on different varieties on each observation data per leaf were averaged. No protection measures were given during the study.

Resistance rating based on the thrip count per flower was worked out at fortnightly periods and graded according to seven point system as given by:

**Grading based on Thrip number (Thanlass Norboo *et al.*, 2017)**

<b>Grade/Scale</b>	<b>Thrip index</b>	<b>Category</b>
0.	0.00	Immune
1.	$> 0.01 \leq 0.30$	Highly Resistant
2.	$> 0.31 \leq 0.60$	Moderately Resistant
3.	$> 0.61 \leq 0.90$	Low Resistant
4.	$> 0.91 \leq 1.20$	Low Susceptible
5.	$> 1.21 \leq 1.50$	Moderately Susceptible
6.	$> 1.51$	Highly Susceptible

**Thrip index:**

- 0 : Plant free from thrip infestation.
- 1 : Only few thrips with very little injury.
- 2 : Small colonies on few twigs, no curling or yellowing of leaves.
- 3 : Thrips colonies on almost all the twigs, stunted growth, curling and yellowing of leaves.
- 4 : Very heavy population of thrips on inflorescence leaves and stem.
- 5 : Whole plant heavily infested

The average thrip index was worked out by using subsequent equation:

$$\text{Average thrips index} = \frac{0N + 1N + 2N + 3N + 4N + 5N}{\text{Total number of plants observed}}$$

Where,

0, 1, 2, 3, 4, 5 was the thrip index.

N= Number of plants showing respective thrip index.



**Plate 5: *Macrosiphum rosae* (Green morph) on different parts of rose plant**



**Plate 6: *Tetranychus urticae* on different parts of rose plant**

Resistance rating based on the aphid count per shoot was taken at fortnightly intermissions and graded according to seven point system as given by:

**Grading based on Aphid number (Thanlass Norboo *et al.*, 2017)**

Grade/Scale	Aphid index	Category
0.	0.00	Immune
1.	$> 0.01 \leq 0.30$	Highly Resistant
2.	$> 0.31 \leq 0.60$	Moderately Resistant
3.	$> 0.61 \leq 0.90$	Low Resistant
4.	$> 0.91 \leq 1.20$	Low Susceptible
5.	$> 1.21 \leq 1.50$	Moderately Susceptible
6.	$> 1.51$	Highly Susceptible

**Aphid index:**

- 0 : Plant free from aphid infestation.
- 1 : Only few aphids with very little injury.
- 2 : Small colonies on few twigs, no curling or yellowing of leaves.
- 3 : Aphids colonies on almost all the twigs, stunted growth, curling and yellowing of leaves.
- 4 : Very heavy population of aphids on inflorescence leaves and stem.
- 5 : Whole plant heavily infested

The average aphid index was worked out by using the given equation:

$$\text{Average aphid index} = \frac{0N + 1N + 2N + 3N + 4N + 5N}{\text{Total number of plants observed}}$$

Where,

0, 1, 2, 3, 4, 5 was the aphid index.

N= Number of plants showing respective aphid index.



**Plate 7: Gypsy Moth on rose Plant**



**Plate 8: Slug sawfly and crane fly on rose Plant**

Resistance rating based on the white fly count per leaf was taken at fortnightly intermissions and graded according to seven point system as given by:

**Grading based on white fly number (Thanlass Norboo *et al.*, 2017)**

Grade/Scale	White fly index	Category
0.	0.00	Immune
1.	$> 0.01 \leq 0.30$	Highly Resistant
2.	$> 0.31 \leq 0.60$	Moderately Resistant
3.	$> 0.61 \leq 0.90$	Low Resistant
4.	$> 0.91 \leq 1.20$	Low Susceptible
5.	$> 1.21 \leq 1.50$	Moderately Susceptible
6.	$> 1.51$	Highly Susceptible

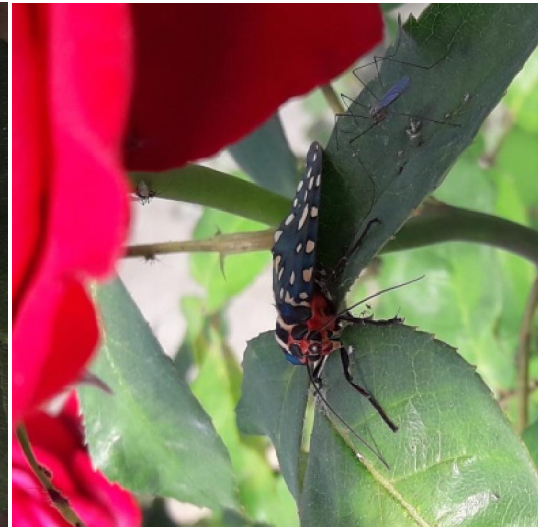
**Whitefly index:**

- 0 : Plant free from white fly infestation.
- 1 : Only few white fly with very little injury.
- 2 : Small colonies on few twigs, no curling or yellowing of leaves.
- 3 : Whitefly colonies on almost all the twigs, stunted growth, curling and yellowing of leaves.
- 4 : Very heavy population of whitefly on inflorescence leaves and stem.
- 5 : Whole plant heavily infested

The average whitefly index was worked out by following the given equation:



**Plate 9: Weevil and flea beetle recorded on rose plant**



**Plate 10: White fly and butterfly (Entomofauna) on rose plant**

$$\text{Average whitefly index} = \frac{0N + 1N + 2N + 3N + 4N + 5N}{\text{Total number of plants observed}}$$

Where,

0, 1, 2, 3, 4, 5 was the whitefly index.

N= Number of plants showing respective whitefly index.

Resistance rating based on the mites count per leaf was taken at fortnightly intermissions and graded according to seven point system as given by:

**Grading based on mite number (Thanlass Norboo *et al.*, 2018)**

Grade/Scale	Mite index	Category
0.	0.00	Immune
1.	> 0.01 ≤ 0.30	Highly Resistant
2.	> 0.31 ≤ 0.60	Moderately Resistant
3.	> 0.61 ≤ 0.90	Low Resistant
4.	> 0.91 ≤ 1.20	Low Susceptible
5.	> 1.21 ≤ 1.50	Moderately Susceptible
6.	>1.51	Highly Susceptible

**Mite index:**

- 0 : Plant free from mite infestation.
- 1 : Only few mites with very little injury.
- 2 : Small colonies on few twigs, no curling or yellowing of leaves.
- 3 : Mite colonies on almost all the twigs, stunted growth, curling and yellowing of leaves.
- 4 : Very heavy population of mite on inflorescence leaves and stem.
- 5 : Whole plant heavily infested

The average mite index was worked out by using the subsequent equation:

$$\text{Average mite index} = \frac{0N + 1N + 2N + 3N + 4N + 5N}{\text{Total number of plants observed}}$$

Where,

0, 1, 2, 3, 4, 5 was the mite index.

N= Number of plants showing respective mite index.

### 3.4 Statistical analysis

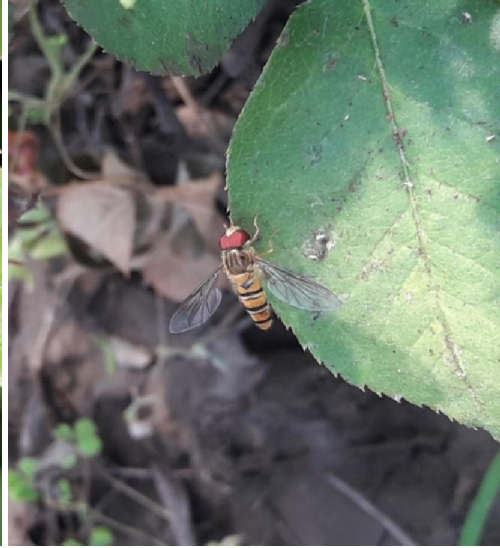
The data collected through the study period on various aspects was analyzed using MSTAT-C statistical software. Correlation studies were done to find the relationship between the weather parameters and seasonal incidences of thrips, aphids, mites and whitefly. The regression analysis was done to know the effect of abiotic factors on thrips, aphid, white fly and mite density.

**Table 1: Varieties screened at agricultural experimental farm, Shalimar, during 2019**

S. No.	Variety	Colour
1.	Arthur bell	yellow
2.	Bijazzo	bicolour
3.	Superstar	orange
4.	Okaholoma	Maroon red
5.	Golden gate	yellow
6.	Kiss of fire	Colour blend
7.	American heritage	Colour blend
8.	Virgo	White
9.	Naomi	red
10.	Message	Light yellow
11.	Noblesse	Reddish pink
12.	Naranga	orange



*Syrphus ribesii* Linnaeus



*Episyrphus balteatus* De Geer



spider



*Hippodamia variegata* Goeze



*Coccinella septempunctata* Linnaeus

**Plate 11: Natural enemies recorded on rose Plant**

## Chapter-4

### EXPERIMENTAL FINDINGS

The results of the investigation “Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests” were conducted in polyhouse at experimental field on Division of Floriculture and Landscaping Architecture, Faculty of Horticulture, SKUAST-K, Shalimar, at field in Shalimar garden, Srinagar and in the experimental field Department of Agriculture, Ganderbal during 2019. The findings of the experiments conducted are presented in this chapter.

#### **4.1 Conduct of survey to document the insect pest complex on rose under open and polyhouse conditions**

The survey was conducted during 2019 which showed that ten pest species belonging to six insect orders (8 families) of class Insecta and one mite species belonging to Acarina were causing damage to different parts of rose plant. Out of ten, four were sap suckers (sucking pests), three were foliage feeders and three were both foliage and flower feeders. Population density was also done by taking average of all insect pests and mite population to know which serve as major or minor pests on rose.

##### **4.1.1 Insect pest complexes:-**

###### **4.1.1.1 Sucking pests**

###### **Thrips (*Scirtothrips dorsalis* Hood) Thysanoptera: Thripidae**

Thrips were found to attack tender shoots, leaves, buds, flowers and growing tips. Both larvae and adults sucked the sap from the tenders parts of the plants especially shoots, leaves, buds and flowers. They lacerate the young tissues by being on the lower surface of the leaves. As a result, the affected leaves become malformed, upward curling and crinkling of the leaves. In case of buds, they became distorted and dark brown lesions on both calyx and bud were found.

**Aphids (*Macrosiphum rosae* L.) Hemiptera: Aphididae**

Aphids were found in large numbers in clusters on tender shoots, buds and flowers, including under the surface of leaf. Nymphs and adults sucked the sap from affected tender parts resulting in loss of vigor. There was distortion and deformation of affected buds. Flowers were also affected causing damage to their petals. Both pink and green morphs were found on the rose plant.

**Whitefly (*Trialeurodes Vaporarium* Westwood) Hemiptera: Aleyrodidae**

Whitefly was found to be a minor pest having little or no damage on rose during the year.

**4.1.1.2 Foliage feeders**

**Gypsy moth (*Lymantria obfuscata* Walker) Lepidoptera: Erebidae, Sawfly (*Endelomyia aethiops*) Hymenoptera: Tenthredinidae and Cabbage butterfly/Entomofauna (*Pieris brassicae* Linn) Lepidoptera: Pieridae**

Both of these causes damage either by feeding on leaves or causing holes in leaves rendering them unfit for photosynthetic practices resulting in loss of rose bloom quality, while as cabbage butterfly causes more or less the same damage as seen above.

**4.1.1.3 Foliage and flower feeders**

**Weevil (*Merhynchites Bicolor* Fabricius) Coleoptera: Attelabidae, Flea beetle (*Altica sps*) Coleoptera: Chrysomelidae and Crane fly (*Nephrotoma appendiculata* (Pierre)) Diptera: Tipulidae**

Both were found to cause damage on buds and leaves especially weevil showing damage on buds including feeding on leaves, while as crane fly tends to cause minor damage either on foliage or bud by sucking the nectar from flowers.

#### **4.1.1.4 Non Insect Pest**

##### **Spider mite (*Tetranychus urticae* (Koch)) Acarina: Tetranychidae**

Two spotted mites were found to be most damaging on rose causing havoc on both sides of leaves due to webbing being a characteristic feature of two spotted mites including on flowers being completely covered by mites.

Among all the insect pests observed thrips, aphids and mites were dominating both in field and polyhouse causing damage on rose.

Also some natural enemies were found on different cultivars on rose at all locations.

**Table 2: Insect and mite pests recorded on rose and their nature of damage, during the year 2019**

S. No.	C. Name	S.Name	Order: Family	Nature of damage	Population density	Remarks
1.	Thrips *	<i>Scirtothrips dorsalis</i> Hood	Thysanoptera:Thripidae	Sucking pests	6 thrips per leaf/flower	Major pest
2.	Aphids *	<i>Macrosiphum rosae</i> Linn.	Hemiptera: Aphididae	Sucking pests	4 colonies per twig	Major pest
3.	Spider mite *	<i>Tetranychus urticae</i> (Koch)	Acarina: Tetranychidae	Sucking pests	8 mites per leaf	Major pest
4.	Weevil **	<i>Merhynchites</i> <i>Bicolor</i> (Fabricius)	Coleoptera: Attelabidae	Bud and foliage feeders	1-2 per plant	Minor pest
5.	Flea beetle*	<i>Altica sps</i>	Coleoptera:Chrysomelidae	Foliage and flower feeder	2-3 per plant	Minor pest
6.	Gypsy moth**	<i>Lymantria obfuscata</i> (Walker)	Lepidoptera : Erebidae	Foliage feeders	4-5 caterpillars per plant	Major pest
7.	Entomofauna /Butterfly**	<i>Pieris brassicae</i> Linn	Lepidoptera: Pieridae	Foliage feeders	1.5 per plant	Minor pest
8.	Whitefly	<i>Trialeurodes</i> <i>Vaporarium</i> (Westwood)	Hemiptera : Aleyrodidae	Sucking pests	0.5-1 per plant	Minor pest
9.	Crane fly	<i>Nephrotoma</i> <i>appendiculata</i> (Pierre)	Diptera : Tipulidae	Nectar from flowers	1.5 per plant	Minor pest
10.	Saw fly	<i>Endelomyia aethiops</i>	Hymenoptera : Tenthredinidae	Foliage feeders	0.5-1 per plant	Minor pest

\* Both in field and Polyhouse

\*\* Only in Polyhouse

**Table 3: Natural enemies recorded on different rose cultivars at all the locations under polyhouse and field conditions**

<b>Cultivar</b>	<b>Location</b>	<b>Common name</b>	<b>Scientific name</b>	<b>Family</b>	<b>Order</b>
Arthur Bell	Shalimar	Adonis Ladybird	<i>Hippodamia variegata</i> Goeze	Coccinellidae	Coleoptera
Okaholoma	Shalimar	Ladybird beetle	<i>Coccinella septempunctata</i> Linnaeus	Coccinellidae	Coleoptera
Grand gala & Himachal Red	Shalimar & Ganderbal	Syrphid fly	<i>Syrphus ribesii</i> Linnaeus and <i>Episyrphus balteatus</i> De Geer	Syrphidae	Diptera
Grand gala	Shalimar	Spider	unspecified	unspecified	Araneae

#### **4.1.2 Thrip distribution on shoots in Shalimar under polyhouse conditions**

Perusal of data in (Table 4, Fig. 1) revealed that thrip population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of thrips in comparison to matured and old. Overall thrip number exhibited a pronounced and positive relation with thrips on young and matured leaves ( $r = 0.94$  and  $0.91$ ). Notably, thrips found on old leaves did not show such results with total thrips ( $r = 0.31$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total thrips against different aged shoots (Fig. 1).

#### **4.1.3 Thrips distribution on flowers in Shalimar under polyhouse conditions**

Thrips density on different aged floral components *viz.*, young buds (unopened bud of 2-5 days old), calyx opened buds (6-10 days old), matured opened flowers (1-5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of thrips were from flower that were fully opened. Overall thrip number exhibited a pronounced and positive relation with flower that were fully opened ( $r = 0.95$ ) as collated with matured flower, unopened bud and calyx opened bud ( $r = 0.92, 0.75$  and  $0.85$ ) (Table 4) Graphical representation showing regression analysis of total thrips against different aged floral group. (Fig. 1).

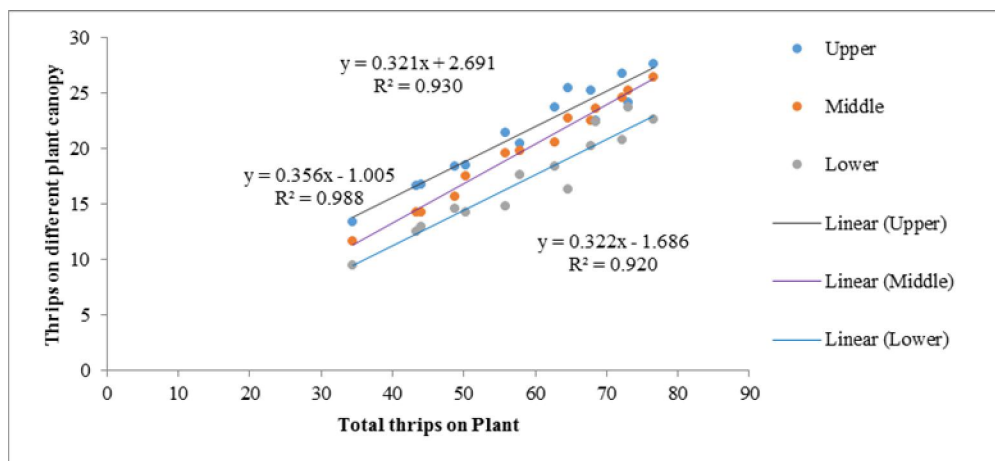
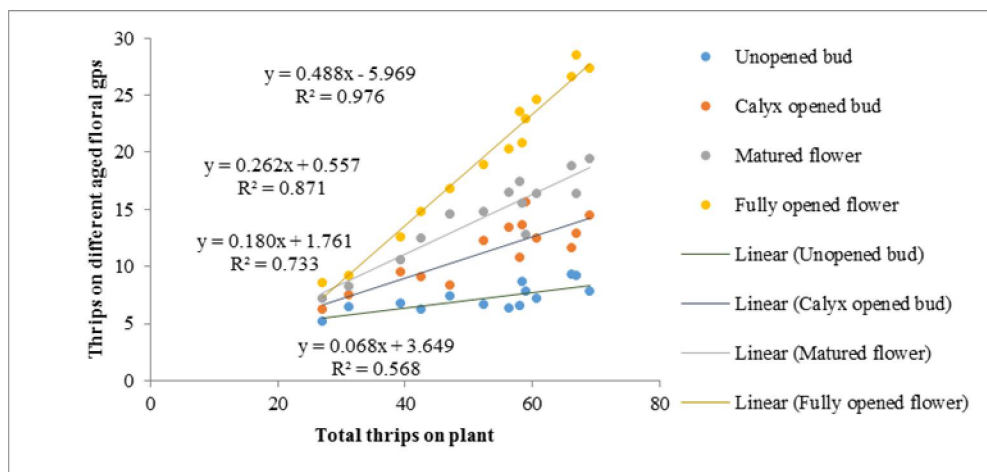
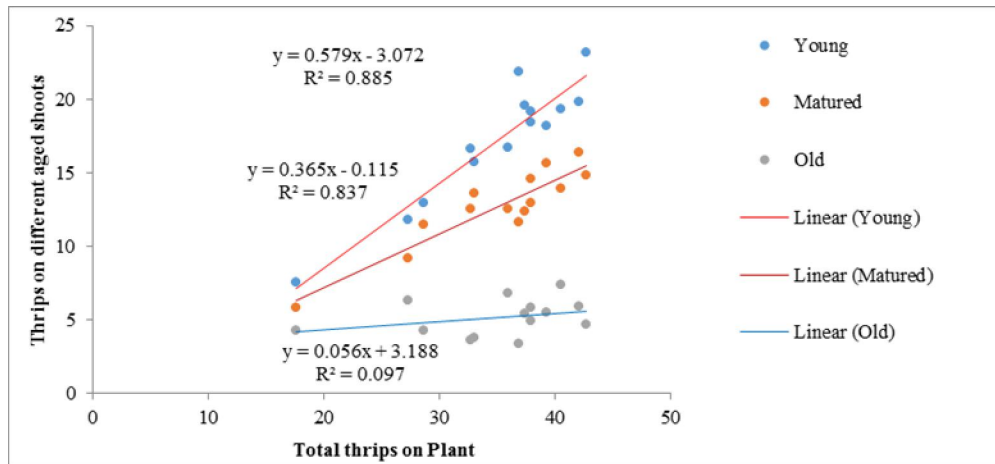
#### **4.1.4 Thrip distribution on canopy in Shalimar under polyhouse conditions**

Thrips density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) vividly demonstrated highest thrip infestation on topmost canopy level when collated with middle and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total thrips in a positive way ( $r = 0.96, 0.92$  and  $0.95$ ) (Table 4). Graphical representation showing regression analysis of total thrips against different plant canopy (Fig. 1).

**Table 4: Thrip (*Scirtothrips dorsalis*) density on different aged shoots/ floral group and plant canopy of rose under Standard Meteorological Week polyhouse at Shalimar, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total thrips
		Thrips number/Shoot/Floral group															
Age of shoots	Young	7.50	11.80	19.20	23.20	19.30	19.60	18.40	21.90	18.20	16.70	15.70	19.80	16.60	12.90	17.2±4.17	0.94*
	Matured	5.80	9.20	12.90	14.80	13.90	12.40	14.60	11.60	15.60	12.50	13.60	16.40	12.50	11.50	12.66±2.70	0.91*
	Old	4.30	6.30	5.80	4.70	7.40	5.40	4.90	3.40	5.50	6.80	3.80	5.90	3.60	4.30	5.15 ±1.21	0.31
	Total	17.60	27.30	37.90	42.70	40.60	37.40	37.90	36.90	39.30	36.00	33.10	42.10	32.70	28.70		
Age of floral group	Unopened bud	5.20	6.40	6.80	6.20	7.40	6.60	7.80	8.60	7.20	9.30	9.20	7.80	6.30	6.50	7.23±1.195	0.75*
	Calyx opened bud	6.20	7.50	9.50	9.10	8.30	12.20	15.60	13.60	12.50	11.60	12.90	14.50	13.40	10.80	11.26±2.78	0.85*
	Matured flower	7.20	8.20	10.50	12.40	14.60	14.80	12.80	15.50	16.40	18.80	16.40	19.40	16.50	17.40	14.35±3.71	0.92*
	Fully opened flower	8.50	9.20	12.60	14.80	16.80	18.90	22.90	20.80	24.60	26.60	28.50	27.30	20.30	23.50	19.66±6.51	0.95*
	Total	27.10	31.30	39.40	42.50	47.10	52.50	59.10	58.50	60.70	66.30	67.00	69.00	56.50	58.20		
Plant canopy	Upper	13.40	16.80	18.40	21.40	25.50	23.70	25.20	26.80	27.60	24.20	20.50	22.50	18.50	16.60	21.50±4.29	0.96*
	Middle	11.60	14.30	15.70	19.60	22.80	20.60	22.50	24.60	26.40	25.20	19.80	23.60	17.50	14.20	19.88±4.62	0.92*
	Lower	9.50	12.90	14.60	14.80	16.30	18.40	20.20	20.80	22.60	23.70	17.60	22.40	14.30	12.50	17.18±4.32	0.95*
	Total	34.50	44.00	48.70	55.80	64.60	62.70	67.90	72.20	76.60	73.10	57.90	68.50	50.30	43.30		

\*. Correlation is significant at the 0.05 level



**Fig. 1: Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar**

#### **4.1.5 Aphid distribution on shoots in Shalimar under polyhouse conditions**

The data in (Table 5) showed that aphid population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of aphids in comparison to matured and old. Overall aphid number exhibited a pronounced and positive relation with aphid on young and matured leaves ( $r = 0.94$  and  $0.88$ ). Notably number of aphids found on old leaves more or less exhibit such relationship with total number of aphids ( $r = 0.80$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total aphids against different aged shoots (Fig. 2).

#### **4.1.6 Aphid distribution on flowers in Shalimar under polyhouse conditions**

Aphid population with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of aphids were from bud which is unopened and calyx opened. Overall aphid number exhibited a pronounced and positive relation with bud which were unopened ( $r = 0.96$ ) as collated with bud which were calyx opened, matured flower and fully opened flower ( $r = 0.94$ ,  $0.92$  and  $0.90$ ) (Table 5). Graphical representation showing regression analysis of total aphids against different aged floral group (Fig. 2).

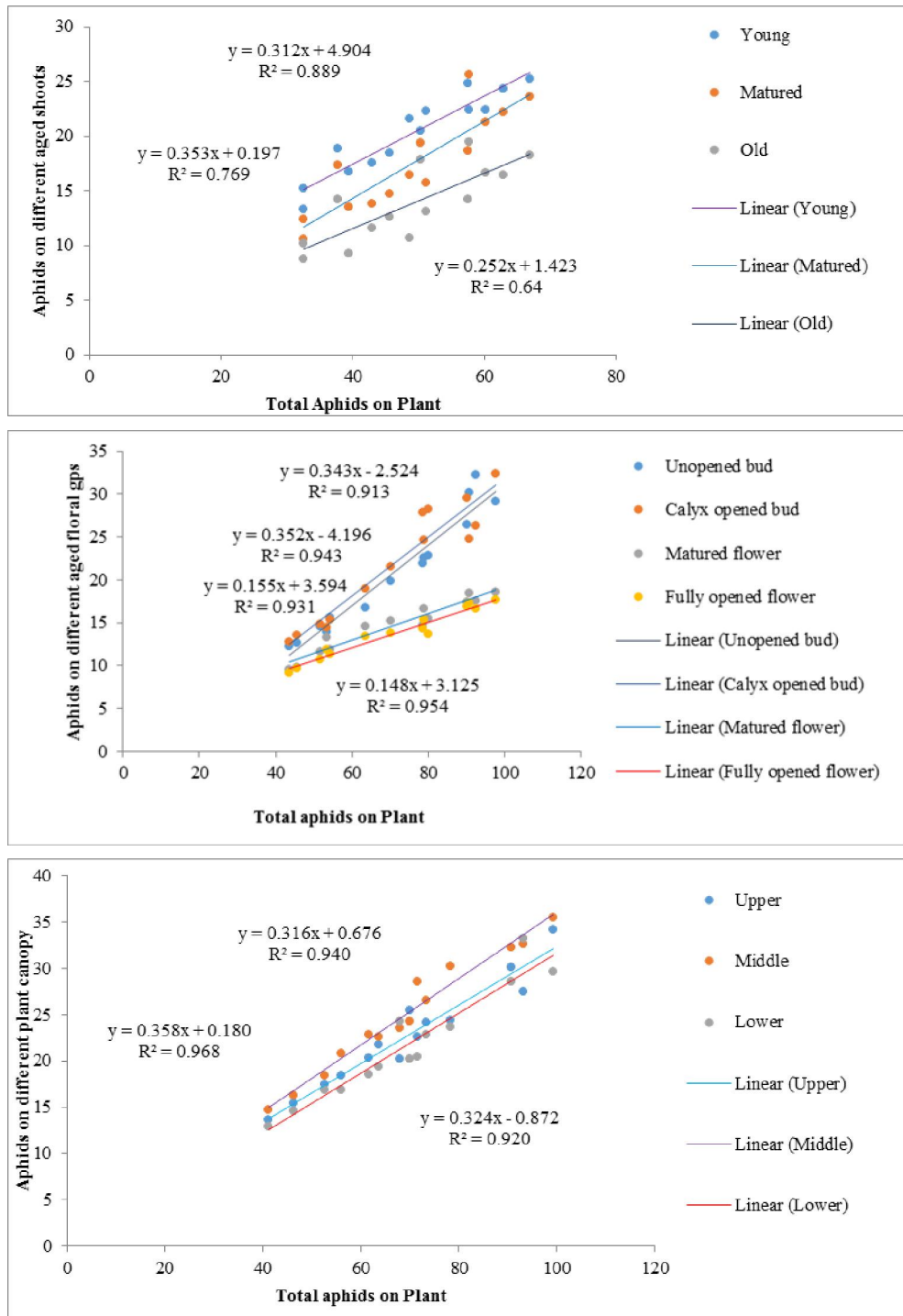
#### **4.1.7 Aphid distribution on canopy in Shalimar under polyhouse conditions**

Aphid density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) noticeably demonstrated highest aphids on intermediate canopy level when collated with topmost and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total aphids in a positive way ( $r = 0.97$ ,  $0.96$  and  $0.95$ ) (Table 5). Graphical representation showing regression analysis of total aphids against different plant canopy (Fig. 2).

**Table 5: Aphid *Macrosiphum rosae* Linn density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total aphids
		Aphid number/Shoot/Floral group															
Age of shoots	Young	13.30	16.70	17.50	18.40	21.60	22.30	24.80	22.40	24.30	25.20	22.40	20.50	18.80	15.20	20.24±3.68	0.94*
	Matured	10.60	13.50	13.80	14.70	16.40	15.70	18.60	21.30	22.20	23.60	25.60	19.40	17.30	12.40	17.50±4.47	0.88*
	Old	8.70	9.20	11.60	12.60	10.70	13.10	14.20	16.60	16.40	18.20	19.50	17.80	14.20	10.20	13.78±3.50	0.80*
	Total	32.60	39.40	42.90	45.70	48.70	51.10	57.60	60.30	62.90	67.00	57.70	50.30	37.80	32.60		
Age of floral group	Unopened bud	12.20	12.60	14.50	15.60	13.90	16.70	19.80	22.50	21.90	22.80	26.40	29.20	32.20	30.20	20.75±6.80	0.96*
	Calyx opened bud	12.80	13.50	14.80	15.40	14.40	18.90	21.50	24.60	27.80	28.30	29.50	32.40	26.30	24.80	21.78±6.73	0.94*
	Matured flower	9.50	9.80	11.60	11.90	13.30	14.60	15.20	16.60	14.70	15.50	17.40	18.60	17.50	18.40	14.61±3.01	0.92*
	Fully opened flower	9.10	9.60	10.70	11.30	11.80	13.40	13.80	15.30	14.30	13.60	16.90	17.60	16.60	17.30	13.66±2.85	0.90*
	Total	43.60	45.50	51.60	54.20	53.40	63.60	70.30	79.00	78.70	80.20	90.20	97.80	92.60	90.70		
Plant canopy	Upper	13.60	15.40	17.50	21.70	24.10	20.20	25.40	30.10	34.20	27.50	24.40	22.60	20.30	18.40	22.52±5.65	0.97*
	Middle	14.70	16.30	18.40	22.60	26.50	23.50	24.20	32.20	35.50	32.60	30.20	28.50	22.80	20.80	24.91±6.31	0.96*
	Lower	12.90	14.60	16.80	19.40	22.80	24.20	20.20	28.50	29.60	33.20	23.70	20.40	18.50	16.80	21.56±5.86	0.95*
	Total	41.20	46.30	52.70	63.70	73.40	67.90	70.10	90.80	99.30	93.30	78.30	71.50	61.60	56.00		

\*. Correlation is significant at the 0.05 level



**Fig. 2: Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar**

#### **4.1.8 Mite distribution on shoots in Shalimar under polyhouse conditions**

Perusal of data in (Table 6) revealed that mite population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of matured age consisted of greater number of mites in comparison to young and old. Overall mite number exhibited a pronounced and positive relation with mite on young and matured leaves ( $r = 0.93$  and  $0.96$ ). Notably, number of mites found on old leaves more or less exhibit such relationship with total number of mites ( $r = 0.90$ ). It was concluded that matured shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total mites against different aged shoots (Fig. 3).

#### **4.1.9 Mite distribution on flowers in Shalimar under polyhouse conditions**

The data in (Table 6) revealed that mite population with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of mites were from flower that were fully opened. Overall mite number exhibited a pronounced and positive relation with flower that were fully opened ( $r = 0.92$ ) as collated with matured flower, unopened bud and calyx opened bud ( $r = 0.90$ ,  $0.82$  and  $0.88$ ) respectively. Graphical representation showing regression analysis of total mites against different aged floral groups (Fig. 3).

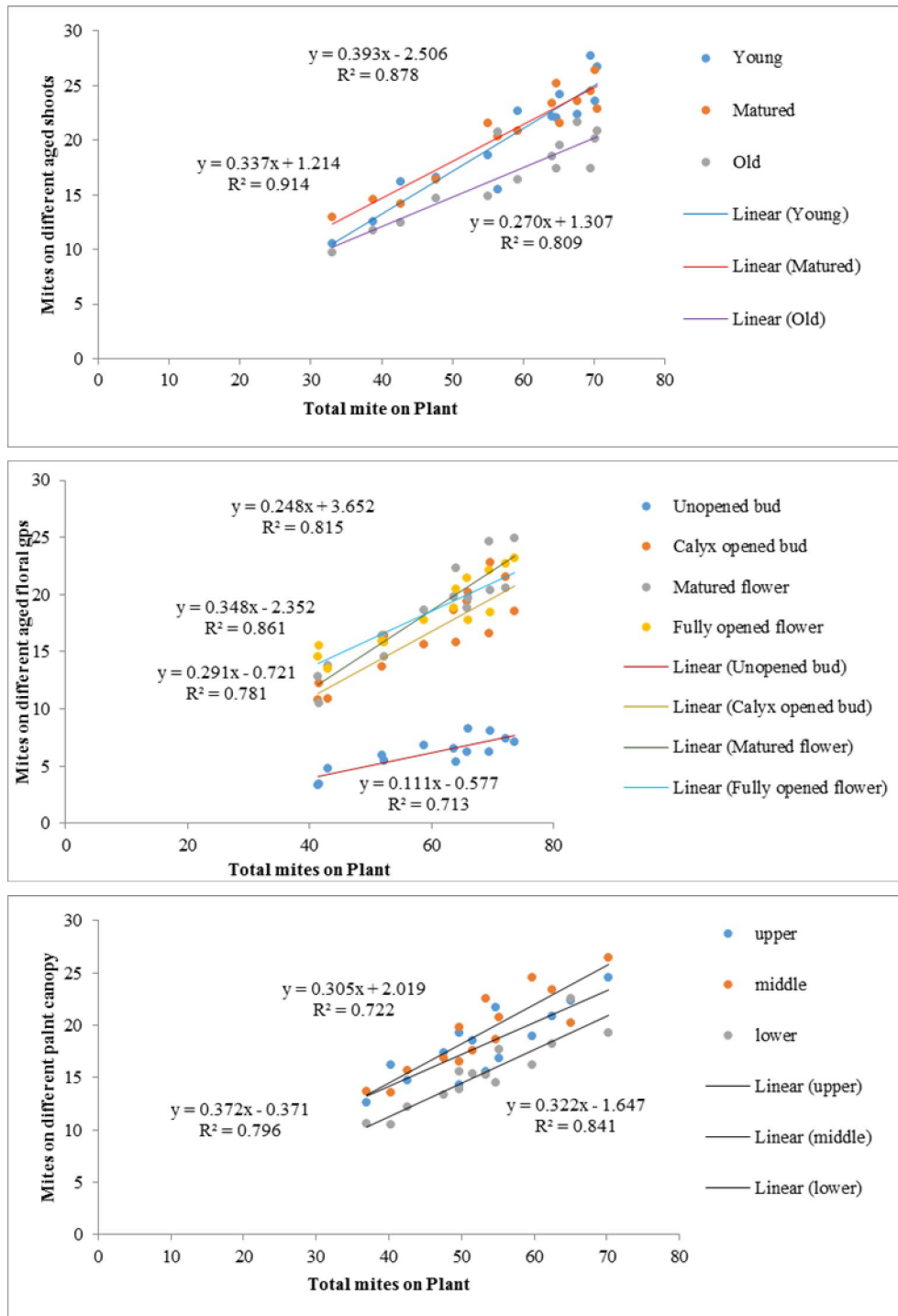
#### **4.1.10 Mite distribution on canopy in Shalimar under polyhouse conditions**

Mite density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) evidently demonstrated highest mites on intermediate canopy level when collated with topmost and lowermost canopy. Notably, results from correlation exhibited that all the three canopies were definitely affecting total mites in a positive way. ( $r = 0.85$ ,  $0.89$  and  $0.91$ ) (Table 6). Graphical representation showing regression analysis of total mites against different plant canopy (Fig. 3).

**Table 6: Mite (*Tetranychus urticae* (Koch)) density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total mite
		Mite number/Shoot/Floral group															
Age of shoots	Young	10.50	12.50	16.60	18.60	22.10	15.50	22.20	26.70	27.70	23.60	24.20	22.40	22.70	16.20	20.10±5.20	0.93*
	Matured	12.90	14.60	16.40	21.50	25.20	20.30	23.40	22.90	24.50	26.40	21.50	23.60	20.80	14.20	20.58±4.37	0.96*
	Old	9.70	11.70	14.70	14.90	17.40	20.70	18.50	20.80	17.40	20.10	19.50	21.60	16.40	12.40	16.84±3.72	0.90*
	Total	33.10	38.80	47.70	55.00	64.70	56.50	64.10	70.40	69.60	70.10	65.20	67.60	59.20	42.80		
Age of floral group	Unopened bud	4.80	5.90	6.80	5.40	6.20	7.10	3.40	5.50	6.20	7.40	8.30	8.10	6.50	3.30	6.06±1.51	0.82*
	Calyx opened bud	10.90	13.70	15.60	15.80	16.60	18.50	12.20	16.40	19.40	21.50	20.20	22.80	18.60	10.80	16.64±3.78	0.88*
	Matured flower	13.80	16.40	18.60	22.30	24.60	24.90	10.50	14.60	18.80	20.60	19.70	20.40	19.80	12.80	18.41±4.31	0.90*
	Fully opened flower	13.50	15.90	17.80	20.50	22.10	23.20	15.50	15.80	21.40	22.70	17.80	18.40	18.80	14.60	18.43±3.15	0.92*
	Total	43.00	51.90	58.80	64.00	69.50	73.70	41.60	52.30	65.80	72.20	66.00	69.70	63.70	41.50		
Plant canopy	Upper	12.60	14.70	17.40	19.30	21.70	15.60	18.90	14.30	16.80	20.90	24.50	22.30	18.50	16.20	18.12±3.39	0.85*
	Middle	13.70	15.70	16.80	16.50	18.60	22.50	24.60	19.80	20.70	23.40	26.40	20.20	17.60	13.60	19.29±3.95	0.89*
	Lower	10.60	12.20	13.40	13.90	14.50	15.20	16.20	15.60	17.70	18.20	19.30	22.50	15.40	10.50	15.37±3.32	0.91*
	Total	36.90	42.60	47.60	49.70	54.80	53.30	59.70	49.70	55.20	62.50	70.20	65.00	51.50	40.30		

\*. Correlation is significant at the 0.05 level



**Fig. 3: Relation between total mites and different aged shoots/ floral group and plant canopy of rose under polyhouse at Shalimar**

#### **4.1.11 Thrip distribution on shoots in Shalimar under field conditions**

Perusal of data in (Table 7) revealed that thrip population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of thrips in comparison to matured and old. Overall thrip number exhibited a pronounced and positive relation with thrips on young and matured leaves ( $r = 0.95$  and  $0.83$ ). Notably, thrips found on old leaves did not show such results with total thrips ( $r = 0.72$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total thrips against different aged shoots (Fig. 4).

#### **4.1.12 Thrip distribution on flowers in Shalimar under field conditions**

Thrips density on different aged floral components *viz.*, young buds (unopened bud of 2-5 days old), calyx opened buds (6-10 days old), matured opened flowers (1-5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of thrips were from flower that were matured. Overall thrip number exhibited a pronounced and positive relation with flower that were matured ( $r = 0.96$ ) as collated with unopened bud, calyx opened bud & flower which were fully opened ( $r = 0.82, 0.85$  &  $0.89$ ) (Table 7). Graphical representation showing regression analysis of total thrips against different aged floral groups (Fig. 4).

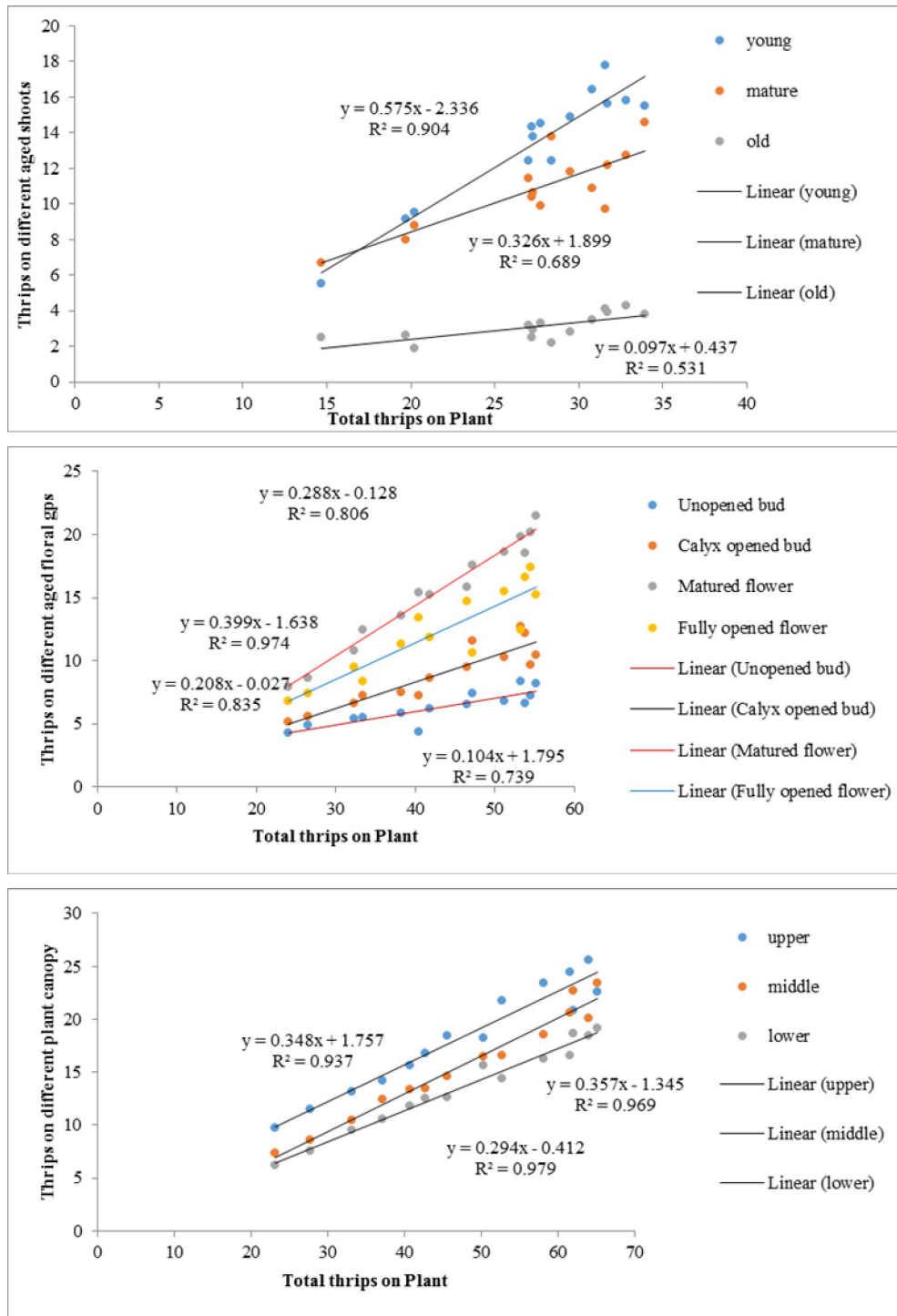
#### **4.1.13 Thrip distribution on canopy in Shalimar under field conditions**

The data pertaining to (Table 7) showed that thrips density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) vividly demonstrated highest thrip infestation on topmost canopy level when collated with middle and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total thrips in a positive way ( $r = 0.96, 0.97$  and  $0.94$ ). Graphical representation showing regression analysis of total thrips against different plant canopy (Fig. 4).

**Table 7: Thrip (*Scirtothrips dorsalis*) density on different aged shoots/ floral group and plant canopy of rose under open condition at Shalimar, 2019**

Standard Meteorological Week		15	17	19	21	23	25	27	29	31	33	35	37	39	41	Mean ± SD	Correlation value for total thrips
		Thrips number/Shoot/Floral group															
Age of shoots	Young	5.50	9.50	12.40	15.50	16.40	17.80	14.50	14.90	15.60	15.80	13.80	12.40	14.30	9.15	13.39±3.34	0.95*
	Matured	6.70	8.80	11.40	14.60	10.9	9.70	9.90	11.80	12.20	12.70	10.60	13.80	10.40	7.98	10.82±2.17	0.83*
	Old	2.50	1.90	3.20	3.80	3.50	4.10	3.30	2.80	3.90	4.30	2.90	2.20	2.50	2.60	3.10±0.74	0.72*
	Total	14.70	20.20	27.00	33.90	30.80	31.60	27.70	29.50	31.70	32.80	27.30	28.40	27.20	19.73		
Age of floral group	Unopened bud	4.30	4.90	5.40	5.80	4.40	6.50	7.40	8.40	8.20	6.60	7.20	6.80	6.20	5.50	6.25±1.29	0.82*
	Calyx opened bud	5.10	5.60	6.60	7.50	7.20	9.50	11.60	12.70	10.40	12.20	9.70	10.30	8.60	7.20	8.87±2.42	0.85*
	Matured flower	7.90	8.60	10.80	13.60	15.40	15.80	17.60	19.80	21.50	18.50	20.20	18.60	15.20	12.40	15.42±4.30	0.96*
	Fully opened flower	6.80	7.40	9.50	11.30	13.40	14.70	10.60	12.40	15.20	16.60	17.40	15.50	11.80	8.34	12.21±3.41	0.89*
	Total	24.10	26.50	32.30	38.20	40.40	46.50	47.20	53.30	55.30	53.90	54.50	51.20	41.80	33.44		
Plant canopy	Upper	9.70	11.50	13.20	15.60	18.40	21.70	23.40	25.60	22.60	24.40	20.80	18.20	16.80	14.20	18.29±5.00	0.96*
	Middle	7.30	8.60	10.50	13.40	14.60	16.60	18.50	20.10	23.40	20.60	22.70	16.50	13.50	12.40	15.62±5.05	0.97*
	Lower	6.20	7.60	9.50	11.80	12.60	14.40	16.30	18.40	19.20	16.60	18.60	15.60	12.50	10.60	13.56±4.13	0.94*
	Total	23.20	27.70	33.20	40.80	45.60	52.70	58.20	64.10	65.20	61.60	62.10	50.30	42.80	37.20		

\*. Correlation is significant at the 0.05 level



**Fig. 4: Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under field at Shalimar**

#### **4.1.14 Aphid distribution on shoots in Shalimar under field conditions**

The data in (Table 8) showed that aphid population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of aphids in comparison to matured and old. Overall aphid number exhibited a pronounced and positive relation with aphid on young and matured leaves ( $r = 0.90$  and  $0.89$ ). Notably number of aphids found on old leaves more or less exhibit such relationship with total number of aphids ( $r = 0.87$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total aphids against different aged shoots (Fig. 5).

#### **4.1.15 Aphid distribution on flowers in Shalimar under field conditions**

The data in (Table 8) showed that aphid population with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of aphids were from bud which is calyx opened. Overall aphid number exhibited a pronounced and positive relation with bud which were calyx opened ( $r = 0.90$ ) as collated with bud which were unopened, matured flower and fully opened flower ( $r = 0.82, 0.84$  &  $0.84$ ). Graphical representation showing regression analysis of total aphids against different aged floral groups (Fig. 5).

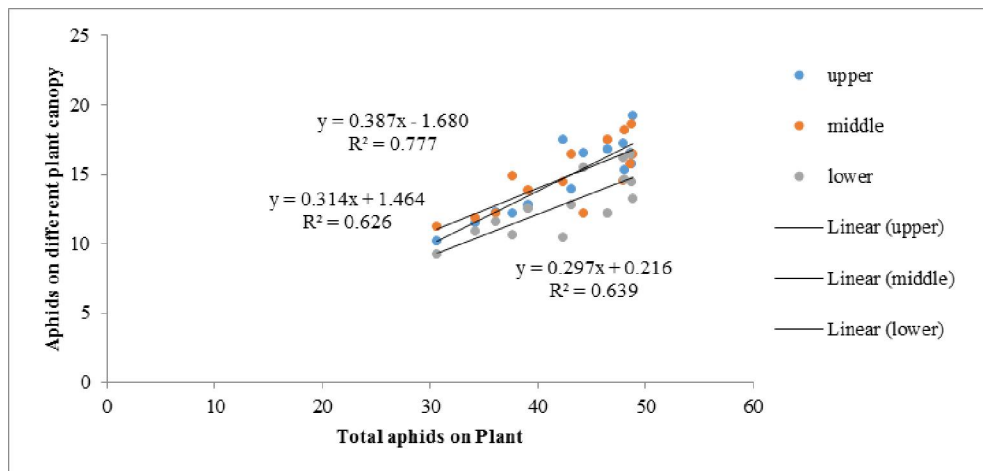
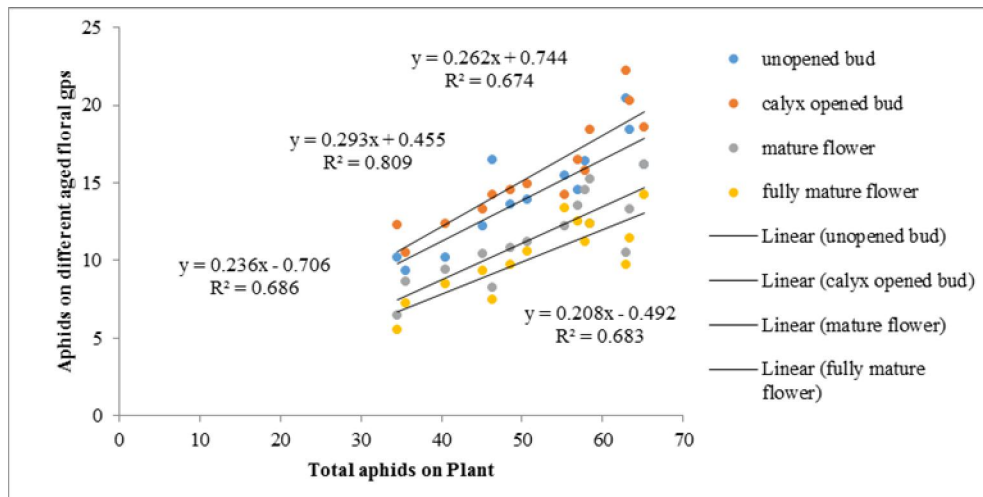
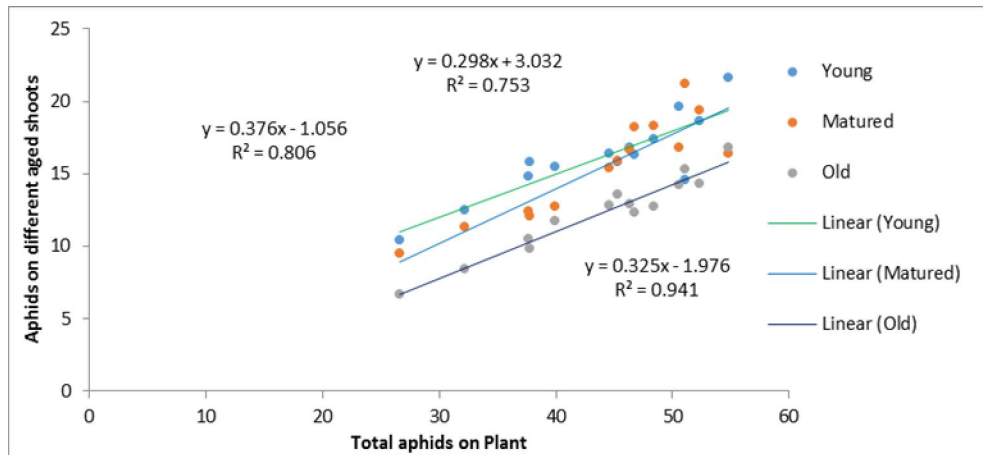
#### **4.1.16 Aphid distribution on canopy in Shalimar under field conditions**

The perusal of data in (Table 8) pertaining to aphid density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) noticeably demonstrated highest aphids on intermediate canopy level when collated with topmost and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total aphids in a positive way ( $r = 0.88, 0.80$  and  $0.79$ ). Graphical representation showing regression analysis of total aphids against different plant canopy (Fig. 5).

**Table 8: Aphid *Macrosiphum rosae* Linn density on different aged shoots/ floral group and plant canopy of rose under open condition at Shalimar, 2019**

Standard Meteorological Week		15	17	19	21	23	25	27	29	31	33	35	37	39	41	Mean ± SD	Correlation value for total aphids s
		Aphid number/Shoot/Floral group															
Age of shoots	Young	10.40	12.50	14.80	15.50	16.40	16.80	15.80	14.60	16.30	18.60	21.60	19.60	17.40	15.80	16.15±2.78	0.90*
	Matured	9.50	11.30	12.40	12.70	15.40	16.60	15.90	21.20	18.20	19.40	16.40	16.80	18.30	12.10	15.44±3.38	0.89*
	Old	6.70	8.40	10.50	11.70	12.80	12.90	13.60	15.30	12.30	14.30	16.80	14.20	12.70	9.84	12.28±2.71	0.87*
	Total	26.60	32.20	37.70	39.90	44.60	46.30	45.30	51.10	46.80	52.30	54.80	50.60	48.40	37.74		
Age of floral group	Unopened bud	9.30	10.20	12.20	13.60	13.90	14.50	15.50	16.40	12.40	16.20	18.40	20.40	16.50	10.20	14.26±3.23	0.82*
	Calyx opened bud	10.50	12.40	13.30	14.50	14.90	16.50	14.20	15.80	18.40	18.60	20.30	22.20	14.20	12.30	15.57±3.29	0.90*
	Matured flower	8.60	9.40	10.40	10.80	11.20	13.50	12.20	14.50	15.20	16.20	13.30	10.50	8.23	6.45	11.46±2.83	0.84*
	Fully opened flower	7.20	8.50	9.30	9.70	10.60	12.50	13.40	11.20	12.40	14.20	11.40	9.75	7.45	5.56	10.22±2.49	0.84*
	Total	35.60	40.50	45.20	48.60	50.60	57.00	55.30	57.90	58.40	65.20	63.40	62.85	46.38	34.51		
Plant canopy	Upper	10.20	11.50	12.30	12.80	13.90	15.70	17.50	16.50	17.20	19.20	15.30	16.50	16.80	12.20	14.82±2.67	0.88*
	Middle	11.20	11.80	12.20	13.80	16.40	18.60	14.40	12.20	14.50	16.40	18.20	15.70	17.50	14.90	14.84±2.41	0.80*
	Lower	9.20	10.90	11.60	12.50	12.80	14.40	10.40	15.50	16.20	13.20	14.60	16.40	12.20	10.60	12.89±2.26	0.79*
	Total	30.60	34.20	36.10	39.10	43.10	48.70	42.30	44.20	47.90	48.80	48.10	48.60	46.50	37.70		

\*. Correlation is significant at the 0.05 level



**Fig. 5: Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under field at Shalimar**

#### **4.1.17 Mite distribution on shoots in Shalimar under field conditions**

The results in (Table 9) showed that mite population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of matured age consisted of greater number of aphids in comparison to young and old. Overall mite number exhibited a pronounced and positive relation with aphid on young and matured leaves ( $r = 0.92$  &  $0.95$ ). Notably, number of mites found on old leaves more or less exhibit such relationship with total number of mites ( $r = 0.86$ ). It was concluded that matured shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total mites against different aged shoots (Fig. 6).

#### **4.1.18 Mite distribution on flowers in Shalimar under field conditions**

The data in (Table 9) revealed that mite density with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of mites were from flower that were fully opened. Overall mite number exhibited a pronounced and positive relation with flower that were fully opened ( $r = 0.90$ ) and calyx opened bud ( $r = 0.92$ ) compared to unopened bud and matured flower ( $r = 0.82$  and  $0.73$ ) respectively. Graphical representation showing regression analysis of total mites against different aged floral groups (Fig. 6).

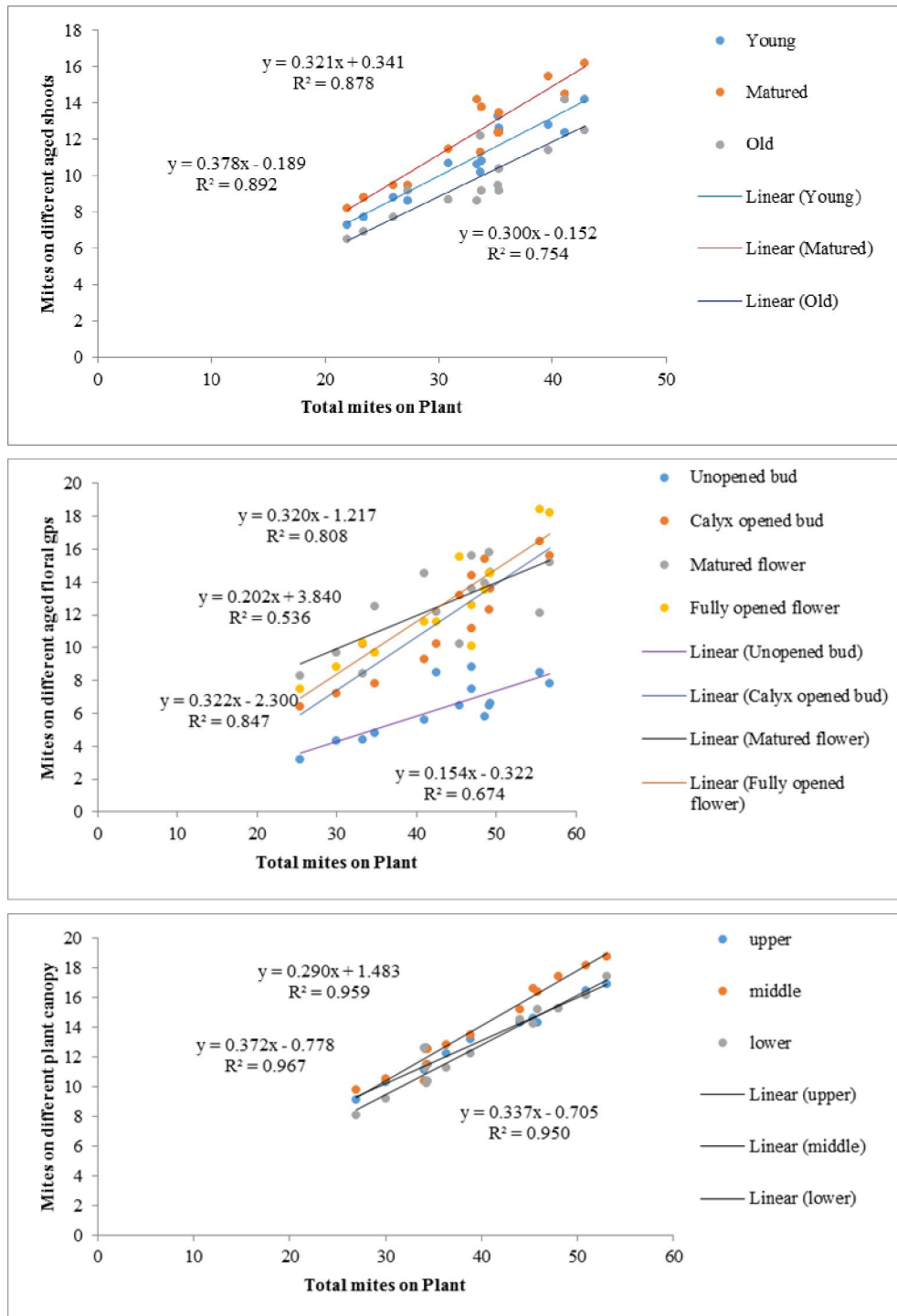
#### **4.1.19 Mite distribution on canopy in Shalimar under field conditions**

Mite density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) evidently demonstrated highest aphids on intermediate canopy level when collated with topmost and lowermost canopy. Notably, results from correlation exhibited that all the three canopies were definitely affecting total mites in a positive way ( $r = 0.96$ ,  $0.97$  &  $0.97$ ) respectively (Table 9). Graphical representation showing regression analysis of total mites against different plant canopy (Fig. 6).

**Table 9: Mite (*Tetranychus urticae* (Koch)) density on different aged shoots/ floral group and plant canopy of rose under open condition at Shalimar, 2019**

Standard Meteorological Week		15	17	19	21	23	25	27	29	31	33	35	37	39	41	Mean ± SD	Correlation value for total mite
		Mite number/Shoot/Floral group															
Age of shoots	Young	7.30	7.70	8.80	10.70	13.30	12.60	10.60	12.50	10.80	12.80	14.20	12.40	10.20	8.60	10.89±2.17	0.92*
	Matured	8.20	8.80	9.50	11.50	12.40	13.50	14.20	12.40	13.80	15.50	16.20	14.50	11.30	9.50	12.23±3.54	0.95*
	Old	6.50	6.90	7.70	8.70	9.50	9.20	8.6	10.40	9.20	11.40	12.50	14.20	12.20	9.20	9.72±2.19	0.86*
	Total	22.00	23.40	26.00	30.90	35.20	35.30	33.40	35.30	33.80	39.70	42.90	41.10	33.70	27.30		
Age of floral group	Unopened bud	3.20	4.30	4.80	5.60	7.50	6.50	8.50	8.80	5.80	6.60	7.80	8.50	6.50	4.40	6.34±1.75	0.82*
	Calyx opened bud	6.40	7.20	7.80	9.30	11.20	12.30	10.20	14.40	15.40	13.60	15.60	16.50	13.20	10.20	11.66±3.27	0.92*
	Matured flower	8.30	9.70	12.50	14.50	15.60	15.80	12.20	13.60	13.90	14.60	15.20	12.10	10.20	8.40	12.61±2.58	0.73*
	Fully opened flower	7.50	8.80	9.70	11.60	12.60	14.50	11.60	10.10	13.50	14.50	18.20	18.40	15.50	10.30	12.63±3.32	0.90*
	Total	25.40	30.00	34.80	41.00	46.90	49.10	42.50	46.90	48.60	49.30	56.80	55.50	45.40	33.30		
Plant canopy	Upper	9.10	10.30	11.50	12.20	13.20	14.30	11.10	12.60	14.60	15.30	16.50	16.90	14.30	10.40	13.02±2.39	0.96*
	Middle	9.80	10.50	12.50	12.80	13.50	15.20	10.40	11.50	16.60	17.40	18.20	18.80	16.40	12.50	14.01±3.00	0.97*
	Lower	8.10	9.20	10.40	11.30	12.20	14.50	12.60	10.20	14.20	15.30	16.20	17.40	15.20	11.30	12.72±2.80	0.97*
	Total	27.00	30.00	34.40	36.30	38.90	44.00	34.10	34.30	45.40	48.00	50.90	53.10	45.90	34.20		

\*. Correlation is significant at the 0.05 level



**Fig. 6: Relation between total mites and different aged shoots/ floral group and plant canopy of rose under field at Shalimar**

#### **4.1.20 Thrips distribution on shoots in Ganderbal under polyhouse conditions**

Perusal of data in (Table 10) revealed that thrip population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of thrips in comparison to matured and old. Overall thrip number exhibited a pronounced and positive relation with thrips on young and matured leaves ( $r = 0.91$  &  $0.82$ ). Notably, thrips found on old leaves did not show such results with total thrips ( $r = 0.63$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total thrips against different aged shoots (Fig. 7).

#### **4.1.21 Thrip distribution on flowers in Ganderbal under polyhouse conditions**

Perusal of data in (Table 10) revealed that thrip population with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of thrips were from flower that were matured & fully opened. Overall thrip number exhibited a pronounced and positive relation with flower that were matured & fully opened ( $r = 0.96$  &  $r = 0.97$ ) as collated with unopened bud and calyx opened bud ( $r = 0.66$  and  $0.89$ ). Graphical representation showing regression analysis of total thrips against different aged floral groups (Fig. 7).

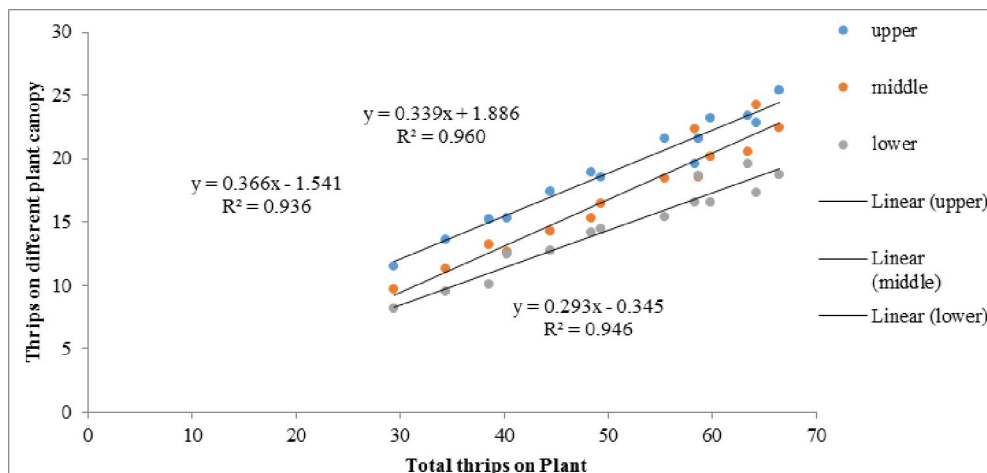
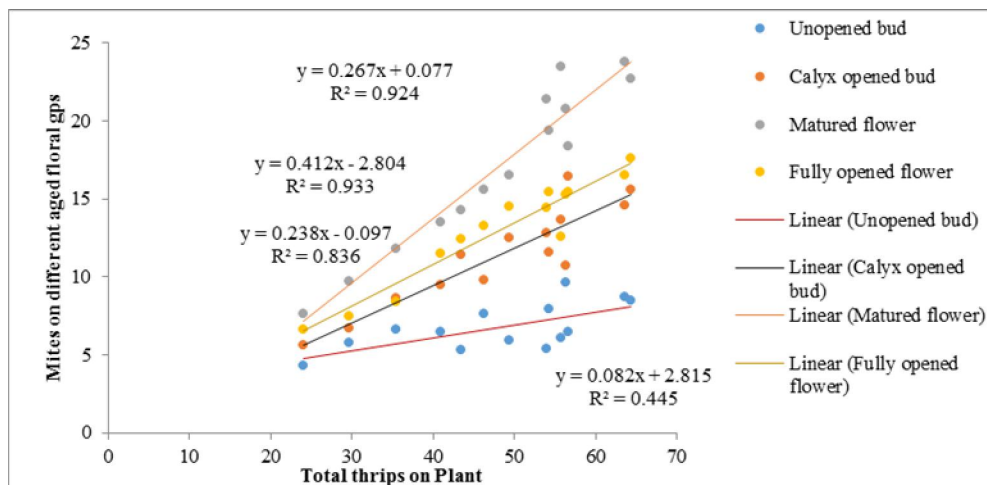
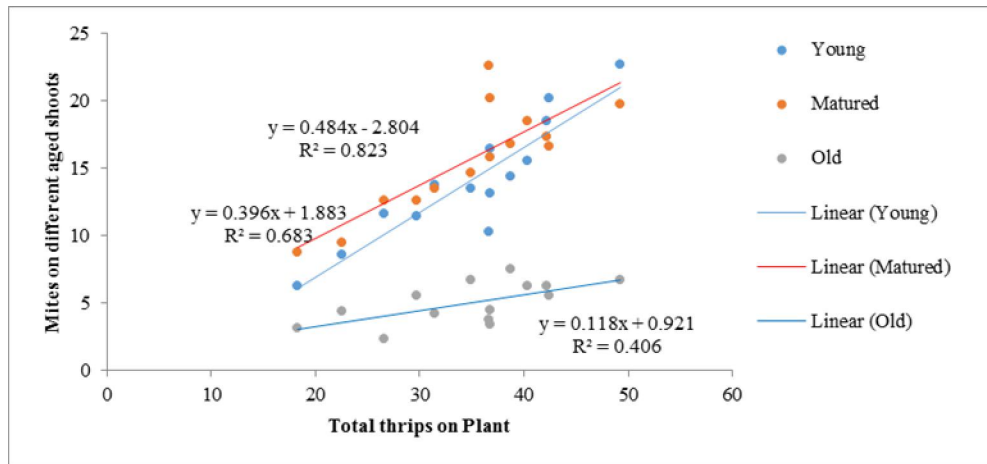
#### **4.1.22 Thrip distribution on canopy in Ganderbal under polyhouse conditions**

Thrips density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) vividly demonstrated highest thrip infestation on topmost canopy level when collated with middle and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total thrips in a positive way ( $r = 0.97$ ,  $0.95$  and  $0.96$ ) respectively (Table 10). Graphical representation showing regression analysis of total thrips against different plant canopy (Fig. 7).

**Table 10: Thrip (*Scirtothrips dorsalis*) density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total thrips
		Thrips number/Shoot/Floral group															
Age of shoots	Young	6.30	8.60	11.50	13.50	14.40	15.60	13.20	10.30	18.50	22.70	20.20	16.50	13.80	11.60	14.05±4.45	0.91*
	Matured	8.80	9.50	12.60	14.70	16.80	18.50	20.20	22.60	17.40	19.80	16.60	15.80	13.50	12.60	15.56±4.00	0.82*
	Old	3.20	4.40	5.60	6.70	7.50	6.30	3.40	3.80	6.30	6.70	5.60	4.50	4.20	2.40	5.04±1.55	0.63*
	Total	18.30	22.50	29.70	34.90	38.70	40.40	36.80	36.70	42.20	49.20	42.40	36.80	31.50	26.60		
Age of floral group	Unopened bud	4.30	5.80	6.60	6.50	7.60	7.90	6.10	5.40	8.70	9.60	8.50	6.50	5.90	5.30	6.76±1.49	0.66*
	Calyx opened bud	5.60	6.70	8.60	9.50	9.80	11.60	13.67	12.80	14.60	10.70	15.60	16.40	12.50	11.40	11.38±3.18	0.89*
	Matured flower	7.60	9.70	11.80	13.50	15.60	19.40	23.50	21.40	23.80	20.80	22.70	18.40	16.50	14.30	17.07±5.20	0.96*
	Fully opened flower	6.60	7.50	8.40	11.50	13.30	15.40	12.60	14.40	16.50	15.30	17.60	15.40	14.50	12.40	12.95±3.39	0.97*
	Total	24.10	29.70	35.40	41.00	46.30	54.30	55.80	54.00	63.60	56.40	64.40	56.70	49.40	43.40		
Plant canopy	Upper	11.50	13.60	15.30	17.40	18.50	21.60	23.20	25.40	22.80	23.40	19.60	21.60	18.90	15.20	19.14±4.13	0.97*
	Middle	9.70	11.30	12.60	14.30	16.40	18.40	20.20	22.40	24.20	20.50	22.30	18.50	15.30	13.20	17.09±4.52	0.95*
	Lower	8.20	9.50	12.40	12.70	14.40	15.40	16.50	18.70	17.30	19.60	16.50	18.60	14.20	10.10	14.57±3.60	0.96*
	Total	29.40	34.40	40.30	44.40	49.30	55.40	59.90	66.50	64.30	63.50	58.40	58.70	48.40	38.50		

\*. Correlation is significant at the 0.05 level



**Fig. 7: Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal**

#### **4.1.23 Aphid distribution on shoots in Ganderbal under polyhouse conditions**

The data in (Table 11) showed that aphid population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of aphids in comparison to matured and old. Overall aphid number exhibited a pronounced and positive relation with aphid on young and matured leaves ( $r = 0.92$  and  $0.90$ ). Notably number of aphids found on old leaves more or less exhibit such relationship with total number of aphids ( $r = 0.88$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total aphids against different aged shoots (Fig. 8).

#### **4.1.24 Aphid distribution on flowers in Ganderbal under polyhouse conditions**

Aphid population with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of aphids were from bud which is unopened and calyx opened. Overall aphid number exhibited a pronounced and positive relation with bud which were unopened ( $r = 0.94$ ) as collated with bud which were calyx opened, matured flower & fully opened flower ( $r = 0.92, 0.89$  &  $0.75$ ) (Table 11). Graphical representation showing regression analysis of total aphids against different aged floral groups (Fig. 8).

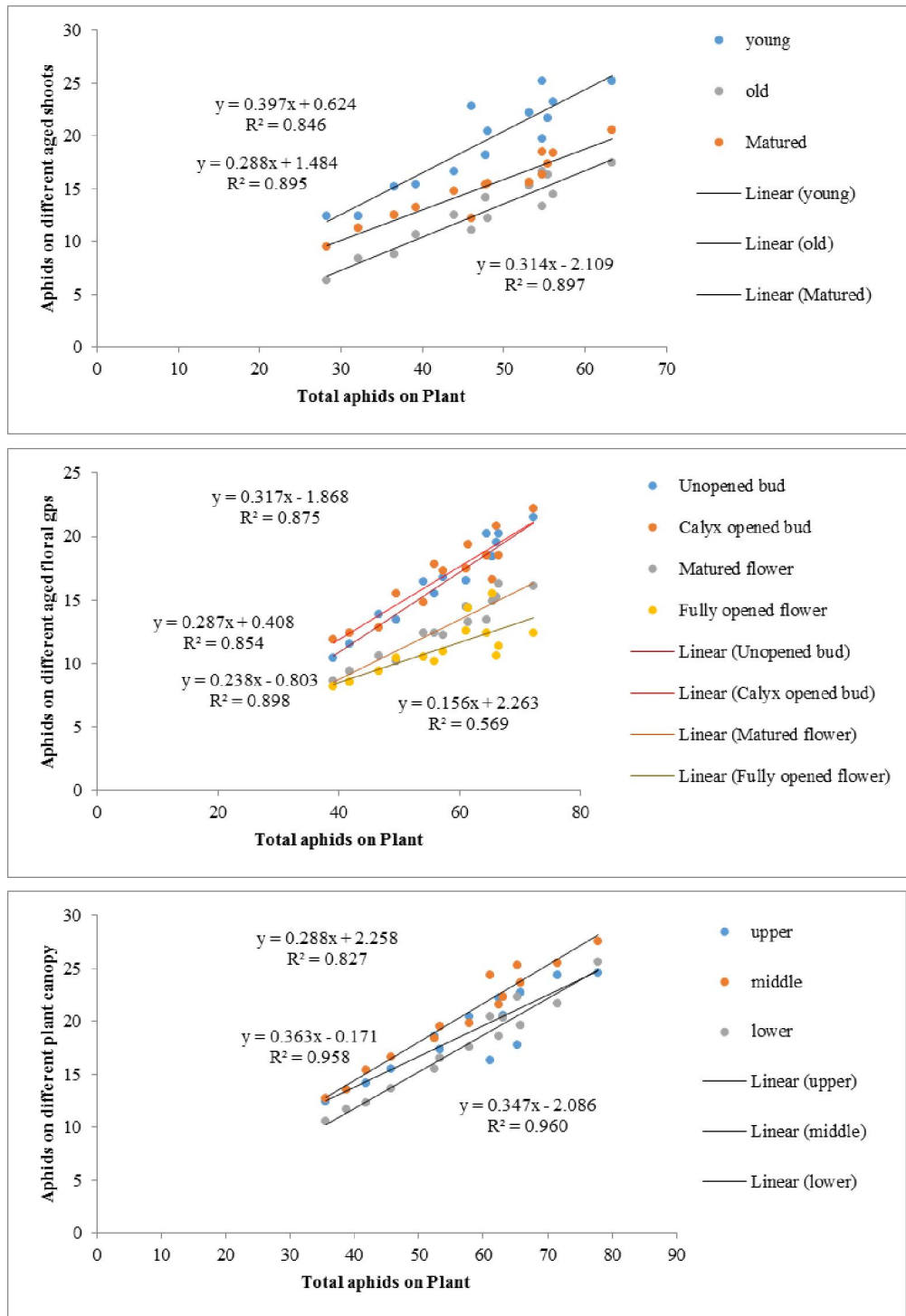
#### **4.1.25 Aphid distribution on canopy in Ganderbal under polyhouse conditions**

Aphid density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) noticeably demonstrated highest aphids on intermediate canopy level when collated with topmost and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total aphids in a positive way ( $r = 0.96, 0.95$  &  $0.93$ ) respectively (Table 11). Graphical representation showing regression analysis of total aphids against different plant canopy (Fig. 8).

**Table 11: Aphid *Macrosiphum rosae* Linn density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total aphids
		Aphid number/Shoot/Floral group															
Age of shoots	Young	12.40	15.20	16.60	18.20	22.20	22.80	25.20	20.40	23.20	25.20	21.70	19.70	15.40	12.40	19.32±4.37	0.92*
	Matured	11.30	12.50	14.80	15.40	15.60	12.20	16.30	15.50	18.40	20.60	17.40	18.50	13.20	9.53	15.08±3.09	0.90*
	Old	8.40	8.80	12.50	14.20	15.30	11.10	13.30	12.20	14.50	17.50	16.30	16.60	10.60	6.34	12.68±3.30	0.88*
	Total	32.10	36.50	43.90	47.80	53.10	46.10	54.80	48.10	56.10	63.30	55.40	54.80	39.20	28.27		
Age of floral group	Unopened bud	10.40	11.50	13.90	16.40	16.50	14.40	18.40	20.20	19.50	21.50	15.50	20.20	16.80	13.40	16.32±3.38	0.94*
	Calyx opened bud	11.90	12.40	12.80	14.80	17.50	19.40	16.60	18.50	20.80	22.20	17.80	18.50	17.30	15.50	16.86±3.09	0.92*
	Matured flower	8.60	9.40	10.60	12.40	14.50	13.30	14.90	16.30	15.20	16.10	12.40	13.40	12.20	10.20	12.82±2.45	0.89*
	Fully opened flower	8.20	8.50	9.40	10.50	12.60	14.40	15.50	11.40	10.60	12.40	10.20	12.40	10.90	10.40	11.24±2.06	0.75*
	Total	39.10	41.80	46.70	54.10	61.10	61.50	65.40	66.40	66.10	72.20	55.90	64.50	57.20	49.50		
Plant canopy	Upper	12.40	13.50	15.50	18.60	22.20	16.30	17.80	24.60	20.50	22.70	24.40	20.60	17.40	14.20	18.62±3.99	0.96*
	Middle	12.70	13.50	16.60	18.40	21.60	24.40	25.30	27.60	19.80	23.60	25.50	22.30	19.50	15.40	20.44±4.67	0.95*
	Lower	10.50	11.70	13.60	15.50	18.60	20.40	22.30	25.60	17.60	19.60	21.70	20.30	16.50	12.30	17.58±4.45	0.93*
	Total	35.60	38.70	45.70	52.50	62.40	61.10	65.40	77.80	57.90	65.90	71.60	63.20	53.40	41.90		

\*. Correlation is significant at the 0.05 level



**Fig. 8: Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal**

#### **4.1.26 Mite distribution on shoots in Ganderbal under polyhouse conditions**

Perusal of data in (Table 12) revealed that mite population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of matured as well as young age consisted of greater number of mites in comparison to old. Overall mite number exhibited a pronounced and positive relation with mite on young and matured leaves ( $r = 0.80$  and  $0.95$ ). Notably, number of mites found on old leaves more or less exhibit such relationship with total number of mites ( $r = 0.88$ ). It was concluded that matured shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total mites against different aged shoots (Fig. 9).

#### **4.1.27 Mite distribution on flowers in Ganderbal under polyhouse conditions**

The data in (Table 12) revealed that mite population with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of mites were from flower that were matured & fully opened. Overall mite number exhibited a pronounced and positive relation with flower that were fully opened ( $r = 0.86$ ) compared to matured flower, unopened bud and calyx opened bud ( $r = 0.84, 0.75$  and  $0.79$ ) respectively. Graphical representation showing regression analysis of total mites against different aged floral groups (Fig. 9).

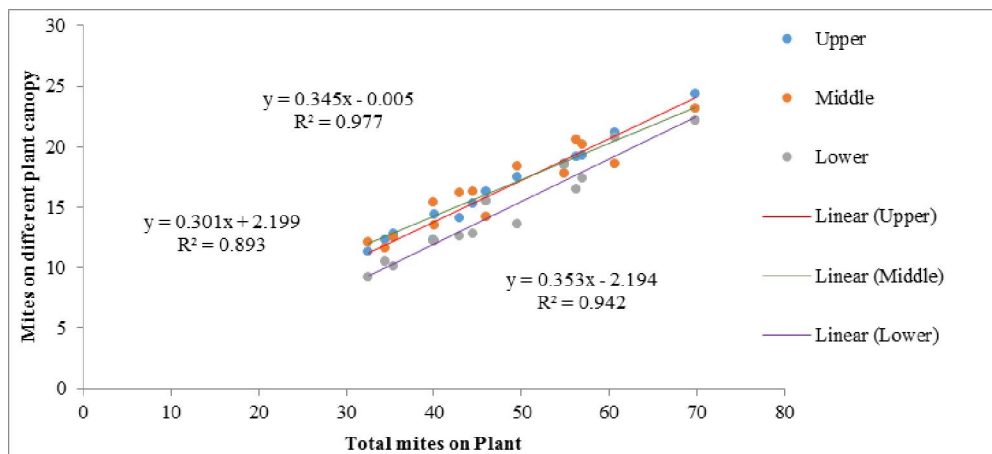
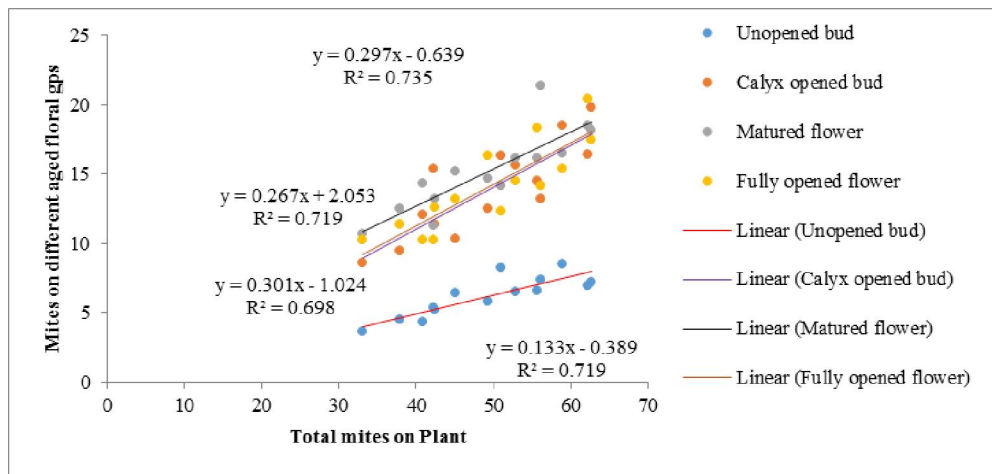
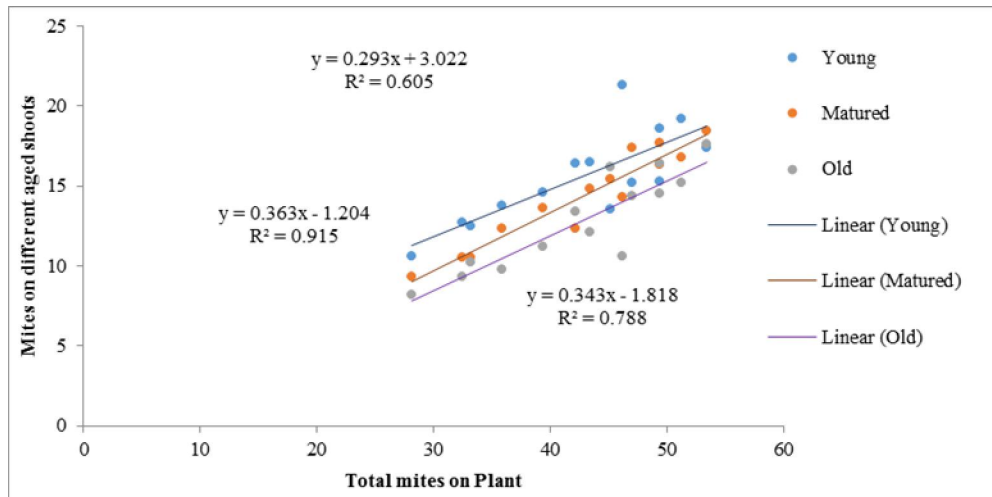
#### **4.1.28 Mite distribution on canopy in Ganderbal under polyhouse conditions**

Mite density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) evidently demonstrated highest mites on intermediate canopy level when collated with topmost and lowermost canopy. Notably, results from correlation exhibited that all the three canopies were definitely affecting total mites in a positive way ( $r = 0.93, 0.94$  and  $0.97$ ) respectively (Table 12). Graphical representation showing regression analysis of total mites against different plant canopy (Fig. 9).

**Table 12: Mite (*Tetranychus urticae* (Koch)) density on different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean $\pm$ SD	Correlation value for total mites
		Mite number/Shoot/Floral group															
Age of shoots	Young	10.60	12.70	13.80	14.60	16.50	18.60	19.20	21.30	16.40	13.50	15.30	17.40	15.20	12.50	15.54 $\pm$ 2.92	0.80*
	Matured	9.30	10.50	12.30	13.60	14.80	16.30	16.80	14.30	12.30	15.40	17.70	18.40	17.40	10.50	14.25 $\pm$ 2.94	0.95*
	Old	8.20	9.30	9.80	11.20	12.10	14.50	15.20	10.60	13.40	16.20	16.40	17.60	14.40	10.20	12.79 $\pm$ 2.98	0.88*
	Total	28.10	32.50	35.90	39.40	43.40	49.40	51.20	46.20	42.10	45.10	49.40	53.40	47.00	33.20		
Age of floral group	Unopened bud	3.60	4.50	5.20	5.80	6.60	6.90	7.40	6.40	5.40	8.20	8.50	7.20	6.50	4.30	6.17 $\pm$ 1.45	0.75*
	Calyx opened bud	8.60	9.50	11.40	12.50	14.50	16.40	13.20	10.30	15.40	16.30	18.50	19.80	15.60	12.10	13.86 $\pm$ 3.34	0.79*
	Matured flower	10.70	12.50	13.20	14.70	16.20	18.50	21.40	15.20	11.30	14.20	16.50	18.20	16.20	14.30	15.22 $\pm$ 2.91	0.84*
	Fully opened flower	10.20	11.40	12.60	16.30	18.30	20.40	14.20	13.20	10.20	12.30	15.40	17.50	14.50	10.20	14.05 $\pm$ 3.21	0.86*
	Total	33.10	37.90	42.40	49.30	55.60	62.20	56.20	45.10	42.30	51.00	58.90	62.70	52.80	40.90		
Plant canopy	Upper	11.30	12.80	14.40	15.30	17.50	19.20	14.10	12.30	18.60	21.20	24.40	19.30	16.30	12.30	16.35 $\pm$ 3.84	0.93*
	Middle	12.10	12.50	13.50	16.30	18.40	20.60	16.20	11.60	17.80	18.60	23.20	20.20	14.20	15.40	16.47 $\pm$ 3.50	0.94*
	Lower	9.20	10.10	12.20	12.80	13.60	16.50	12.60	10.50	18.50	20.80	22.20	17.40	15.50	12.20	14.57 $\pm$ 4.01	0.97*
	Total	32.60	35.40	40.10	44.40	49.50	56.30	42.90	34.40	54.90	60.60	69.80	56.90	46.00	39.90		

\*. Correlation is significant at the 0.05 level



**Fig. 9: Relation between total mites and different aged shoots/ floral group and plant canopy of rose under polyhouse at Ganderbal**

#### **4.1.29 Thrips distribution on shoots in Ganderbal under field conditions**

Perusal of data in (Table 13) revealed that thrip population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of thrips in comparison to matured and old. Overall thrip number exhibited a pronounced and positive relation with thrips on young and matured leaves ( $r = 0.97$  &  $0.94$ ). Notably, thrips found on old leaves did not show such results with total thrips ( $r = 0.69$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total thrips against different aged shoots (Fig. 10).

#### **4.1.30 Thrips distribution on flowers in Ganderbal under field conditions**

Thrips density on different aged floral components *viz.*, young buds (unopened bud of 2-5 days old), calyx opened buds (6-10 days old), matured opened flowers (1-5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of thrips were from flower that were matured. Overall thrip number exhibited a pronounced and positive relation with flower that were matured ( $r = 0.97$ ) as collated with unopened bud, calyx opened bud & flower which were fully opened ( $r = 0.82, 0.86$  and  $0.91$ ) respectively (Table 13). Graphical representation showing regression analysis of total thrips against different aged floral groups (Fig. 10).

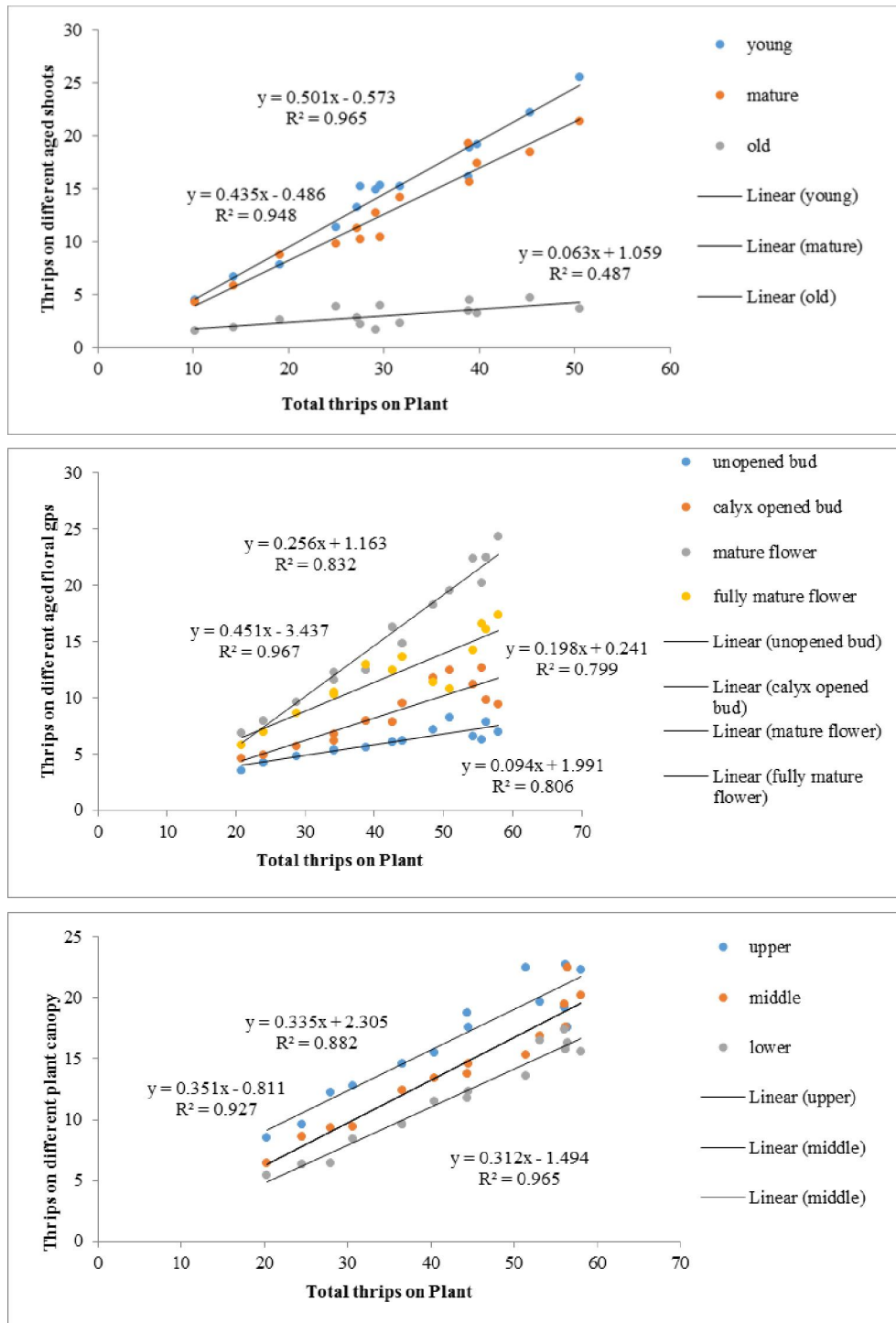
#### **4.1.31 Thrips distribution on canopy in Ganderbal under field conditions**

The data pertaining to (Table 13) showed that thrips density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) vividly demonstrated highest thrip infestation on topmost canopy level when collated with middle and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total thrips in a positive way ( $r = 0.94, 0.96$  &  $0.91$ ) respectively. Graphical representation showing regression analysis of total thrips against different plant canopy (Fig. 10).

**Table 13: Thrip (*Scirtothrips dorsalis*) density on different aged shoots/ floral group and plant canopy of rose under open condition at Ganderbal, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total thrips
		Thrips number/Shoot/Floral group															
Age of shoots	Young	4.50	6.60	7.80	11.40	15.30	18.90	22.20	25.60	19.20	16.20	13.20	15.20	14.90	15.20	14.72±5.86	0.97*
	Matured	4.20	5.80	8.70	9.80	10.40	15.60	18.50	21.40	17.40	19.30	11.20	14.20	12.70	10.20	12.81±5.14	0.94*
	Old	1.50	1.80	2.60	3.80	3.90	4.50	4.70	3.60	3.20	3.40	2.80	2.30	1.60	2.20	2.99±1.09	0.69*
	Total	10.20	14.20	19.10	25.00	29.60	39.00	45.40	50.60	39.80	38.90	27.20	31.70	29.20	27.60		
Age of floral group	Unopened bud	3.50	4.20	4.80	5.30	5.60	6.20	7.10	8.20	7.80	6.30	6.90	6.50	6.10	5.40	5.99±1.31	0.82*
	Calyx opened bud	4.60	4.90	5.70	6.70	7.90	9.50	11.80	12.40	9.80	12.60	9.40	11.20	7.80	6.20	8.60±2.75	0.86*
	Matured flower	6.80	7.90	9.60	11.60	12.40	14.80	18.20	19.50	22.50	20.20	24.30	22.40	16.30	12.20	15.62±5.71	0.97*
	Fully opened flower	5.80	6.90	8.60	10.50	12.90	13.60	11.40	10.80	16.10	16.60	17.40	14.20	12.40	10.30	11.95±3.40	0.91*
	Total	20.70	23.90	28.70	34.10	38.80	44.10	48.50	50.90	56.20	55.50	58.00	54.30	42.60	34.10		
Plant canopy	Upper	8.50	9.60	12.80	14.60	18.80	22.50	22.80	19.20	17.60	22.30	19.70	17.60	15.50	12.20	16.69±4.66	0.94*
	Middle	6.40	8.60	9.40	12.40	13.80	15.30	17.60	19.50	22.50	20.20	16.90	14.60	13.40	9.34	14.28±4.77	0.96*
	Lower	5.40	6.30	8.40	9.60	11.80	13.60	15.80	17.40	16.30	15.60	16.50	12.30	11.50	6.38	11.92±4.15	0.91*
	Total	20.30	24.50	30.60	36.60	44.40	51.40	56.20	56.10	56.40	58.10	53.10	44.50	40.4	27.92		

\*. Correlation is significant at the 0.05 level



**Fig. 10: Relation between total thrips and different aged shoots/ floral group and plant canopy of rose under field at Ganderbal**

#### **4.1.32 Aphid distribution on shoots in Ganderbal under field conditions**

The data in (Table 14) showed that aphid population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of young age consisted of greater number of aphids in comparison to matured and old. Overall aphid number exhibited a pronounced and positive relation with aphid on young and matured leaves ( $r = 0.97$  &  $0.95$ ). Notably number of aphids found on old leaves more or less exhibit such relationship with total number of aphids ( $r = 0.90$ ). It was concluded that young shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total aphids against different aged shoots (Fig. 11).

#### **4.1.33 Aphid distribution on flowers in Ganderbal under field conditions**

The data in (Table 14) showed that aphid population with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of aphids were from bud which were unopened & calyx opened. Overall aphid number exhibited a pronounced and positive relation with bud which were calyx opened ( $r = 0.89$ ) as collated with bud which were unopened, matured flower and fully opened flower ( $r = 0.86, 0.84$  and  $0.82$ ) respectively. Graphical representation showing regression analysis of total aphids against different aged floral group (Fig. 11).

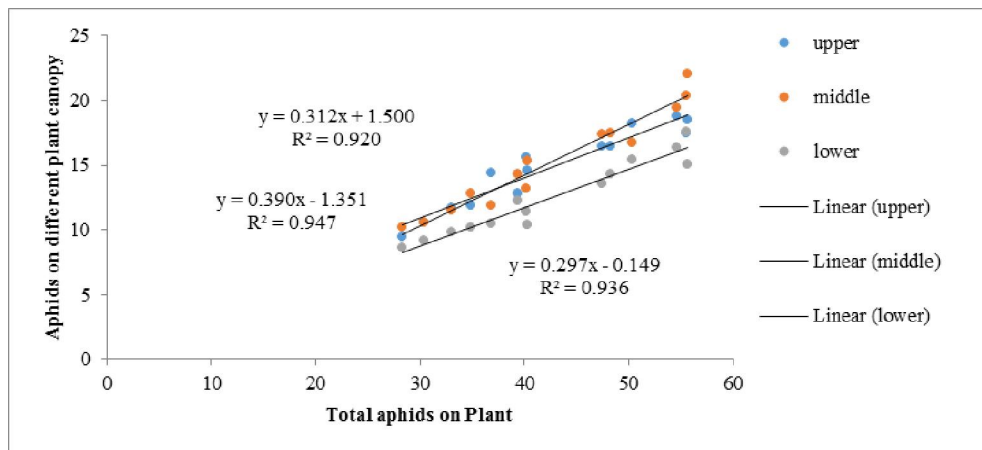
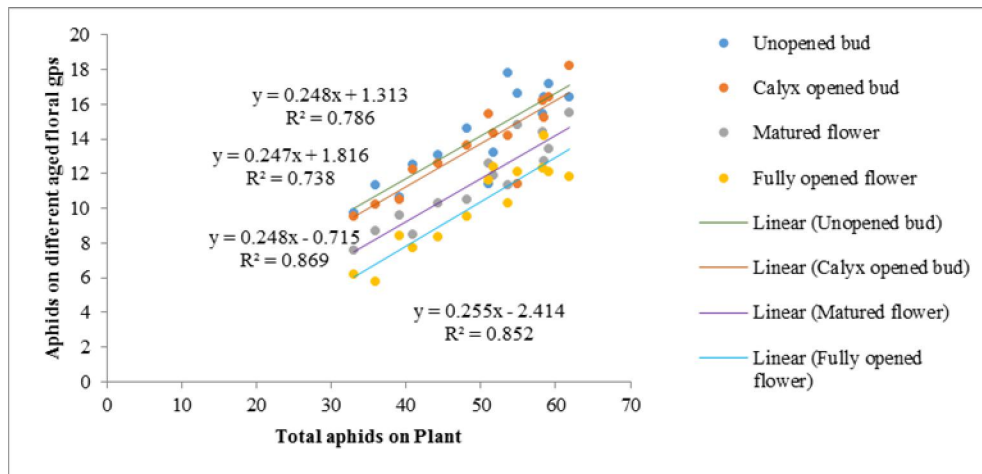
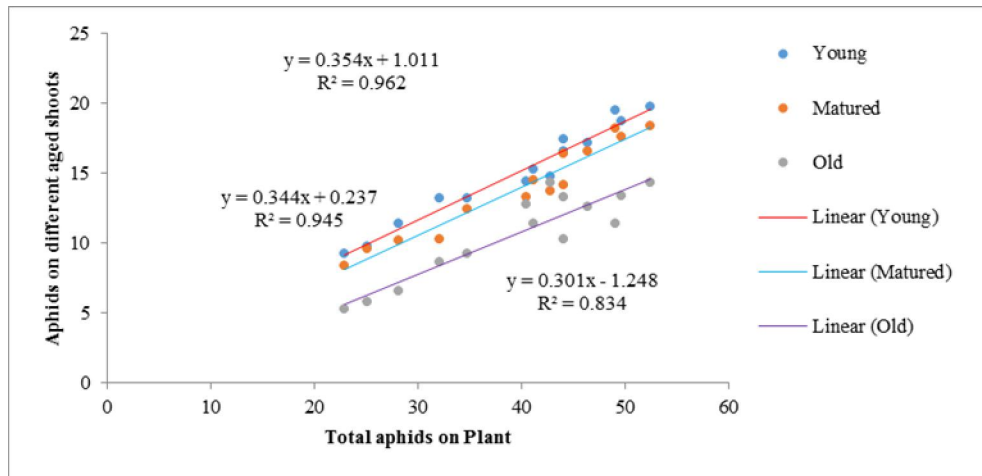
#### **4.1.34 Aphid distribution on canopy in Ganderbal under field conditions**

Aphid density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) noticeably demonstrated highest aphids on intermediate canopy level when collated with topmost and lowermost canopy. Notably results from correlation exhibited that all the three canopies were definitely affecting total aphids in a positive way ( $r = 0.96, 0.95$  and  $0.93$ ) respectively (Table 14). Graphical representation showing regression analysis of total aphids against different plant canopy (Fig. 11).

**Table 14: Aphid *Macrosiphum rosae* Linn density on different aged shoots/ floral group and plant canopy of rose under open condition at Ganderbal, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total aphids
		Aphid number/Shoot/Floral group															
Age of shoots	Young	9.20	9.80	11.40	13.20	15.30	17.20	14.40	14.80	19.50	17.40	18.70	19.80	16.60	13.20	15.03±3.40	0.97*
	Matured	8.40	9.60	10.20	12.40	14.50	16.60	13.30	13.70	18.20	16.40	17.60	18.40	14.20	10.30	13.84±3.33	0.95*
	Old	5.30	5.80	6.60	9.20	11.40	12.60	12.80	14.30	11.40	10.30	13.40	14.30	13.30	8.65	10.66±3.10	0.90*
	Total	22.90	25.20	28.20	34.80	41.20	46.40	40.50	42.80	49.10	44.10	49.70	52.50	44.10	32.15		
Age of floral group	Unopened bud	9.70	10.60	12.50	14.60	13.20	11.40	16.60	17.80	16.40	17.20	16.40	15.40	13.10	11.30	14.01±2.68	0.86*
	Calyx opened bud	9.50	10.50	12.20	13.60	14.30	15.40	11.40	14.20	15.20	16.40	18.20	16.20	12.60	10.20	13.56±3.60	0.89*
	Matured flower	7.60	9.60	8.50	10.50	11.90	12.60	14.80	11.30	12.70	13.40	15.50	14.40	10.30	8.67	11.55±2.48	0.84*
	Fully opened flower	6.20	8.40	7.70	9.50	12.40	11.60	12.10	10.30	14.20	12.10	11.80	12.30	8.34	5.76	10.19±2.57	0.82*
	Total	33.00	39.10	40.90	48.20	51.80	51.00	54.90	53.60	58.50	59.10	61.90	58.30	44.34	35.93		
Plant canopy	Upper	9.50	10.60	11.70	11.90	12.80	16.50	15.60	14.40	18.20	18.80	17.50	18.50	16.50	14.60	14.79±3.07	0.96*
	Middle	10.20	10.60	11.50	12.80	14.30	17.40	13.20	11.90	16.70	19.40	20.40	22.10	17.50	15.30	15.23±3.78	0.95*
	Lower	8.60	9.20	9.80	10.20	12.30	13.60	11.40	10.50	15.40	16.40	17.60	15.10	14.30	10.40	12.48±2.89	0.93*
	Total	28.30	30.40	33.00	34.90	39.40	47.50	40.20	36.80	50.30	54.60	55.50	55.70	48.30	40.30		

\*. Correlation is significant at the 0.05 level



**Fig. 11: Relation between total aphids and different aged shoots/ floral group and plant canopy of rose under field at Ganderbal**

#### **4.1.35 Mite distribution on shoots in Ganderbal under field conditions**

The results in (Table 15) showed that mite population on shoots of varied ages were collated amongst young (between 5 to 20 days), matured (more than 20 to 45 days old) & old (greater than 45 days old), it was concluded that shoots of matured age consisted of greater number of aphids in comparison to young and old. Overall mite number exhibited a pronounced and positive relation with aphid on young and matured leaves ( $r = 0.79$  &  $0.96$ ). Notably, number of mites found on old leaves more or less exhibit such relationship with total number of mites ( $r = 0.89$ ). It was concluded that matured shoots were more dependable for use in sampling units. Graphical representation showing regression analysis of total mites against different aged shoots (Fig. 12).

#### **4.1.36 Mite distribution on flowers in Ganderbal under field conditions**

The data in (Table 15) revealed that mite density with varied aged floral groups including buds of young age (unopened bud of 2 to 5 days old), buds which are calyx opened (6 to 10 days old), matured opened flowers (1 to 5 days old) & fully opened flowers (more than 5 days old) exhibited that highest number of mites were from flower that were fully opened. Overall mite number exhibited a pronounced and positive relation with flower that were fully opened ( $r = 0.91$ ) and calyx opened bud ( $r = 0.92$ ) compared to unopened bud and matured flower ( $r = 0.88$  and  $0.72$ ) respectively. Graphical representation showing regression analysis of total mites against different aged floral groups (Fig. 12).

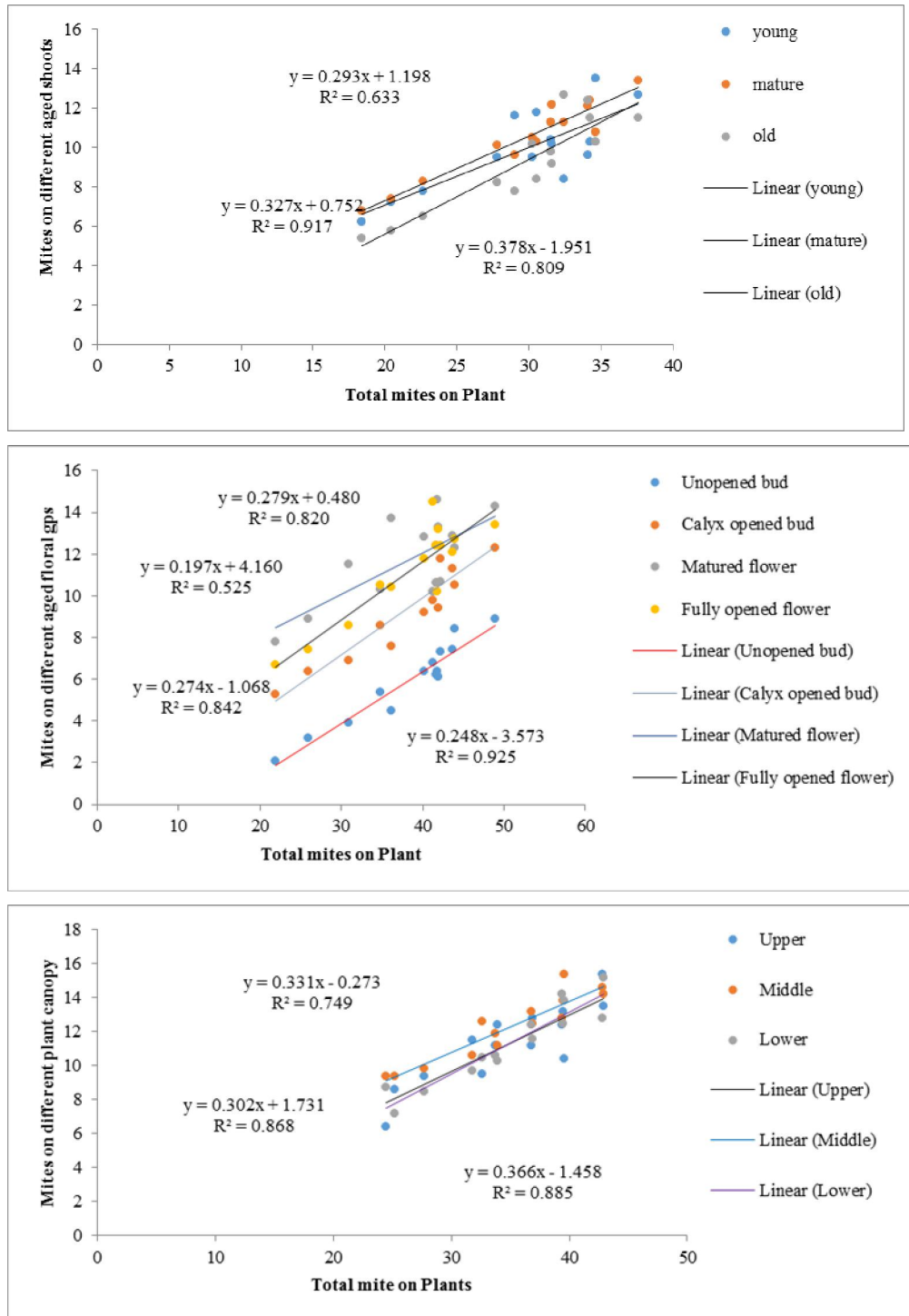
#### **4.1.37 Mite distribution on canopy in Ganderbal under field conditions**

Mite density on different canopy consisting of three levels as shown in: lowest (0 to 50cm from bottom soil level), intermediate (more than 50 to 100 cm from bottom soil level) & topmost (greater than 100cm from bottom soil level) evidently demonstrated highest mites on intermediate canopy level when collated with topmost and lowermost canopy. Notably, results from correlation exhibited that all the three canopies were definitely affecting total mites in a positive way ( $r = 0.87, 0.93$  and  $0.94$ ) respectively (Table 15). Graphical representation showing regression analysis of total mites against different plant canopy (Fig. 12).

**Table 15: Mite (*Tetranychus urticae* (Koch)) density on different aged shoots/ floral group and plant canopy of rose under open condition at Ganderbal, 2019**

Standard Meteorological Week		14	16	18	20	22	24	26	28	30	32	34	36	38	40	Mean ± SD	Correlation value for total mites
		Mite number/Shoot/Floral group															
Age of shoots	Young	6.20	7.20	7.80	11.60	10.40	11.80	13.50	10.30	9.60	8.40	9.50	12.70	10.20	9.50	9.90±2.00	0.79*
	Matured	6.80	7.40	8.30	9.60	11.30	10.30	10.80	12.40	12.10	11.30	10.50	13.40	12.20	10.10	10.46±1.92	0.96*
	Old	5.40	5.80	6.50	7.80	9.80	8.40	10.30	11.50	12.40	12.70	10.20	11.50	9.20	8.20	9.26±2.36	0.89*
	Total	18.40	20.40	22.60	29.00	31.50	30.50	34.60	34.20	34.10	32.40	30.20	37.60	31.60	27.80		
Age of floral group	Unopened bud	2.10	3.20	3.90	4.50	6.40	6.20	7.40	6.40	6.10	6.80	8.40	8.90	7.30	5.40	5.92±1.93	0.88*
	Calyx opened bud	5.30	6.40	6.90	7.60	9.20	12.40	11.30	10.60	9.40	9.80	10.50	12.30	11.80	8.60	9.43±2.24	0.92*
	Matured flower	7.80	8.90	11.50	13.70	12.80	10.60	12.90	14.60	13.30	10.20	12.30	14.30	10.70	10.30	11.70±2.00	0.72*
	Fully opened flower	6.70	7.40	8.60	10.40	11.80	12.40	12.10	10.20	13.20	14.50	12.70	13.40	12.40	10.50	11.16±2.31	0.91*
	Total	21.90	25.90	30.90	36.20	40.20	41.60	43.70	41.80	42.00	41.30	43.90	48.90	42.20	34.80		
Plant canopy	Upper	8.60	9.40	11.50	12.80	13.20	15.40	12.40	11.20	10.40	12.40	13.50	11.20	9.50	6.40	11.27±2.30	0.87*
	Middle	9.40	9.80	10.60	12.50	13.80	14.60	11.20	11.90	15.40	12.80	14.20	13.20	12.60	9.40	12.24±1.94	0.93*
	Lower	7.20	8.50	9.70	11.60	12.50	12.80	10.30	10.60	13.80	14.20	15.20	12.40	10.50	8.70	11.28±2.33	0.94*
	Total	25.20	27.70	31.80	36.90	39.50	42.80	33.90	33.70	39.60	39.40	42.90	36.80	32.60	24.50		

\*. Correlation is significant at the 0.05 level



**Fig. 12: Relation between total mites and different aged shoots/ floral group and plant canopy of rose under field at Ganderbal**

## **4.2 To study the seasonal incidence of sucking pests on rose**

### **4.2.1 Incidence of thrips on flower in Shalimar under polyhouse conditions**

The data on the incidence of thrips on flowers of rose was recorded at fortnightly interval and is presented in (Table 16).

As regards thrip incidence on flowers, a low population of 6.21 thrips/flower was recorded during 16th SMW-2019, which gradually increased to 13.52 thrips/flower during 22<sup>th</sup> SMW and recorded maximum during 28<sup>th</sup> SMW (26.67 thrips/flower) with the maximum mean temperature of 37.0<sup>o</sup>C. A gradual decrease in thrips population was observed from 32<sup>nd</sup> SMW (16.34 thrips/flower) to a sudden decrease during 42<sup>th</sup> SMW (5.22 thrips/flower).

#### **4.2.1.1 Relationship between weather parameters and thrips population**

##### **4.2.1.1.1 Thrips population on flowers**

There was a positive and highly significant correlation between thrips population versus maximum and minimum temperatures with correlation coefficient values of 0.85 and 0.83 respectively. A negative and significant correlation was noticed between minimum relative humidity and thrips population ( $r = -0.80$ ). Similarly, there was also a negative and highly significant correlation between maximum relative humidity and thrips population ( $r = -0.91$ ). The multiple regression analysis ( $R^2$ ) revealed that 85 percent variation in thrips population was due to weather parameters (Table 17). Graphical representation showing effect of different weather parameters on population of thrips (Fig. 13)

##### **4.2.1.2 Crop damage**

Lowest per cent incidence of thrips on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (3.33 percent) during the crop period. The incidence gradually increased from 2<sup>nd</sup> fortnight of May 2019 (33.33 percent) and reached a maximum during 2<sup>nd</sup> fortnight of June (53.33 percent). Later the incidence of thrips gradually decreased from 1<sup>st</sup> fortnight of August (30 percent) to 2<sup>nd</sup> fortnight of October (6.66 percent). (Table 20)

#### **4.2.2 Incidence of Aphids on plant in Shalimar under polyhouse conditions**

The data on the incidence of aphids on rose plant was recorded at fortnightly intervals and presented in (Table 16).

In Aphid incidence on plant population of 12.34 aphids/plant was recorded during 16th SMW-2019, which gradually increased to 18.26 aphids/plant during 22<sup>th</sup> SMW and recorded maximum during 30<sup>th</sup> SMW (32.24 aphids/plant) with the maximum mean temperature of 36.7<sup>0</sup>C. A gradual decrease in aphid population was observed from 32<sup>nd</sup> SMW (23.42 aphids/plant) to a sudden decrease during 42<sup>th</sup> SMW (7.24 aphids/plant).

##### **4.2.2.1 Relationship between weather parameters and aphid population**

###### **4.2.2.1.1 Aphid population on rose plant**

There was a positive and highly significant correlation between aphid population versus maximum and minimum temperatures with correlation coefficient values of 0.86 and 0.89, respectively. A negative and highly significant correlation was noticed between aphid population versus maximum and minimum relative humidity with correlation coefficient values of -0.85 and -0.82, respectively. The regression analysis ( $R^2$ ) indicated that the aphid population showed 82 percent variation with weather parameters (Table 17). Graphical representation showing effect of different weather parameters on population of aphids (Fig. 13)

###### **4.2.2.2 Crop damage**

Per cent incidence of aphid on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (33.33 percent) during the crop period. The incidence gradually increased from 1<sup>st</sup> fortnight of June 2019 (50 percent) and reached a maximum during 2<sup>nd</sup> fortnight of July (63.66 percent). Later the incidence of aphid gradually decreased from 1<sup>st</sup> fortnight of August (40 percent) to 2<sup>nd</sup> fortnight of October (6.66 percent). (Table 21)

### **4.2.3 Incidence of Mites on leaves in Shalimar under polyhouse conditions**

The data on the incidence of mites on leaves of rose was recorded at fortnightly interval and presented in (Table 16).

The mite population on leaves was first recorded during 16<sup>th</sup> SMW which was 14.35mites/leaf. A gradual increasing of mite population was observed from 22<sup>th</sup> SMW (34.15 mites/leaf) and reached a peak during 26<sup>th</sup> SMW (41.32 mites/leaf) with the maximum mean temperature of 36.4 °C. Later, mite population started decreasing from 28<sup>th</sup> SMW (32.43 mites/leaf) to 34<sup>th</sup> SMW (8.25 mites/ leaf). A sudden increase in mite population was observed on 38<sup>th</sup> SMW (11.22 mites/leaf) which then started to decrease from 42<sup>th</sup> SMW (7.24mites/leaf).

#### **4.2.3.1 Relationship between weather parameters and mite population**

##### **4.2.3.1.1 Mite population on leaves**

There was a positive and significant correlation between mite population versus maximum and minimum temperatures with correlation coefficient values of 0.52 and 0.61, respectively. A negative and significant correlation was noticed between mite population versus maximum and minimum relative humidity with correlation coefficient values of -0.50 and -0.36, respectively. The regression analysis ( $R^2$ ) indicated that mite population showed 46 percent variation with weather parameters (Table 17). Graphical representation showing effect of different weather parameters on population of mites (Fig. 13)

##### **4.2.3.2 Crop damage**

Lowest per cent incidence of mites on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (26.66 percent) during the crop period. The incidence gradually increased from 1<sup>st</sup> fortnight of May 2019 (50 percent) and reached a maximum during 1<sup>st</sup> fortnight of June (60 percent). Later the incidence of mites gradually decreased from 1<sup>st</sup> fortnight of July (46.66 percent) to 2<sup>nd</sup> fortnight of October (6.66 percent). (Table 22)

**Table 16: Seasonal Incidence of sucking pests on rose under polyhouse at Shalimar, 2019**

<b>Observation Period (2019)</b>	<b>Standard Meteorological Week</b>	<b>Aphids/ Plant</b>	<b>Thrips/ Flowers</b>	<b>Mites/leaf</b>
<b>Spring</b>	16	12.34	6.21	14.35
	18	14.43	8.16	19.23
	20	16.56	10.23	26.68
	22	18.26	13.52	34.15
<b>Summer</b>	24	22.63	15.58	39.26
	26	25.42	18.25	41.32
	28	27.50	26.67	32.43
	30	32.24	23.36	25.46
	32	23.42	16.34	16.62
	34	18.14	12.65	8.25
<b>Autumn</b>	36	14.22	14.26	9.24
	38	12.30	12.65	11.22
	40	10.52	10.32	12.13
	42	7.24	5.22	7.24
<b>Mean</b>		<b>18.23</b>	<b>13.81</b>	<b>21.25</b>

**Table 17: Relationship between population of sucking pests and weather parameters under protected conditions in Shalimar, 2019**

Sucking pests (Thrips, Aphids and Mites)	Correlation coefficient values (r)				R <sup>2</sup>	Multiple Regression equation
	Temperature (°C)		Relative Humidity (%)			
	Minimum (X <sub>1</sub> )	Maximum (X <sub>2</sub> )	Minimum (X <sub>3</sub> )	Maximum (X <sub>4</sub> )		
Number of thrips/ flower	0.83**	0.85**	-0.80**	-0.91**	0.85	Y=31.809+0.297X <sub>1</sub> + 0.305X <sub>2</sub> +0.287X <sub>3</sub> -0.815X <sub>4</sub>
Number of aphids/ plant	0.89**	0.86**	-0.82**	-0.85**	0.82	Y=22.692+0.704X <sub>1</sub> +0.213 X <sub>2</sub> +0.003X <sub>3</sub> -0.441 X <sub>4</sub>
Number of mites/ leaf	0.61**	0.52**	-0.36*	-0.50**	0.46	Y= -35.515+1.422 X <sub>1</sub> +0.467 X <sub>2</sub> +1.530 X <sub>3</sub> - 1.095X <sub>4</sub>

\*. Correlation is significant at the 0.05 level

\*\* . Correlation is significant at the 0.01 level

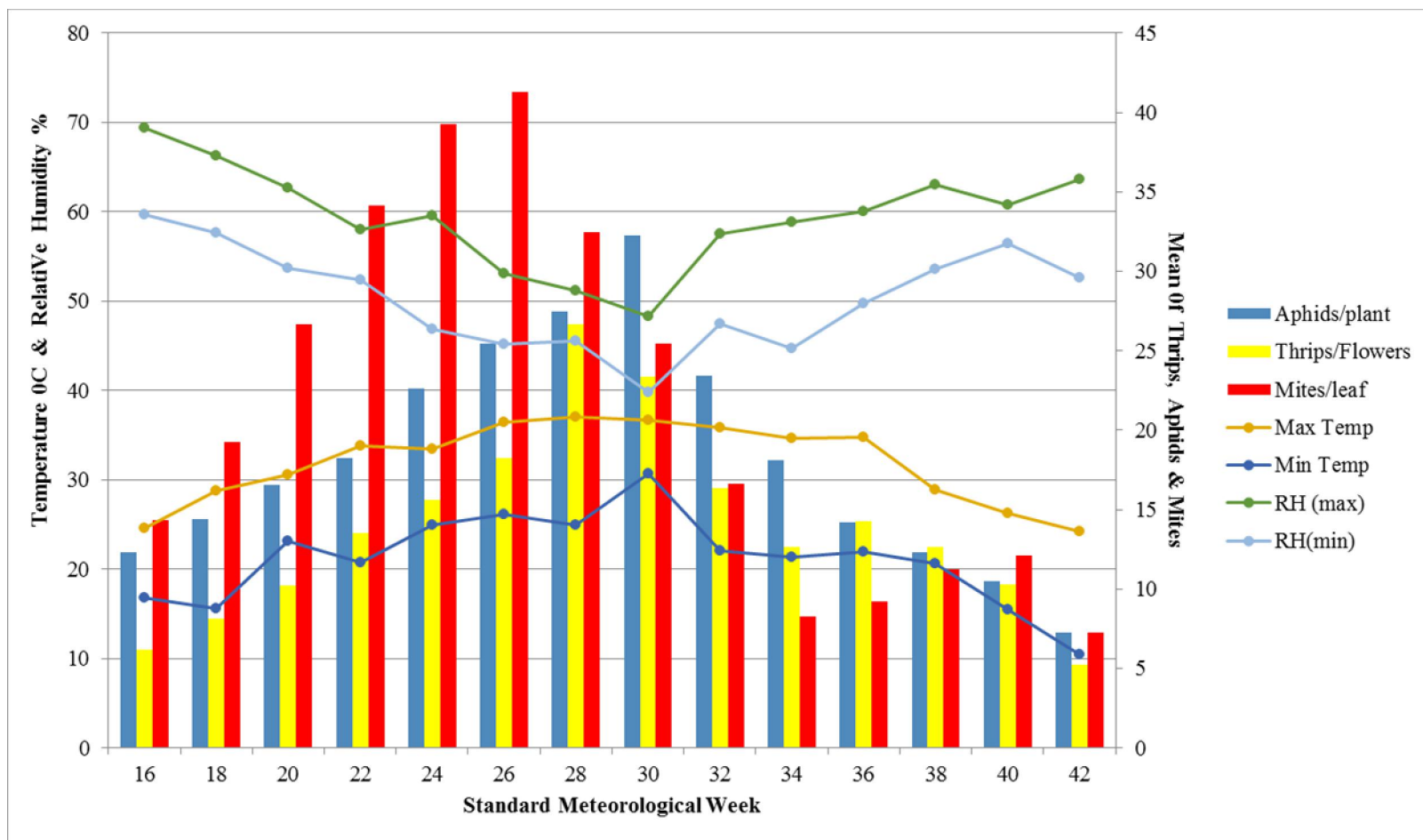


Fig. 13: Seasonal incidence of major sucking pests on rose under protected condition at Shalimar during the year 2019

#### **4.2.4 Incidence of thrips on flower in Shalimar under field conditions**

The data on the incidence of thrips on flowers of rose was recorded at fortnightly interval and presented in (Table 18).

As regards thrip incidence on flowers, a low population of 1.26 thrips/flower was recorded during 16th SMW 2019, which gradually increased to 14.38 thrips/flower during 22<sup>th</sup> SMW and recorded maximum during 30<sup>th</sup> SMW (29.62 thrips/flower) with the maximum mean temperature of 34.5 °C. A gradual decrease in thrip population was observed from 32<sup>nd</sup> SMW (23.44 thrips/flower) to a sudden decrease during 42<sup>th</sup> SMW (4.32 thrips/flower).

##### **4.2.4.1 Relationship between weather parameters and thrips population**

###### **4.2.4.1.1 Thrip population on flowers**

There was a positive and highly significant correlation between thrip population versus maximum and minimum temperatures with correlation coefficient values of 0.82 and 0.87 respectively. A negative and highly significant correlation was noticed between minimum relative humidity and thrips population ( $r = -0.92$ ). Similarly, there was also a negative and highly significant correlation between maximum relative humidity and thrips population ( $r = -0.88$ ). Rainfall have negative and non- significant correlation ( $r = -0.08$ ) with thrip population. The multiple regression analysis ( $R^2$ ) revealed that 93 percent variation in thrips population was due to weather parameters (Table 19). Graphical representation showing effect of different weather parameters on population of thrips (Fig. 14).

###### **4.2.4.2 Crop damage**

Lowest per cent incidence of thrips on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (3.33 percent) during the crop period. The incidence gradually increased from 2<sup>nd</sup> fortnight of May 2019 (23.33 percent) and reached a maximum during 2<sup>nd</sup> fortnight of July (46.66 percent). Later the incidence of thrips gradually decreased from 1<sup>st</sup> fortnight of September (43.33 percent) to 2<sup>nd</sup> fortnight of October (6.66 percent). (Table 20)

#### **4.2.5 Incidence of Aphids on plant in Shalimar under field conditions**

The data on the incidence of aphids on rose plant was recorded at fortnightly interval and is presented in (Table 18)

Low population of 7.26 aphids/plant was recorded during 16th SMW-2019, which gradually increased to 14.24 aphids/plant during 22<sup>th</sup> SMW and recorded maximum during 30<sup>th</sup> SMW (26.25 aphids/plant) with the maximum mean temperature of 34.5<sup>o</sup>C. A gradual decrease in aphid population was observed from 34<sup>nd</sup> SMW (24.32 aphids/plant) to a sudden decrease during 42<sup>th</sup> SMW (9.38 aphids/plant).

##### **4.2.5.1 Relationship between weather parameters and aphid population**

###### **4.2.5.1.1 Aphid population on rose plant**

There was a positive and highly significant correlation between aphid population versus maximum and minimum temperatures with correlation coefficient values of 0.78 and 0.93, respectively. A negative and highly significant correlation was noticed between aphid population v/s minimum and maximum relative humidity with correlation coefficient values of -0.83 and -0.85, respectively. Rainfall have negative and significant correlation ( $r = -0.16$ ) with aphid population. The regression analysis ( $R^2$ ) indicated that the aphid population showed 91 percent variation with weather parameters (Table 19). Graphical representation showing effect of different weather parameters on population of aphids (Fig. 14)

###### **4.2.5.2 Crop damage**

Per cent incidence of aphid on rose plant was observed during 2<sup>nd</sup> fortnight of April 2019 (6.66 percent) during the crop period. The incidence gradually increased from 1<sup>st</sup> fortnight of June 2019 (23.33 percent) and reached a maximum during 2<sup>nd</sup> fortnight of July (40 percent). Later the incidence of aphid gradually decreased from 1<sup>st</sup> fortnight of August (33.33 percent) to 2<sup>nd</sup> fortnight of October (10 percent). (Table 21)

#### **4.2.6 Incidence of Mites on leaves in Shalimar under field conditions**

The data on the incidence of mites on leaves of rose was recorded at fortnightly interval and is presented in (Table 19).

The mite population on leaves was first recorded during 16<sup>th</sup> SMW which was 2.34 mites/leaf. A gradual increasing of mite population was observed from 22<sup>th</sup> SMW (11.45 mites/leaf) and reached a peak during 26<sup>th</sup> SMW (22.20 mites/leaf) with the maximum mean temperature of 30.5 °C. Later, mite population started decreasing from 28<sup>th</sup> SMW (16.23 mites/leaf) to 34<sup>th</sup> SMW (9.25 mites/ leaf). A sudden increase in mite population was observed on 36<sup>th</sup> SMW (12.31 mites/leaf) which then started to decrease from 42<sup>th</sup> SMW (5.43mites/leaf).

##### **4.2.6.1 Relationship between weather parameters and mite population**

###### **4.2.6.1.1 Mite population on leaves**

There was a positive and significant correlation between mite population versus maximum and minimum temperatures with correlation coefficient values of 0.56 and 0.62, respectively. A negative and significant correlation was noticed between mite population v/s minimum and maximum relative humidity with correlation coefficient values of -0.78 and -0.73, respectively. Rainfall have negative and significant correlation ( $r = -0.19$ ) with mite population. The regression analysis ( $R^2$ ) indicated that the mite population showed 69 percent variation with weather parameters (Table 19). Graphical representation showing effect of different weather parameters on population of mites (Fig. 14)

###### **4.2.6.2 Crop damage**

Lowest per cent incidence of mites on rose plant was observed during 2<sup>nd</sup> fortnight of April 2019 (3.33 percent) during the crop period. The incidence gradually increased from 2<sup>nd</sup> fortnight of May 2019 (10 percent) and reached a maximum during 2<sup>nd</sup> fortnight of June (30 percent). Later the incidence of mites gradually decreased from 1<sup>st</sup> fortnight of July (23.33 percent) to 1<sup>st</sup> fortnight of October (6.66 percent). (Table 22)

**Table 18: Seasonal Incidence of sucking pests on rose under field at Shalimar, 2019**

<b>Observation Period (2019)</b>	<b>Standard Meteorological Week</b>	<b>Aphids/Plant</b>	<b>Thrips/Flowers</b>	<b>Mites/leaf</b>
<b>Spring</b>	16	7.26	1.26	2.34
	18	5.24	3.76	1.27
	20	11.53	6.35	8.65
	22	14.24	14.38	11.45
<b>Summer</b>	24	17.36	20.54	14.40
	26	19.22	23.26	22.20
	28	22.56	25.16	16.23
	30	26.25	29.62	12.26
	32	20.28	23.44	10.64
	34	24.32	19.24	9.25
<b>Autumn</b>	36	16.78	16.75	12.31
	38	13.35	12.17	13.24
	40	10.45	6.28	8.23
	42	9.38	4.32	5.43
<b>Mean</b>		<b>15.58</b>	<b>14.72</b>	<b>10.56</b>

**Table 19: Relationship between population of sucking pests and weather parameters under open conditions in Shalimar, 2019**

Sucking pests (Thrips, Aphids and Mites)	Correlation coefficient values (r)					R <sup>2</sup>	Multiple Regression equation
	Temperature (°C)		Relative Humidity (%)		Rainfall (mm) (X5)		
	Minimum (X <sub>1</sub> )	Maximum (X <sub>2</sub> )	Minimum (X <sub>3</sub> )	Maximum (X <sub>4</sub> )			
Number of thrips/ flower	0.87**	0.82**	-0.92**	-0.88**	-0.08	0.93	Y=66.267+0.749X <sub>1</sub> +0.09 0X <sub>2</sub> -0.926X <sub>3</sub> - 0.265X <sub>4</sub> +0.226X <sub>5</sub>
Number of aphids/ plant	0.93**	0.78**	-0.83**	-0.85**	-0.16*	0.91	Y=44.786+0.799X <sub>1</sub> +0.14 8X <sub>2</sub> -0.155X <sub>3</sub> - 0.438X <sub>4</sub> +0.035X <sub>5</sub>
Number of mites/ leaf	0.62**	0.56**	-0.78**	-0.73**	-0.19*	0.69	Y=78.803+0.234X <sub>1</sub> - 0.555X <sub>2</sub> -1.043X <sub>3</sub> - 0.103X <sub>4</sub> -0.125X <sub>5</sub>

\*. Correlation is significant at the 0.05 level

\*\* . Correlation is significant at the 0.01 level

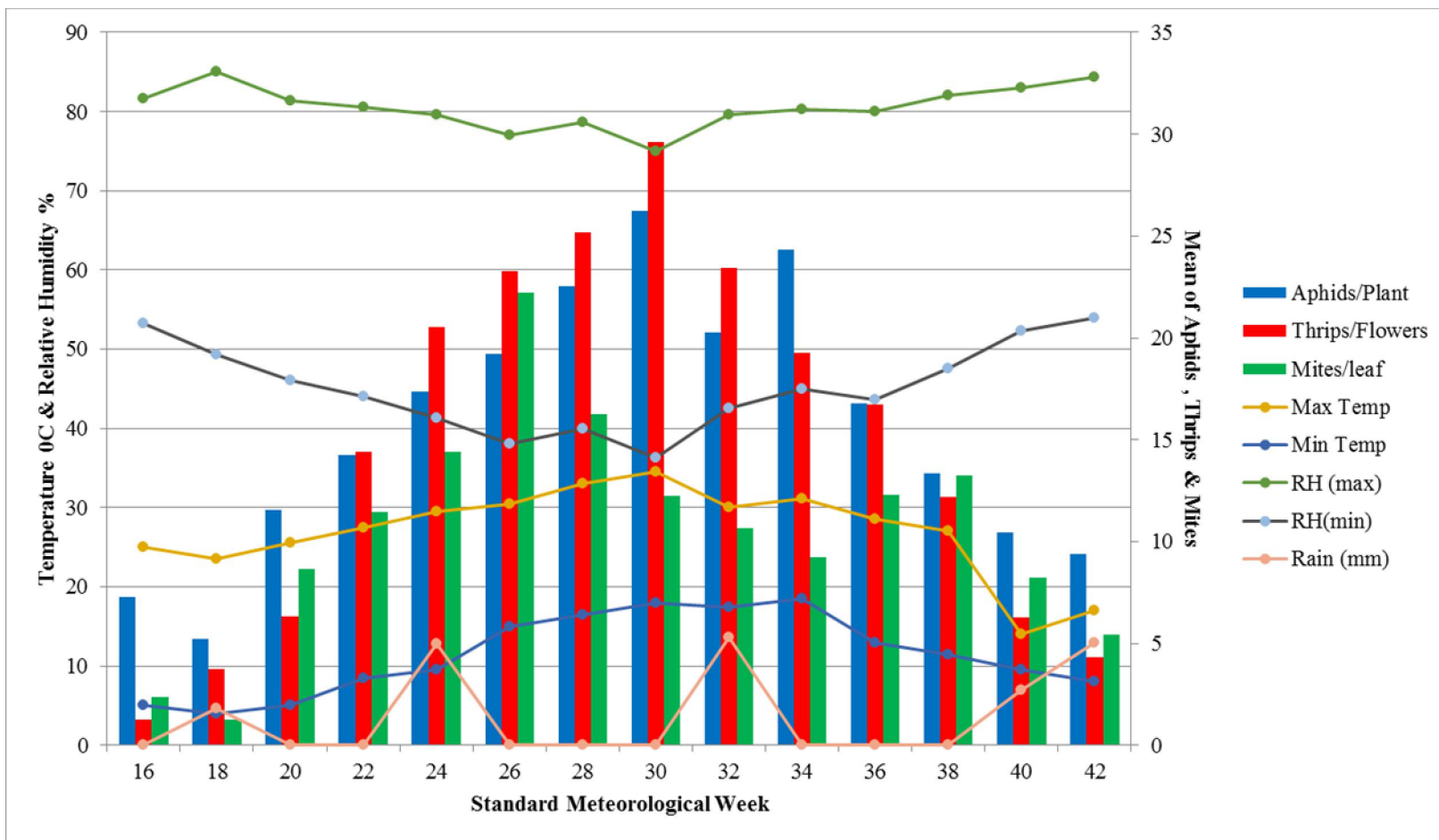


Fig. 14: Seasonal incidence of major sucking pests on rose under open condition at Shalimar during the year 2019

**Table 20: Incidence and Severity index of Thrips under polyhouse and open conditions at Shalimar, 2019**

<b>CW*</b>	<b>SMW**</b>	<b>Per cent incidence (PI)</b>	<b>Severity Index (SI)</b>
<b>under polyhouse conditions</b>			
April I	16	3.33	1.00
April II	18	6.66	1.00
May I	20	16.33	1.00
May II	22	33.33	1.00
June I	24	46.66	1.00
June II	26	53.33	2.00
July I	28	46.66	1.00
July II	30	50.00	2.00
August I	32	30.00	1.00
August II	34	26.66	1.00
Sept I	36	30.00	1.00
Sept II	38	16.33	1.00
October I	40	13.33	1.00
October II	42	6.66	1.00
<b>Mean</b>		<b>27.09</b>	<b>-</b>
<b>under open conditions</b>			
April I	16	3.33	1.00
April II	18	10.00	1.00
May I	20	16.33	1.00
May II	22	23.33	1.00
June I	24	36.66	1.00
June II	26	40.00	1.00
July I	28	43.33	2.00
July II	30	46.66	2.00
August I	32	33.33	1.00
August II	34	40.00	1.00
Sept I	36	43.33	1.00
Sept II	38	23.33	1.00
October I	40	10.00	1.00
October II	42	6.66	1.00
<b>Mean</b>		<b>26.87</b>	<b>-</b>

CW\* Calculated week

SMW\*\* Standard Meteorological Week

**Table 21: Incidence and Severity index of aphids under polyhouse and open conditions at Shalimar, 2019**

CW*	SMW**	Per cent incidence (PI)	Severity Index (SI)
<b>under polyhouse conditions</b>			
April I	16	33.33	1.00
April II	18	40.00	1.00
May I	20	33.33	1.00
May II	22	40.00	1.00
June I	24	50.00	2.00
June II	26	60.00	2.00
July I	28	46.66	1.00
July II	30	63.33	3.00
August I	32	40.00	1.00
August II	34	20.00	1.00
Sept I	36	23.33	1.00
Sept II	38	20.00	1.00
October I	40	13.33	1.00
October II	42	6.66	1.00
<b>Mean</b>		<b>37.17</b>	<b>-</b>
<b>under open conditions</b>			
April I	16	13.33	1.00
April II	18	6.66	1.00
May I	20	16.33	1.00
May II	22	20.00	1.00
June I	24	23.33	1.00
June II	26	26.66	1.00
July I	28	30.00	2.00
July II	30	40.00	2.00
August I	32	33.33	1.00
August II	34	30.00	2.00
Sept I	36	23.33	1.00
Sept II	38	20.00	1.00
October I	40	13.33	1.00
October II	42	10.00	1.00
<b>Mean</b>		<b>22.79</b>	<b>---</b>

CW\* Calculated week

SMW\*\* Standard Meteorological Week

**Table 22: Incidence and Severity index of Mites under polyhouse and open conditions at Shalimar, 2019**

<b>CW*</b>	<b>SMW**</b>	<b>Per cent incidence (PI)</b>	<b>Severity Index (SI)</b>
<b>under polyhouse conditions</b>			
April I	16	26.66	1.00
April II	18	43.33	1.00
May I	20	50.00	2.00
May II	22	46.66	1.00
June I	24	60.00	2.00
June II	26	53.33	2.00
July I	28	46.66	1.00
July II	30	40.00	1.00
August I	32	33.33	1.00
August II	34	20.00	1.00
Sept I	36	23.33	1.00
Sept II	38	20.00	1.00
October I	40	10.00	1.00
October II	42	6.66	1.00
<b>Mean</b>		<b>34.28</b>	-
<b>under open conditions</b>			
April I	16	6.66	1.00
April II	18	3.33	1.00
May I	20	13.33	1.00
May II	22	10.00	1.00
June I	24	20.00	1.00
June II	26	30.00	2.00
July I	28	23.33	1.00
July II	30	16.33	1.00
August I	32	13.33	1.00
August II	34	10.00	1.00
Sept I	36	16.33	1.00
Sept II	38	20.00	1.00
October I	40	6.66	1.00
October II	42	10.00	1.00
<b>Mean</b>		<b>14.23</b>	-

CW\* Calculated week

SMW\*\* Standard Meteorological Week

#### **4.2.7 Incidence of thrips on flower in Ganderbal under polyhouse conditions**

The data on the incidence of thrips on flowers of rose was recorded at fortnightly interval and is presented in (Table 23).

As regards incidence of thrips on flowers, a low population of 4.32 thrips/flower was recorded during 16<sup>th</sup> SMW-2019, which gradually increased to 16.47 thrips/flower during 22<sup>th</sup> SMW and recorded maximum during 30<sup>th</sup> SMW (25.53 thrips/flower) with the maximum mean temperature of 42.8<sup>o</sup>C. A gradual decrease in thrips population was observed from 32<sup>nd</sup> SMW (23.34 thrips/flower) to a sudden decrease during 42<sup>th</sup> SMW (6.37 thrips/flower).

##### **4.2.7.1 Relationship between weather parameters and thrips population**

###### **4.2.7.1.1 Thrip population on flowers**

There was a positive and highly significant correlation between thrips population versus maximum and minimum temperatures with correlation coefficient values of 0.56 and 0.62 respectively. A negative and significant correlation was noticed between minimum relative humidity and thrip population ( $r = -0.73$ ). Similarly, there was also a negative and highly significant correlation between maximum relative humidity and thrips population ( $r = -0.61$ ). The multiple regression analysis ( $R^2$ ) revealed that 65 percent variation in thrips population was due to weather parameters (Table 24). Graphical representation showing effect of different weather parameters on population of thrips (Fig. 15)

###### **4.2.7.2 Crop damage**

Lowest per cent incidence of thrips on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (10 percent) during the crop period. The incidence gradually increased from 2<sup>nd</sup> fortnight of May 2019 (30 percent) and reached a maximum during 2<sup>nd</sup> fortnight of July (50 percent). Later the incidence of thrips gradually decreased from 1<sup>st</sup> fortnight of August (46.66 percent) to 2<sup>nd</sup> fortnight of October (13.33 percent). (Table 27)

#### **4.2.8 Incidence of Aphids on plant in Ganderbal under polyhouse conditions**

The data on the incidence of aphids on rose plant was recorded at fortnightly interval and is presented in (Table 23).

The incidence of 10.21 aphids/plant was recorded during 16th SMW-2019, which gradually increased to 32.45 aphids/plant during 22<sup>th</sup> SMW and recorded maximum during 30<sup>th</sup> SMW (47.13 aphids/plant) with the maximum mean temperature of 42.8<sup>o</sup>C. A gradual decrease in aphid population was observed from 32<sup>nd</sup> SMW (36.24 aphids/plant) to a sudden decrease during 42<sup>th</sup> SMW (8.29 aphids/plant).

##### **4.2.8.1 Relationship between weather parameters and aphid population**

###### **4.2.8.1.1 Aphid population on rose plant**

There was a positive and highly significant correlation between aphid population versus maximum and minimum temperatures with correlation coefficient values of 0.86 and 0.68, respectively. A negative and highly significant correlation was noticed between aphid population v/s minimum and maximum relative humidity with correlation coefficient values of -0.48 and -0.35, respectively. The regression analysis ( $R^2$ ) indicated that the aphid population showed 77 percent variation with weather parameters (Table 24). Graphical representation showing effect of different weather parameters on population of aphids (Fig. 15).

###### **4.2.8.2 Crop damage**

Per cent incidence of aphid on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (20 percent) during the crop period. The incidence gradually increased from 1<sup>st</sup> fortnight of June 2019 (60 percent) and reached a maximum during 2<sup>nd</sup> fortnight of July (70 percent). Later the incidence of aphid gradually decreased from 1<sup>st</sup> fortnight of August (43.33 percent) to 2<sup>nd</sup> fortnight of October (10 percent). (Table 28)

#### **4.2.9 Incidence of Mites on leaves in Ganderbal under polyhouse conditions**

The data on the incidence of mites on leaves of rose was recorded at fortnightly interval and is presented in (Table 23).

The population of mites on leaves was first recorded during 16<sup>th</sup> SMW which was 9.45mites/leaf. A gradual increase in mite population was observed from 22<sup>th</sup> SMW (18.35 mites/leaf) and reached a peak during 26<sup>th</sup> SMW (25.45 mites/leaf) with the maximum mean temperature of 36.2 °C. Later, mite population started decreasing from 28<sup>th</sup> SMW (19.16 mites/leaf) to 34<sup>th</sup> SMW (10.48 mites/ leaf). A sudden increase in mite population was observed on 36<sup>th</sup> SMW (11.52 mites/leaf) which then decreased from 42<sup>th</sup> SMW (8.16mites/leaf).

##### **4.2.9.1 Relationship between weather parameters and mite population**

###### **4.2.9.1.1 Mite population on leaves**

There was a positive significant correlation between mite population versus maximum and minimum temperatures with correlation coefficient values of 0.71 and 0.66, respectively. A negative and non-significant correlation was noticed between mite population v/s minimum and maximum relative humidity with correlation coefficient values of -0.14 and -0.05, respectively. The regression analysis ( $R^2$ ) indicated that the mite population showed 57 percent variation with weather parameters (Table 24). Graphical representation showing effect of different weather parameters on population of mites (Fig. 15)

###### **4.2.9.2 Crop damage**

Lowest per cent incidence of mites on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (20 percent) during the crop period. The incidence gradually increased from 1<sup>st</sup> fortnight of May 2019 (40 percent) and reached a maximum during 2<sup>nd</sup> fortnight of June (60 percent). Later the incidence of mites gradually decreased from 1<sup>st</sup> fortnight of July (36.66 percent) to 2<sup>nd</sup> fortnight of October (3.33 percent). (Table 29)

**Table 23: Seasonal Incidence of sucking pests on rose under polyhouse at Ganderbal, 2019**

<b>Observation Period (2019)</b>	<b>Standard Meteorological Week</b>	<b>Aphids/Plant</b>	<b>Thrips/Flowers</b>	<b>Mites/leaf</b>
<b>Spring</b>	16	10.21	4.32	9.45
	18	18.34	9.45	11.64
	20	24.26	12.56	15.84
	22	32.45	16.47	18.35
<b>Summer</b>	24	26.57	13.23	20.58
	26	31.15	15.75	25.45
	28	39.28	18.28	19.16
	30	47.13	25.53	16.38
	32	36.24	23.34	14.35
	34	25.62	24.48	10.48
<b>Autumn</b>	36	22.47	19.15	11.52
	38	15.23	14.25	13.47
	40	13.72	11.21	10.22
	42	8.29	6.37	8.16
<b>Mean</b>		<b>25.06</b>	<b>15.31</b>	<b>14.64</b>

**Table 24: Relationship between population of sucking pests and weather parameters under protected conditions in Ganderbal, 2019**

Sucking pests (Thrips, Aphids and Mites)	Correlation coefficient values (r)				R <sup>2</sup>	Multiple Regression equation
	Temperature (°C)		Relative Humidity (%)			
	Minimum (X <sub>1</sub> )	Maximum (X <sub>2</sub> )	Minimum (X <sub>3</sub> )	Maximum (X <sub>4</sub> )		
Number of thrips/ flower	0.62**	0.56**	-0.73**	-0.61**	0.65	Y=42.029+0.384X <sub>1</sub> +0.141X <sub>2</sub> -0.777X <sub>3</sub> +0.075X <sub>4</sub>
Number of aphids/ plant	0.68**	0.86**	-0.48**	-0.35*	0.77	Y= -10.462-0.203X <sub>1</sub> +1.624X <sub>2</sub> -0.705X <sub>3</sub> +0.388 X <sub>4</sub>
Number of mites/ leaf	0.66**	0.71**	-0.14*	-0.05	0.57	Y= - 23.117+ 0.392X <sub>1</sub> + 0.428X <sub>2</sub> + 0.121X <sub>3</sub> +0.132X <sub>4</sub>

\*. Correlation is significant at the 0.05 level

\*\* . Correlation is significant at the 0.01 level

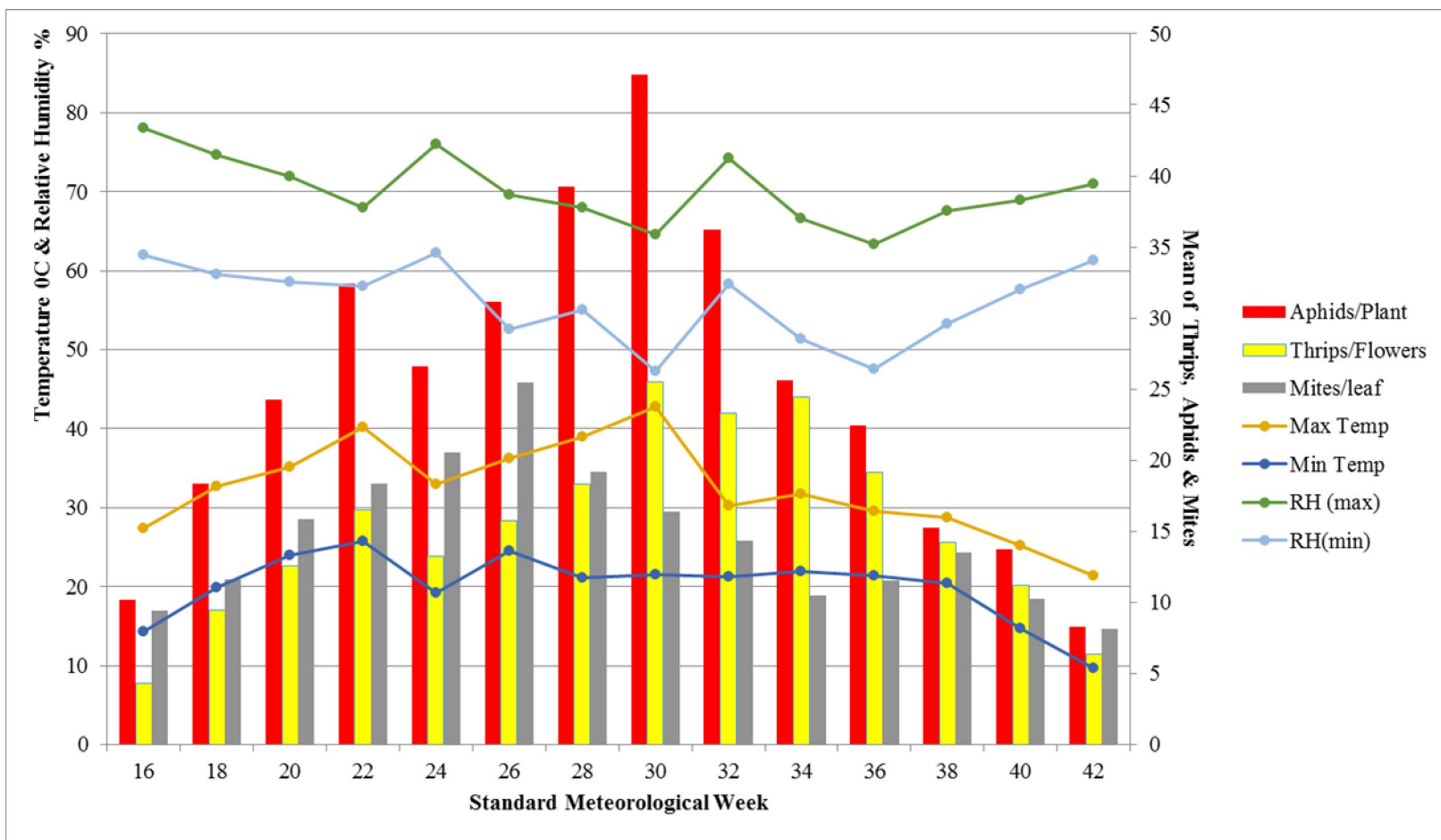


Fig No. 15: Seasonal incidence of major sucking pests on rose under protected condition at Ganderbal during the year 2019

#### **4.2.10 Incidence of thrips on flower in Ganderbal under field conditions**

The data on the incidence of thrips on flowers of rose was recorded at fortnightly interval and is presented in (Table 25).

A low population of 1.13 thrips/flower was recorded during 16th SMW-2019, which gradually increased to 11.38 thrips/flower during 22<sup>th</sup> SMW and recorded maximum during 30<sup>th</sup> SMW (19.72 thrips/flower) with the maximum mean temperature of 31.8 °C. A gradual decrease in thrip population was observed from 32<sup>nd</sup> SMW (16.52 thrips/flower) to a sudden decrease during 42<sup>th</sup> SMW (3.26 thrips/flower).

##### **4.2.10.1 Relationship between weather parameters and thrips population**

###### **4.2.10.1.1 Thrips population on flowers**

There was a positive and highly significant correlation between thrip population versus maximum and minimum temperatures with correlation coefficient values of 0.79 and 0.86 respectively. A negative and highly significant correlation was noticed between minimum relative humidity and thrip population ( $r = -0.71$ ). Similarly, there was also a negative and highly significant correlation between maximum relative humidity and thrip population ( $r = -0.77$ ). Rainfall have negative and significant correlation ( $r = -0.37$ ) with thrip population. The multiple regression analysis ( $R^2$ ) revealed that 82 percent variation in thrip population was due to weather parameters (Table 26). Graphical representation showing effect of different weather parameters on population of thrips (Fig. 16)

##### **4.2.10.2 Crop damage**

Lowest per cent incidence of thrips on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (6.66 percent) during the crop period. The incidence gradually increased from 2<sup>nd</sup> fortnight of May 2019 (20 percent) and reached a maximum during 2<sup>nd</sup> fortnight of July (40 percent). Later the incidence of thrips gradually decreased from 2<sup>nd</sup> fortnight of September (33.33 percent) to 2<sup>nd</sup> fortnight of October (3.33 percent). (Table 27)

#### **4.2.11 Incidence of Aphids on plant in Ganderbal under field conditions**

The data on aphid incidence on rose plant was recorded at fortnightly interval and is presented in (Table 25)

In Aphid incidence on plant, a low population of 6.35 aphids/plant was recorded during 16th SMW-2019, which gradually increased to 14.87 aphids/plant during 22<sup>th</sup> SMW and recorded maximum during 30<sup>th</sup> SMW (23.27 aphids/plant) with the maximum mean temperature of 31.8<sup>o</sup>C. A gradual decrease in aphid population was observed from 34<sup>nd</sup> SMW (13.21 aphids/plant) to a sudden decrease during 42<sup>th</sup> SMW (4.42 aphids/plant).

##### **4.2.11.1 Relationship between weather parameters and aphid population**

###### **4.2.11.1.1 Aphid population on rose plant**

There was a positive and highly significant correlation between aphid population versus maximum and minimum temperatures with correlation coefficient values of 0.78 and 0.61, respectively. A negative and highly significant correlation was noticed between aphid population versus maximum and minimum relative humidity with correlation coefficient values of -0.74 and -0.83, respectively. Also rainfall have negative and significant correlation ( $r = -0.15$ ) with aphid population. The regression analysis ( $R^2$ ) indicated that the aphid population showed 75 percent variation with weather parameters (Table 26). Graphical representation showing effect of different weather parameters on population of aphids (Fig. 16).

###### **4.2.11.2 Crop damage**

Per cent incidence of aphids on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (13.33 percent) during the crop period. The incidence gradually increased from 1<sup>st</sup> fortnight of May 2019 (20 percent) and reached a maximum during 2<sup>nd</sup> fortnight of June (50 percent). Later the incidence of aphid gradually decreased from 1<sup>st</sup> fortnight of August (30 percent) to 2<sup>nd</sup> fortnight of October (6.66 percent). (Table 28)

#### **4.2.12 Incidence of Mites on leaves in Ganderbal under field conditions**

The data on the incidence of mites on leaves of rose was recorded at fortnightly interval and is presented in (Table 25).

The mite population was first recorded during 16<sup>th</sup> SMW which was 4.52 mites/leaf. A gradual increase in mite population was observed from 22<sup>th</sup> SMW (13.61 mites/leaf) and reached a peak during 26<sup>th</sup> SMW (18.23 mites/leaf) with the maximum mean temperature of 26.8 °C. Later, mite population started decreasing from 28<sup>th</sup> SMW (14.32 mites/leaf) to 34<sup>th</sup> SMW (9.25 mites/ leaf). A sudden increase in mite population was observed on 36<sup>th</sup> SMW (10.12 mites/leaf) which then started to decrease from 42<sup>th</sup> SMW (2.10 mites/leaf).

##### **4.2.12.1 Relationship between weather parameters and mite population**

###### **4.2.12.1.1 Mite population on leaves**

There was a positive and significant correlation between mite population versus maximum and minimum temperatures with correlation coefficient values of 0.63 and 0.55, respectively. A negative and significant correlation was noticed between mite population v/s minimum and maximum relative humidity with correlation coefficient values of -0.68 and -0.75, respectively. Also rainfall have negative and significant correlation ( $r = -0.26$ ) with mite population. The regression analysis ( $R^2$ ) indicated that the mite population showed 71 percent variation with weather parameters (Table 26). Graphical representation showing effect of different weather parameters on population of mites (Fig. 16).

###### **4.2.12.2 Crop damage**

Lowest per cent incidence of mites on rose plant was observed during 1<sup>st</sup> fortnight of April 2019 (3.33 percent) during the crop period. The incidence gradually increased from 2<sup>nd</sup> fortnight of May 2019 (16.66 percent) and reached a maximum during 2<sup>nd</sup> fortnight of July (40 percent). Later the incidence of mites gradually decreased from 2<sup>nd</sup> fortnight of September (23.33 percent) to 2<sup>nd</sup> fortnight of October (3.33 percent). (Table 29)

**Table 25: Seasonal Incidence of sucking pests on rose under field at Ganderbal, 2019**

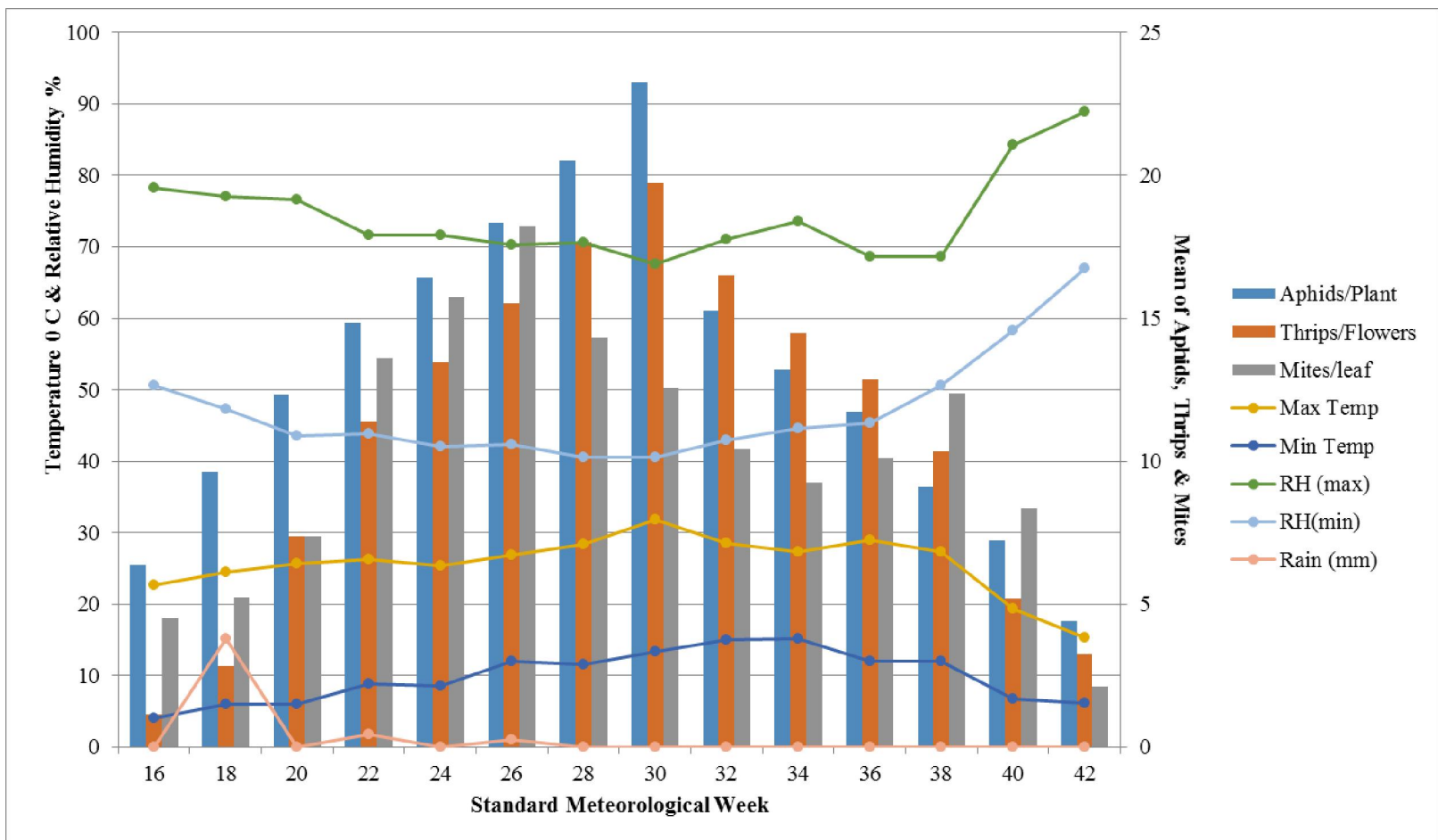
<b>Observation Period (2019)</b>	<b>Standard Meteorological Week</b>	<b>Aphids/ Plant</b>	<b>Thrips/ Flowers</b>	<b>Mites/leaf</b>
<b>Spring</b>	16	6.35	1.13	4.52
	18	9.63	2.82	5.24
	20	12.32	7.37	7.36
	22	14.87	11.38	13.61
<b>Summer</b>	24	16.43	13.45	15.74
	26	18.34	15.54	18.23
	28	20.53	17.68	14.32
	30	23.27	19.72	12.57
	32	15.27	16.52	10.43
	34	13.21	14.48	9.25
<b>Autumn</b>	36	11.73	12.85	10.12
	38	9.12	10.35	12.38
	40	7.23	5.21	8.34
	42	4.42	3.26	2.10
<b>Mean</b>		<b>13.05</b>	<b>10.84</b>	<b>10.30</b>

**Table 26: Relationship between population of sucking pests and weather parameters under open conditions in Ganderbal, 2019**

Sucking pests (Thrips, Aphids and Mites)	Correlation coefficient values (r)				Rainfall (mm) (X5)	R <sup>2</sup>	Multiple Regression equation
	Temperature (°C)		Relative Humidity (%)				
	Minimum (X <sub>1</sub> )	Maximum (X <sub>2</sub> )	Minimum (X <sub>3</sub> )	Maximum (X <sub>4</sub> )			
Number of thrips/ flower	0.86**	0.79**	-0.71**	-0.77**	-0.37*	0.82	Y=32.526+1.085X <sub>1</sub> -0.318X <sub>2</sub> -0.434X <sub>3</sub> -0.04X <sub>4</sub> -0.282X <sub>5</sub>
Number of aphids/ plant	0.61**	0.78**	-0.83**	-0.74**	-0.15*	0.75	Y=27.752+0.442X <sub>1</sub> -0.05X <sub>2</sub> -0.661X <sub>3</sub> +0.184X <sub>4</sub> -0.142X <sub>5</sub>
Number of mites/ leaf	0.55**	0.63**	-0.68**	-0.75**	-0.26*	0.71	Y=172.401+0.479X <sub>1</sub> -2.146X <sub>2</sub> -0.543X <sub>3</sub> -1.161X <sub>4</sub> -0.138X <sub>5</sub>

\*. Correlation is significant at the 0.05 level

\*\* . Correlation is significant at the 0.01 level



**Fig No. 16: Seasonal incidence of major sucking pests on rose under open condition at Ganderbal during the year 2019**

**Table 27: Incidence and Severity index of Thrips under polyhouse and open conditions at Ganderbal, 2019**

CW*	SMW**	Per cent incidence (PI)	Severity Index (SI)
<b>under polyhouse conditions</b>			
April I	16	10.00	1.00
April II	18	16.66	1.00
May I	20	23.33	1.00
May II	22	30.00	1.00
June I	24	40.00	2.00
June II	26	36.66	1.00
July I	28	40.00	1.00
July II	30	50.00	2.00
August I	32	46.66	1.00
August II	34	43.33	1.00
Sept I	36	40.00	1.00
Sept II	38	30.00	1.00
October I	40	20.00	1.00
October II	42	13.33	1.00
<b>Mean</b>		<b>31.42</b>	-
<b>under open conditions</b>			
April I	16	6.66	1.00
April II	18	10.00	1.00
May I	20	10.00	1.00
May II	22	20.00	1.00
June I	24	23.33	1.00
June II	26	30.00	1.00
July I	28	33.33	1.00
July II	30	40.00	2.00
August I	32	33.33	1.00
August II	34	30.00	1.00
Sept I	36	40.00	1.00
Sept II	38	33.33	1.00
October I	40	6.66	1.00
October II	42	3.33	1.00
<b>Mean</b>		<b>22.85</b>	

CW\* Calculated week

SMW\*\* Standard Meteorological Week

**Table 28: Incidence and Severity index of Aphid under polyhouse and open conditions at Ganderbal, 2019**

<b>CW*</b>	<b>SMW**</b>	<b>Per cent incidence (PI)</b>	<b>Severity Index (SI)</b>
<b>under polyhouse conditions</b>			
April I	16	20.00	1.00
April II	18	36.66	2.00
May I	20	50.00	2.00
May II	22	40.00	2.00
June I	24	60.00	2.00
June II	26	63.33	2.00
July I	28	66.66	2.00
July II	30	70.00	3.00
August I	32	43.33	1.00
August II	34	40.00	1.00
Sept I	36	46.66	1.00
Sept II	38	30.00	1.00
October I	40	6.66	1.00
October II	42	10.00	1.00
<b>Mean</b>		<b>41.66</b>	<b>-</b>
<b>under open conditions</b>			
April I	16	13.33	1.00
April II	18	16.66	1.00
May I	20	20.00	1.00
May II	22	30.00	1.00
June I	24	46.66	2.00
June II	26	50.00	2.00
July I	28	33.33	1.00
July II	30	40.00	2.00
August I	32	30.00	1.00
August II	34	20.00	1.00
Sept I	36	20.00	1.00
Sept II	38	16.66	1.00
October I	40	10.00	1.00
October II	42	6.66	1.00
<b>Mean</b>		<b>25.23</b>	<b>-</b>

CW\* Calculated week

SMW\*\* Standard Meteorological Week

**Table 29: Incidence and Severity index of Mite under polyhouse and open conditions at Ganderbal, 2019**

<b>CW*</b>	<b>SMW**</b>	<b>Per cent incidence (PI)</b>	<b>Severity Index (SI)</b>
<b>under polyhouse conditions</b>			
April I	16	20.00	1.00
April II	18	30.00	1.00
May I	20	40.00	2.00
May II	22	53.33	2.00
June I	24	40.00	1.00
June II	26	60.00	2.00
July I	28	36.66	1.00
July II	30	30.00	1.00
August I	32	20.00	1.00
August II	34	10.00	1.00
Sept I	36	23.33	1.00
Sept II	38	10.00	1.00
October I	40	6.66	1.00
October II	42	3.33	1.00
<b>Mean</b>		<b>27.37</b>	<b>-</b>
<b>under open conditions</b>			
April I	16	3.33	1.00
April II	18	10.00	1.00
May I	20	6.66	1.00
May II	22	16.66	1.00
June I	24	13.33	1.00
June II	26	20.00	2.00
July I	28	30.00	1.00
July II	30	40.00	1.00
August I	32	36.66	1.00
August II	34	30.00	1.00
Sept I	36	40.00	2.00
Sept II	38	23.33	1.00
October I	40	10.00	1.00
October II	42	3.33	1.00
<b>Mean</b>		<b>20.23</b>	<b>-</b>

CW\* Calculated week

SMW\*\* Standard Meteorological Week

### **4.3 To screen various rose cultivars against sucking pest damage under open conditions**

#### **4.3.1 Varietal resistance**

Twelve rose varieties were screened at experimental field, Shalimar during 2019. Seven observations were recorded during May-July during the year and the data are presented in the Table. These varieties were grouped into different resistance ratings based on the thrip index.

##### **4.3.1.1 Varietal screening of rose cultivars against thrips under field conditions**

The mean thrip population per flower per plant on different varieties varied from 4.34 – 8.92. Among the twelve varieties screened against thrips, only one variety (Virgo 0.57) was found to be moderately resistant to a score of 0.30 - 0.60. The varieties which were found low resistant to thrips with a score of 0.60 – 0.90 are Arthur bell (0.71), golden gate (0.85), kiss of fire (0.71), American heritage (0.85) and message (0.71) respectively. The varieties Bijazzo (1.00), superstar (1.00) and Naranga (1.14) were found low susceptible with a score of 0.90 – 1.20. Out of the twelve varieties screened against thrips three varieties Okaholoma (1.42), Naomi (1.28) and Noblesse (1.28) were found moderately susceptible against the pest with a score of 1.20 – 1.50. (Table 30)

**Table 30: Varietal screening of rose cultivars against Thrip (*Scirtothrips dorsalis*) infestation during the year 2019**

S. No	Variety	Color	Standard Meteorological week						Mean	Thrip index	Resistance rating
			19	21	23	25	27	29			
			Thrip Number/ flower								
1.	Arthur bell	yellow	4.23	5.52	5.92	6.44	7.64	7.87	6.27	0.71	3
2.	Bijazzo	Bicolor	5.91	6.78	6.56	7.66	5.43	6.96	6.55	1.00	4
3.	Superstar	Orange	6.74	5.35	5.67	6.54	7.60	8.03	6.65	1.00	4
4.	Okaholoma	Maroon red	7.58	7.95	8.86	9.32	9.78	10.07	8.92	1.42	5
5.	Golden gate	Light yellow	4.43	5.26	6.35	6.65	7.16	7.53	6.23	0.85	3
6.	Kiss of fire	Color blend	5.32	2.24	3.56	5.68	6.45	4.31	4.59	0.71	3
7.	American heritage	Color blend	4.54	2.96	5.76	6.54	5.22	6.20	5.20	0.85	3
8.	Virgo	White	2.01	3.22	3.54	5.63	6.34	5.35	4.34	0.57	2
9.	Naomi	Red	5.54	6.41	7.78	8.69	10.67	9.56	8.10	1.28	5
10.	Message	yellow	3.43	4.59	4.86	5.69	6.56	7.75	5.48	0.71	3
11.	Noblesse	Reddish pink	5.65	6.85	7.42	7.62	8.34	9.14	7.50	1.28	5
12.	Naranga	orange	4.65	5.53	8.32	5.71	6.37	6.68	6.21	1.14	4

#### **4.3.1.2 Varietal screening of rose cultivars against aphids under field conditions**

The mean aphid population per plant on different varieties varied from 5.02 – 7.35. Among the twelve varieties screened against aphids, only one variety (Superstar 0.14) was found to be highly resistant to a score of 0.01 -0.30. The varieties which were found low resistant to aphids with a score of 0.60 – 0.90 are Golden gate (0.85) and kiss of fire (0.71) respectively. The varieties Arthur bell (1.00), Naomi (1.14) and Message (1.00) were found low susceptible with a score of 0.90 – 1.20. Out of the twelve varieties screened against aphids three varieties Okaholoma (1.42), Naranga (1.28) and Noblesse (1.28) were found moderately susceptible against the pest with a score of 1.20 – 1.50. Three varieties namely Bijazzo (0.42), American heritage (0.57) and Virgo (0.42) was found to be moderately resistant. (Table 31)

**Table 31: Varietal screening of rose cultivars against Aphid spp. infestation during the year 2019**

S. No.	Variety	Color	Standard Meteorological week						Mean	Aphid index	Resistance rating
			19	21	23	25	27	29			
			Aphid Number/ Plant								
1.	Arthur bell	yellow	4.34	5.24	6.32	6.48	7.12	7.22	6.12	1.00	4
2.	Bijazzo	Bicolor	4.32	4.57	5.65	3.34	5.56	6.68	5.02	0.42	2
3.	Superstar	Orange	5.24	4.45	3.43	5.53	4.22	3.23	4.35	0.14	1
4.	Okaholoma	Maroon red	5.22	6.35	6.86	7.42	7.76	8.86	7.07	1.42	5
5.	Golden gate	Light yellow	4.27	5.26	5.58	6.22	7.14	7.26	5.95	0.85	3
6.	Kiss of fire	Color blend	5.35	7.76	4.78	5.93	4.32	4.25	5.39	0.71	3
7.	American heritage	Color blend	2.34	5.06	6.43	5.74	6.63	4.26	5.08	0.57	2
8.	Virgo	White	4.68	5.82	4.47	3.59	6.36	5.28	5.03	0.42	2
9.	Naomi	Red	5.12	5.88	6.46	7.25	7.66	8.32	6.78	1.14	4
10.	Message	yellow	3.84	5.39	6.78	4.55	7.52	6.24	5.72	1.00	4
11.	Noblesse	Reddish pink	5.22	6.28	7.52	9.18	8.36	7.58	7.35	1.28	5
12.	Naranga	orange	5.34	6.45	7.65	8.56	7.52	6.38	6.98	1.28	5

#### **4.3.1.3 Varietal screening of rose cultivars against mites under field conditions**

The mean mite population per leaf per plant on different varieties varied from 7.08 – 9.86. Among the twelve varieties screened against mites, none was found to be neither resistant nor moderately resistant to this pest. The varieties which were found low resistant to mites with a score of 0.60 – 0.90 are Bijazzo (0.85), Golden gate (0.71), American heritage (0.85) and Virgo (0.71) respectively. The varieties Arthur bell (1.14), Superstar (1.14), kiss of fire (1.00), Naomi (1.14), Message (1.00), Noblesse (1.14) and Naranga (1.00) were found low susceptible with a score of 0.90 – 1.20. Out of the twelve varieties screened against mites only one variety Okaholoma (1.42) was found moderately susceptible against the pest with a score of 1.20 – 1.50. (Table 32)

**Table 32: Varietal screening of rose cultivars against Mite (*Tetranychus urticae* (Koch)) infestation during the year 2019**

S. No.	Variety	Color	Standard Meteorological week						Mean	Mite index	Resistance rating
			19	21	23	25	27	29			
			Mite Number/ leaves								
1.	Arthur bell	yellow	7.65	6.22	9.23	8.52	7.87	6.58	7.71	1.14	4
2.	Bijazzo	Bicolor	6.53	8.35	7.45	5.25	8.42	7.56	7.26	0.85	3
3.	Superstar	Orange	5.26	6.62	8.47	10.26	9.53	7.36	7.92	1.14	4
4.	Okaholoma	Maroon red	7.74	8.61	11.42	12.24	9.32	8.72	9.86	1.42	5
5.	Golden gate	Light yellow	5.54	5.79	7.42	8.17	9.22	6.39	7.08	0.71	3
6.	Kiss of fire	Color blend	6.26	7.53	8.48	9.79	8.32	6.38	7.79	1.00	4
7.	American heritage	Color blend	5.33	6.16	6.85	9.52	8.35	7.25	7.24	0.85	3
8.	Virgo	White	6.30	7.28	9.42	8.67	6.45	5.28	7.23	0.71	3
9.	Naomi	Red	6.14	6.68	7.52	8.78	9.38	8.52	7.83	1.14	4
10.	Message	yellow	5.37	6.87	9.22	8.34	9.46	7.58	7.80	1.00	4
11.	Noblesse	Reddish pink	7.54	8.44	9.23	9.56	8.34	5.45	8.09	1.14	4
12.	Naranga	orange	5.38	6.32	8.75	10.36	6.63	7.94	7.56	1.00	4

## Chapter-5

### DISCUSSION

The Results of the present investigation “Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests” was conducted at the experimental field, Division of Floriculture and Landscaping Architecture, Faculty of Horticulture as well as in the experimental field Department of Agriculture, Ganderbal both in field as well as under polyhouse conditions during the year 2019. The findings of the experiments are discussed here under based on the data obtained.

#### **5.1 Conduct of survey to document the insect pest complex on rose under open and polyhouse conditions**

##### **5.1.1 Insect pest complexes**

Surveys revealed that 10 insects and mite pests were damaging rose crop throughout the crop growth period. This included one Thysanoptera, two Hemiptera, two Coleoptera, one Lepidoptera, one Diptera, one Hymenoptera and one Acarina. Reddy (1997) reported 29 insect and mite pests on rose.

##### **5.1.1.1 Sucking pests**

Thrips, *S. dorsalis* was found to cause harm in different parts of rose plant such as, leaves, buds, flowers and shoots in field as well as in polyhouse condition. This was the most severe and major insect pest causing considerable flower loss. Nair *et al.* (1991), Rani and Reddy (2001) also reported that chilli thrips, *S. dorsalis* was one of the devastating pests of rose in polyhouse.

Aphid, *Macrosiphum rosae* was found in clusters on tender shoots, buds and flowers. Nymphs and adults sucked the sap from affected tender parts resulting in loss of vigor. There was distortion and deformation of affected buds. Reddy *et al.* (2001) reported that rose aphid was a very serious pest, both nymphs

and adults sucked the sap from tender shoots, leaves, and flower buds and flowers resulting in loss of plant vitality and flower production.

Whitefly, *Trialeurodes Vaporarium* was found less damaging on rose both in polyhouse and field. Reddy (1997) reported damage of spiraling whitefly, *Aleurodicus disperses* on rose.

#### **5.1.1.2 Foliage Feeders**

Gypsy moth, *Lymantria obfuscata* was found causing huge damage to foliage by feeding on them.

Sawfly, *Endelomyia aethiops* also caused good amount of damage on rose foliage by making holes on leaves and feeding.

Butterfly, *Pieris brassicae* was seen to cause a minor amount of damage on rose foliage.

#### **5.1.1.3 Foliage and flower feeders**

Weevil, *Merhynchites Bicolor* was found to cause damage both to bud as well foliage mostly during April- June.

Flea beetle, *Altica sps* also had same instance of damage found in rose both flower as well as foliage suffered from them.

Crane fly, *Nephrotoma appendiculata* was also seen in both rose foliage and flower but found to be minor pest causing very less or no damage.

#### **5.1.1.4 Non-Insect Pest**

Spider mite, *Tetranychus urticae* was also observed feeding on leaves in silken webbings by sucking the sap. Nair (1975), Puttarudriah (1977), Mali *et al.* (1983) and Reddy (1997) also recorded mite on rose.

### **5.1.2 Thrips distribution on rose plant in Shalimar under field and polyhouse conditions**

A study was conducted to find out which part of the plant gives effective result with respect to thrips density. The aggregate thrips exhibited a positive and definite relation with thrips found on shoots of young age (5 to 20 days old) and matured leaves (>20-45 days old) both in field ( $r = 0.95$  and  $0.83$ , respectively) and polyhouse ( $r = 0.94$  and  $0.91$  respectively). Similar observations were found with Bergh *et al.* (1997), who recorded that thrip levels were found to be higher on young leaves while as Jayanthi and Abraham (2008) outlined that in order to estimate thrip population young leaves were found to be more suitable with variability upto 98 percent. Since flowers are the most preferred and damaged part by thrips, it was found essential to know which stage of the flowers gives good thrips count. Hence present study was conducted. The aggregate thrips exhibited a positive and definite relation with flowers that were matured ( $r = 0.96$ ) as collated with buds that were unopened, calyx opened, matured flower & fully opened flower ( $r = 0.82, 0.85, 0.96$  &  $0.89$ , respectively). In protected condition, flowers that were fully opened and matured had maximum positive relationship with ( $r = 0.95$  and  $0.92$  respectively). Therefore, it was found suitable that thrip sampling could be done both in matured as well as fully opened flowers. Due to the uninterrupted environment in greenhouse, it was observed that thrip number was more in fully opened flower, different from field where population of thrips was interrupted in fully opened flowers particularly by wind. That is why highest count was seen in matured flowers in open field and both fully opened and matured flower in protected condition. To know the thrips distribution in different canopy, and to decide the best canopy level for sampling, present study was conducted. Although thrips were found to be high on uppermost canopy, but statistical analysis by correlation found that all the three canopies were positively affecting the overall thrips both in field as well as in polyhouse. Similar

observations were found with Hegde *et al.* (2017) who reported that all three canopies were positively correlated with total thrips.

### **5.1.3 Aphid distribution on rose plant in Shalimar under field and polyhouse conditions**

A study was conducted to find which part of the plant gives effective result with respect to aphid density. The aggregate aphids exhibited a positive and definite relation with aphid found on shoots of young age (5 to 20 days old) and matured leaves (>20-45 days old) both in field ( $r = 0.90$  and  $0.89$ , respectively) and polyhouse ( $r = 0.94$  and  $0.88$  respectively). Since flowers are also damaged by aphid. Present study was conducted it was to know which stage of the flowers gives good aphid count. The aggregate aphids exhibited a positive and definite relation with calyx opened bud ( $r = 0.90$ ) as collated with bud which is unopened & calyx opened, flower which were matured & fully opened ( $r = 0.82, 0.90, 0.84$  and  $0.84$ , respectively). In polyhouse, unopened bud and calyx opened bud had maximum positive relationship with ( $r = 0.96$  and  $0.94$ , respectively). Hence, both unopened bud and calyx opened bud can be taken for aphid density sampling. To know the aphid distribution in different canopy. Present study was conducted to decide the best canopy level for sampling. Although aphids were found to be high on intermediate canopy, but statistical analysis by correlation found that all the three canopies were positively affecting the overall aphids both in field as well as in polyhouse.

### **5.1.4 Mite distribution on rose plant in Shalimar under field and polyhouse conditions**

A study was conducted to find which part of the plant gives effective result with respect to mite density. The aggregate mites exhibited a positive and definite relation with mites found on leaves of matured aged shoots (more than 20-45 days old) both in field ( $r = 0.95$ , respectively) and polyhouse ( $r = 0.96$  respectively). Since flowers are also preferred and damaged by mites, it was important to know

which stage of the flowers gives good mite count, hence present study was conducted. The aggregate aphids exhibited a positive and definite relation with calyx opened bud and fully opened flower ( $r = 0.92$  and  $0.90$ ) as collated with bud which is unopened & calyx opened, flower which were matured & fully opened ( $r = 0.82, 0.92, 0.73$  and  $0.90$ , respectively). In protected condition, fully opened flowers and matured flowers had maximum positive relationship with ( $r = 0.92$  and  $0.90$ , respectively). Hence, both calyx opened bud and fully opened flowers can be taken for mite density sampling. Present study was conducted to know the mite distribution in different canopy, and to decide the best canopy level for sampling. Although mites were found to be high on intermediate canopy, but statistical analysis by correlation found that all the three canopies were positively affecting the overall mites both in field as well as in polyhouse.

#### **5.1.5 Thrips distribution on rose plant in Ganderbal under field and polyhouse conditions**

A study was conducted to find which part of the plant gives effective result with respect to thrips density. The aggregate thrips exhibited a positive and definite relation with thrips found on shoots of young age (5 to 20 days old) and matured leaves (>20-45 days old) both in field ( $r = 0.97$  and  $0.94$ , respectively) and polyhouse ( $r = 0.91$  and  $0.82$  respectively). Similar observations were found with Bergh *et al.* (1997), who recorded that thrip levels were found to be higher on young leaves while as Jayanthi and Abraham (2008) outlined that in order to estimate thrip population young leaves were found to be more suitable with variability upto 98 percent. Since flowers are the most preferred and damaged part by thrips, it was found essential to know which stage of the flowers gives good thrips count, hence present study was conducted. The aggregate thrips exhibited a positive and definite relation with flowers that were matured ( $r = 0.97$ ) as collated with buds that were unopened, calyx opened, matured flower & fully opened flower ( $r = 0.82, 0.86, 0.97$  &  $0.91$ , respectively). In protected condition, flowers that were fully opened and matured had maximum positive relationship with ( $r =$

0.97 and 0.96 respectively). Therefore, it was found suitable that thrip sampling could be done both in matured as well as fully opened flowers. Due to the uninterrupted environment in greenhouse, it was observed that thrip number was more in fully opened flower, different from field where population of thrips was interrupted in fully opened flowers particularly by wind. That is why highest count was seen in matured flowers in open field and both fully opened and matured flower in protected condition. To know the thrips distribution in different canopy, and to decide the best canopy level for sampling, present study was conducted. Although thrips were found to be high on uppermost canopy, but statistical analysis by correlation found that all the three canopies were positively affecting the overall thrips both in field as well as in polyhouse. Similar observations were found with Hegde *et al.* (2017) who reported that all three canopies were positively correlated with total thrips.

#### **5.1.6 Aphid distribution on rose plant in Ganderbal under field and polyhouse conditions**

A study was conducted to find which part of the plant gives effective result with respect to aphid density. The aggregate aphids exhibited a positive and definite relation with aphid found on shoots of young age (5 to 20 days old) and matured leaves (>20-45 days old) both in field ( $r = 0.97$  and  $0.95$ , respectively) and polyhouse ( $r = 0.92$  and  $0.90$  respectively). Since flowers are also damaged by aphids, it was observed to know which stage of the flowers gives good aphid count, hence present study was conducted. The aggregate aphids exhibited a positive and definite relation with calyx opened bud ( $r = 0.89$ ) as collated with bud which is unopened & calyx opened, flower which were matured & fully opened ( $r = 0.86, 0.89, 0.84$  and  $0.82$ , respectively). In polyhouse, unopened bud and calyx opened bud had maximum positive relationship with ( $r = 0.94$  and  $0.92$ , respectively). Hence, both unopened bud and calyx opened bud can be taken for aphid density sampling. To know the aphid distribution in different canopy, and to decide the best canopy level for sampling, present study was conducted. Although

aphids were found to be high on intermediate canopy, but statistical analysis by correlation found that all the three canopies were positively affecting the overall aphids both in field as well as in polyhouse.

#### **5.1.7 Mite distribution on rose plant in Ganderbal under field and polyhouse conditions**

A study was conducted to find which part of the plant gives effective result with respect to mites' density. The aggregate mites exhibited a positive and definite relation with mites found on leaves of matured aged shoots (more than 20 to 45 days old) both in field ( $r = 0.96$ , respectively) and polyhouse ( $r = 0.95$  respectively). Since flowers are also preferred and damaged part by mites, it was found paramount to know which stage of the flowers gives good mite count, hence present study was conducted. The aggregate aphids exhibited a positive and definite relation with calyx opened bud and fully opened flower ( $r = 0.92$  and  $0.91$ ) as collated with bud which is unopened & calyx opened, flower which were matured & fully opened ( $r = 0.88, 0.92, 0.72$  &  $0.91$  respectively). In protected condition, fully opened flowers and matured flowers had maximum positive relationship with ( $r = 0.86$  and  $0.84$ , respectively). Hence, both calyx opened bud and fully opened flowers can be taken for mite density sampling. To know the mite distribution in different canopy, and to decide the best canopy level for sampling, present study was conducted. Although mites were found to be high on intermediate canopy, but statistical analysis by correlation found that all the three canopies were positively affecting the overall mites both in field as well as in polyhouse.

### **5.2 To study the seasonal incidence of sucking pests on rose**

#### **5.2.1 Incidence of thrips in Shalimar under open and polyhouse conditions**

The data from the table revealed that the thrip infestation started building up from 16<sup>th</sup> SMW which gradually increased and attained the peak during 28<sup>th</sup> - 30<sup>th</sup> SMW both in field and polyhouse. The present findings are supported by the

reports of Guihong *et al.* (2007) who observed a peak population of thrips from April – July. There was a significantly positive correlation between thrips population versus temperature (minimum and maximum) with highest mean population (26.67 thrips/flower) at maximum temperature of 37<sup>0</sup>C. In field also a significantly positive correlation was observed between thrips population versus temperature (minimum and maximum) with highest mean population (29.62 thrips/flower) at maximum temperature of 34.5<sup>0</sup>C. However the effect of rainfall showed negative correlation but not significant. Similar conclusion was observed by Murugan and Jagadish (2004) who recorded that the positive correlation between the thrips population and minimum and maximum temperature and negatively correlated with total rainfall, though not significant.

In relation to RH, negative correlation was noticed between thrips population and RH. The regression analysis depicting the influence of weather parameters on population density of thrips both in polyhouse and field showed that 85 percent and 93 percent variability due to weather parameters. These observations are similar to that observed by Sathyan *et al.* (2017) who reported that the thrips population was negatively correlated with the relative humidity under polyhouse condition. Under field conditions same results were found, Patnaik *et al.* (1986) also observed that relative humidity was negatively correlated with thrips population.

### **5.2.2 Incidence of aphids in Shalimar under open and polyhouse conditions**

During the studies on the seasonal incidence of sucking pests, the aphid population started building up from 16<sup>th</sup> SMW and increased to attain the peak during 22<sup>th</sup> SMW- 30<sup>th</sup> SMW both on field and polyhouse. These observations are similar to that observed by Pal and Sarkar (2010) who recorded the maximum population of aphids during dry summer months (from April – July) which coinciding with the flowering stage.

The population started to decline during 34<sup>st</sup> SMW to 42<sup>th</sup> SMW on plant.

Present findings are in conformity with the findings of Gupta (2016) who reported the decline of aphid population which started to decrease from July onwards. There was a significantly positive correlation between aphid population versus temperature (minimum and maximum) with highest mean population (32.24 aphids/plant) recorded at maximum temperature of 36.7<sup>0</sup>C. In field significantly positive correlation between aphid population versus temperature (minimum and maximum) with highest mean population (26.25 aphids/plant) recorded at maximum temperature of 34.5<sup>0</sup>C. However the effect of rainfall had negative correlation to the population of aphids.

With reference to relative humidity, negative correlation was noticed between aphid population and RH both in field and polyhouse. These observations are similar to that observed by Gupta (2016) who reported negative correlation in between aphid population with the relative humidity.

### **5.2.3 Incidence of mites in Shalimar under open and polyhouse conditions**

During the studies on the seasonal incidence of mites, the population started building up from 16<sup>th</sup> SMW and gradually increased to attain the peak during 26<sup>th</sup> SMW. In field population started building up from 16<sup>th</sup> SMW and gradually increased to attain the peak during 26<sup>th</sup> SMW. The present findings are supported by the reports of Rajkumar (2003) who observed the higher incidence of mites during March - May. Dhooria (1999) reported that infestation of mites *T. urticae* was noticed on field roses during April to June respectively.

The mite population started gradually decreasing from 28<sup>th</sup> SMW to 34<sup>th</sup> SMW and suddenly increased during 36<sup>th</sup> SMW to 38<sup>th</sup> SMW both in field and polyhouse. These observations are similar to that observed by Kumar (2007) who reported the low mite population during June – August and their build up from September onwards. There was significant positive correlation between mite population versus temperature (minimum and maximum) with highest mean population (41.32 mites/leaf) recorded at maximum temperature of 36.4<sup>0</sup>C. In

field also a significantly positive correlation between mite population versus temperature (minimum and maximum) with highest mean population (22.20 mites/leaf) recorded at maximum temperature of 30.5<sup>0</sup>C. Similar observation was detected by Moanaro and Choudhary (2018) who recorded that the mite population was positively correlated with minimum and maximum temperature.

With reference to relative humidity and rainfall, negative correlation was noticed between mite population and RH and rainfall both in field and polyhouse. These observations are similar to that observed by Sathyan *et al.* (2017) who reported that the negative correlation of mite population with the relative humidity and rainfall.

#### **5.2.4 Incidence of thrips in Ganderbal under open and polyhouse conditions**

The data from the table revealed that the thrip infestation started building up from 16<sup>th</sup> SMW which gradually increased and attained the peak during 28<sup>th</sup> - 30<sup>th</sup> SMW both in field and polyhouse. The present findings are supported by the reports of Guihong *et al.* (2007) who observed a peak population of thrips from April – July. There was significant positive correlation between thrips population versus temperature (minimum and maximum) with highest mean population (25.53 thrips/flower) at maximum temperature of 42.8<sup>0</sup>C. In field a significantly positive correlation was observed between thrips population versus temperature (minimum and maximum) with highest mean population (19.72 thrips/flower) at maximum temperature of 31.8<sup>0</sup>C. However the effect of rainfall showed negative correlation but was not significant. Similar conclusion was observed by Murugan and Jagadish (2004) who recorded that the positive correlation between the thrips population and minimum and maximum temperature and negatively correlated with total rainfall though not significant.

In relation to relative humidity, negative correlation was noticed between thrips population and RH. These observations are similar to that observed by Sathyan *et al.* (2017) who reported that the thrips population was negatively

correlated with the relative humidity under polyhouse and field condition. Patnaik *et al.* (1986) also observed that relative humidity were negatively correlated with thrips population.

#### **5.2.5 Incidence of aphids in Ganderbal under open and polyhouse conditions**

During the studies on the seasonal incidence of sucking pests, aphid population started building up from 16<sup>th</sup> SMW and increased to attain the peak during 22<sup>th</sup>- 30<sup>th</sup> SMW both in field and polyhouse. These observations are similar to that observed by Pal and Sarkar (2010) who recorded the maximum population of aphids during dry summer months (from April – July) which coinciding with the flowering stage.

The population started to decline during 34<sup>st</sup> to 42<sup>th</sup> SMW on plant. Present findings are in conformity with the findings of Gupta (2016) who reported the decline of aphid population which started to decrease from July onwards. There was a significantly positive correlation between aphid population versus temperature (minimum and maximum) with highest mean population (47.13 aphids/plant) recorded at maximum temperature of 42.8<sup>o</sup>C. In field a significantly positive correlation between aphid population versus temperature (minimum and maximum) with highest mean population (23.27 aphids/plant) recorded at maximum temperature of 31.8 <sup>o</sup>C. However the effect of rainfall had negative correlation with the population of aphids.

With reference to relative humidity, negative correlation was noticed between aphid population and RH both in field and polyhouse. These observations are similar to that observed by Gupta (2016) who reported negative correlation in between aphid population with the relative humidity.

#### **5.2.6 Incidence of mites in Ganderbal under open and polyhouse conditions**

During the studies on the seasonal incidence of mites, the population started building up from 16<sup>th</sup> SMW and gradually increased to attain the peak

during 26<sup>th</sup> SMW. In field, population started building up from 16<sup>th</sup> SMW and gradually increased to attain the peak during 26<sup>th</sup> SMW. The present findings are supported by the reports of Rajkumar (2003) who observed the higher incidence of mites during March - May. Dhooria (1999) reported that infestation of mites *T. urticae* was noticed on field roses during April to June respectively.

The mite population started gradually decreasing from 28<sup>th</sup> to 34<sup>th</sup> SMW and suddenly increased during 36<sup>th</sup> to 38<sup>th</sup> SMW both in field and polyhouse. These observations are similar to that observed by Kumar (2007) who reported the low mite population during June – August and their build up from September onwards. There was a significantly positive correlation between mite population versus temperature (minimum and maximum) with highest mean population (25.45 mites/leaf) recorded at maximum temperature of 36.2<sup>o</sup>C. In field a significantly positive correlation between mite population versus temperature (minimum and maximum) with highest mean population (18.23 mites/leaf) recorded at maximum temperature of 26.8<sup>o</sup>C. Similar observation was detected by Moanaro and Choudhary (2018) who recorded that the mite population was positively correlated with minimum and maximum temperature.

With reference to relative humidity and rainfall, negative correlation was noticed between mite population and RH and rainfall both in field and polyhouse. These observations are similar to that observed by Sathyan *et al.* (2017) who reported that the negative correlation of mite population with the relative humidity and rainfall.

### **5.3 To screen various rose cultivars against sucking pest damage under open conditions**

#### **5.3.1 Varietal screening of rose cultivars against thrips under field conditions**

Out of the twelve varieties screened, none of them were totally free from thrips in field. However varieties like Virgo (0.57) followed by Arthur bell (0.71),

Golden gate (0.85), Kiss of fire (0.71), American heritage (0.85) and Message (0.71) recorded least infestation of thrips with thrip index between 0.60 – 0.90. While Bijazzo (1.00), Superstar (1.00) and Naranga (1.14) being low susceptible with thrip index between 0.90 – 1.20. Okaholoma (1.42), Naomi (1.28) and Noblesse (1.28) were found to be moderately susceptible with thrip index 1.20 – 1.50. Our results are in agreement with Jhansi Rani and Sridhar (2003) who have reported that flower with yellow petals recorded less thrips than the flowers of red and orange petals.

### **5.3.2 Varietal screening of rose cultivars against aphid under field conditions**

Out of the twelve varieties screened, none of them were totally free from aphid in field. However varieties like Superstar (0.14) were found to be highly resistant with aphid index between 0.01- 0.30 followed by Virgo (0.42), Bijazzo (0.42) and American heritage (0.57) which recorded least infestation of aphids with aphid index between 0.30 – 0.60. While golden gate (0.85) and kiss of fire (0.71) being resistant with aphid index between 0.60 – 0.90. Arthur bell (1.00), Naomi (1.14) and message (1.00) were found to be low susceptible with aphid index 0.90 – 1.20. Okaholoma (1.42), Noblesse (1.28) and Naranga (1.28) were found to be moderately susceptible with aphid index 1.20 – 1.50. Our results are in agreement with Thanlass *et al.* (2018) who have reported that superstar was recorded to be highly resistant to aphids in field conditions.

### **5.3.3 Varietal screening of rose cultivars against mites under field conditions**

Out of the twelve varieties screened, none of them were totally free from mites in field. However varieties like Virgo (0.71), golden gate (0.71), American heritage (0.85) and Bijazzo (0.85) recorded least infestation of mites with mite index between 0.60 – 0.90. While Arthur bell (1.14), Superstar (1.14), kiss of fire (1.00), Naomi (1.14), Message (1.00), Noblesse (1.14) and Naranga (1.00) being

low susceptible with mite index between 0.90 – 1.20. Okaholoma (1.42) was found to be moderately susceptible with mite index 1.20 – 1.50.

## Chapter-6

### SUMMARY AND CONCLUSION

During the survey, 10 species of insect pests including one mite belonging to six insect orders and one Acarina were recorded on rose damaging plants in different seasons and different parts. Out of 10, three were sap suckers (sucking pests), two were foliage feeders, and two were both foliage and flower feeder and one mite pest.

Thrips, whitefly, mite, aphid, gypsy moth, flea beetle and weevil were recorded in polyhouse. However, thrips, aphid, mite and gypsy moth were dominating. Thrips, aphids and mites on rose were dominant pest in both field and polyhouse.

Matured flower as well as young shoot was most suitable plant parts for recording the incidence of thrips in protected as well as in field conditions. These two parameters were found out to be pre-eminent sampling unit in protected as well as in field conditions of Shalimar. Therefore, matured flowers proved to be the most consistent and trustworthy parameter for sampling of thrips. Young shoots can be helpful for recording the thrips count for the duration of non-flowering period. Similarly same was observed in Ganderbal with matured flower and young shoot in polyhouse and in field being preferred parts for thrips and for sampling them.

Young shoots and calyx bud was most suitable plant parts for recording the incidence of aphids in protected as well as in field conditions. These two parameters were regarded as the effective sampling unit in protected as well as in field conditions of Shalimar. Henceforth, calyx bud was the most effective parameter for sampling of aphids Young shoots can be helpful for recording the aphid count for the duration of non- flowering period. Similarly same was observed in Ganderbal with calyx opened bud and young shoot in polyhouse and in field being preferred parts for aphids and for sampling them.

Matured shoot and fully opened flower of the plant was found out to be pre-eminent sampling unit for recording the incidence of mites in protected as well as in field conditions of Shalimar. Therefore fully opened flowers proved to be most trustworthy parameter. Hence, matured shoots can be taken for effective mite count for the duration of non- flowering period. Similarly same was observed in Ganderbal with fully opened flower and matured shoot in polyhouse and in field being preferred parts for mites and for sampling them.

The incidence of thrips (*Scirtothrips dorsalis*) on flowers was maximum during May to July and minimum during September to October both in polyhouse and field in Shalimar and Ganderbal. There was positive correlation between thrips population versus temperature with highest population (thrips/flower) recorded at maximum temperature in polyhouse and in field. With relation to relative humidity and rainfall negative correlation was noticed between thrips population and relative humidity.

The aphid found in rose under polyhouse and field was *Macrosiphum rosae* and the incidence of aphids on plant was maximum during June to July and minimum during September to October. There was a significantly positive correlation between aphid population v/s temperature (minimum and maximum) and negative correlation was noticed between aphid population and RH and rainfall both in polyhouse and field in Shalimar and Ganderbal same situation was observed.

The incidence of mites was maximum during May to June and minimum during July to August and October. Mite found in the polyhouse and field was *Tetranychus urticae*. There was also a significantly positive correlation between mite population v/s temperature and negative correlation was noticed between mite population and RH and rainfall both in polyhouse and field in Shalimar and Ganderbal same situation was observed.

Varietal screening revealed that, none of the varieties were totally free

from thrips, aphid and mite damage. However, varieties like Virgo (0.57) followed by Arthur bell, Golden gate, Kiss of fire, American heritage and Message recorded least infestation of thrips with thrip index between 0.60 – 0.90. While Bijazzo, Superstar and Naranga being low susceptible with thrip index between 0.90 – 1.20. Okaholoma, Naomi and Noblesse were found to be moderately susceptible with thrip index 1.20 – 1.50 were red and pink colors. Varieties with red and pink color flowers were more susceptible and white flower bearing varieties were found promising.

Variety Superstar was found to be highly resistant with aphid index between 0.01- 0.30 followed by Virgo, Bijazzo and American heritage which recorded least infestation of aphids with aphid index between 0.30 – 0.60, While golden gate and kiss of fire being resistant with aphid index between 0.60 – 0.90. Arthur bell, Naomi and message were found to be low susceptible with aphid index 0.90 – 1.20. Okaholoma, Noblesse and Naranga were found to be moderately susceptible with aphid index 1.20 – 1.50.

Varieties like Virgo, golden gate, American heritage and Bijazzo recorded least infestation of mites with mite index between 0.60 – 0.90. While Arthur bell, Superstar, kiss of fire Naomi, Message, Noblesse and Naranga being low susceptible with mite index between 0.90 – 1.20. Okaholoma was found to be moderately susceptible with mite index 1.20 – 1.50.

- The major sucking pests observed on rose during the year 2019 in Shalimar and Ganderbal under protected and open conditions were thrips (*Scirtothrips dorsalis* Hood), aphids (*Macrosiphum rosae* Linn) and mites (*Tetranychus urticae* (Koch)) and other pests like gypsy moth (*Lymantria obfusca* (Walker))
- In population dynamics matured flower and young shoots were found to serve as best sampling unit for thrips in field as well as polyhouse, for aphids young shoots and calyx opened bud serve as fine sampling units in

field as well as polyhouse while as for mites matured shoots and fully opened flowers serve as good sampling unit in field as well as polyhouse at all canopy levels

- The peak incidence of thrips and aphids was observed during June to July and lowest during Sept to Oct while the incidence of mites was peak during April to June and lowest during July to August and October
- Among different varieties against thrips Virgo, Golden Gate, Arthur Bell, Message, Kiss of Fire and American Heritage showed some resistance.
- Among different varieties against aphids' Superstar, Virgo, Bijazzo, Kiss of Fire and American Heritage showed some resistance.

## LITERATURE CITED

- Abdullah-Al-Rahad, M., Rahman, M. S., Akter, T., Akter, J., Rahman, M. A. and Aziz, S. M. S. 2018. Varietal Screening of Mungbean against Whitefly and Aphid. *Journal of Bioscience and Agriculture Research* **18**(1): 1478-1487.
- Ananthakrishan, T. N. 1971. Thrips (Thysanoptera) in agriculture, horticulture and forestry-diagnosis, bionomics and control. *Journal of Scientific and Industrial Research, India* **30**(3): 113-146.
- Ananthakrishan, T. N. and Jagadish, A., 1968. Biological and ecological studies on *Anaphothrips flavicinctus* (Karny). *Journal of Bombay Natural History Society* **65**: 243.
- Anonymous, 2007. The area and production statement of flower crops of India for the year 2007. National Horticulture Board, Gurgaun, Haryana.
- Anonymous, 2011. The area and production statement of flower crops of India for the year 2011. National Horticulture Board, Gurgaun, Haryana.
- Anonymous, 2015-16. Horticultural statistics at a glance 2015-16. Department of Agriculture, Cooperation and Farmers Welfare, Horticultural Statistics Division. Government of India. New Delhi.
- Anonymous, 2016-17. The area and production statement of flower crops of India for the year 2016-17. National Horticulture Board, Gurgaun, Haryana.
- Ayyar, T. V. R. 1963. *Handbook of Economic Entomology for South India*, Second Edition, Supd., Govt. Press, Madras pp. 516.
- Ayyar, T. V. R., Subbiah, M. S. and Krishnamurthy, P. S. 1935. The leaf curl disease of chillies caused by thrips in the Guntur and Madras tracts. *Madras Agricultural Journal* **23**: 403-410.

- Bene, G. D. and Garnai, E. 1990. Infestations of thrips on greenhouse chrysanthemum, gerbera and rose. *Colture-Protette* **19**(10): 69-75.
- Bergh, J. C. and Blanc, J. P. R. 1997. Performance of western flower thrips (Thysanoptera: Thripidae) on cultivars of miniature rose. *Journal of Economic Entomology* **90**(2): 679-688.
- Bhuyan, U., Bhattacharyya and Baruah, A. A. L. H. 2008. Incidence of Scarab Beetles on Rose in Assam. *Insect Environment* **14**(1): 15-16.
- Borah, D. C. 1987. Bioecology of *Polypaghotarsonemus latus* (Banks) (Acari: Tarsonemidae) and *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) infesting chilli and their natural enemies. Ph. D. Thesis, University of Agricultural Sciences, Dharwad (India) pp. 166.
- \*Borthakur, B. 1984. Notes on efficient pest control with special reference to Cachar. *Two and a Bud* **31**(1): 9-12.
- Bose, T. K. and Yadav, L. P. 1989. Commercial flowers, Naya Prokash. Publication, Calcutta pp. 872.
- Butani, D. K. 1974. Pests damaging roses, in India and their control. *Pesticides* **8**(12): 40-42.
- Chauhan, R. P., Vekaria, M. V., Chaudhary, H. K. and Chaudhary, N. J. 2017. Seasonal incidence of sucking pests and their natural enemies in Bt cotton. *Journal of Entomology and Zoology Studies* **5**(5): 1274-1282.
- Cloyd, R. A. 2003. Seasonal abundance and the use of an action threshold for western flower thrips in a cut carnation greenhouse. *Horticultural Technology* **13**: 497-498.

- Dash, P. C. and Naik, A. K. 1998. Thrips fauna associated with rose in Orissa. *Insect Environment* **4**(2): 59.
- Dattatraya, N. S. 2007. Insect Pests Associated with Flower Crops Under South Gujarat Region with Special Reference to Bionomics and Chemical Control of Chrysanthemum Aphids. *M. Sc. (Agri) Thesis*, Department of Agricultural Entomology, NM College of agriculture Navsari Agricultural University.
- Dev, H. N. 1964. Preliminary studies on the biology of the Assam thrips, *Scirtothrips dorsalis* Hood on tea. *Indian Journal of Entomology* **26**(2): 184-194.
- Dhananjaya, K. S. 2007. Incidence and management of mites and thrips on rose under naturally ventilated polyhouse condition. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka.
- Dhandge, S. R., S. A. Bangale, A. S. Vaja and Virani, V. R. 2018. Seasonal Incidence of Sucking Pest of Okra and its Relationship with Weather Parameters in Summer Season. *International Journal of Current Microbiological Applied Science* **7**(11): 2697-2704.
- Dhooria, M. S. 1999. Two spotted spider mite, *Tetranychus urticae* a serious pest of roses in polyhouses and its control. *Journal of Acarology* **14**(1-2): 84-87.
- Farooq, A. and Tasawar, Z. 2007. Varietal Screening of *Brassica spp.* against Aphids in Southern Punjab (Pakistan). *Pakistan Journal of Zoology* **39**(3): 195-198.
- Gahukar, R. T. 1999. New record of thrips attacking roses in central India. *Journal of Insect Sciences* **12**(1): 89.

- Gahukar, R. T. 2003. Factors influencing thrips abundance and distribution on rose flowers in central India. *Journal of Entomology Research* **27**(4): 271-179.
- Ganai, S. A., Ahmad, H., Bandral, R. S., Sharma, S. and Kaur, R. 2018. Evaluation of marigold varieties against red spider mite, *Tetranychus urticae* Koch. *Journal of Entomology and Zoology Studies* **6**(1): 294-296.
- Grzeszkiewicz, W. H. and Witaszek, W. 1994. Evaluating the suitability of 26 rose cultivars grown for cut flowers in heated plastic tunnel. *Zeszyty Naukowe, Instytutu Sadownictwa i kwiaciarnictwa w Skierniewicach* **1**: 85-94.
- Guihong, L., Hongrui, Z., Ziming, L. and Tao L. 2007. Studies on the species of flower thrips and its occurrence in Dounan Chenggong county of Yunnan, Southwest China. *Journal of Agricultural Sciences* **20**(6): 1291-1295.
- Gupta, J. K. 2016. Seasonal Incidence of Insect-Pest Complex on Capsicum (*Capsicum annum* L.) and their management under shade net house. *PhD (Agri) Thesis, Sri Karan Narendra Agriculture University, Jobner, Rajasthan*.
- Hafeez-ur-Rehman, Ayyaz, M. Nadeem, M. and Begum, H. A. 2017. Screening of okra varieties resistance against insect pests under agro climatic conditions of Dera Ismail Khan, Pakistan. *Russian Agricultural Sciences* **43**(2): 149-152.
- Halagatti, S. B. 2006. Ecobiology and management of thrips and mite of rose under polyhouse condition. *M. Sc. (Agri) Thesis, University of Agricultural Sciences, Dharwad (India)*.

- Hegde, J. N., Chakravarthy, A. K., Kumar, N. G., Ashok-Kumar, C. T., Thyagaraj, N. E., Jayanthi, R. and Surendra, H. S. 2017. Population distribution of thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) in rose plant within different plant parameters. *Journal of Entomology and Zoology Studies* **5**(2): 1357-1361.
- Hegde, J. N., Chakravarthy, A. K., Kumar, N. G., Ashok-Kumar, C. T., Thyagaraj, N. E., Jayanthi, R., Surendra, H. S. and Prasanna-Kumar, N. R. 2016. Varietal resistance of rose to thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae). *Pest Management in Horticultural Ecosystems* **22**(2): 169-175.
- Hegde, J. N., Chakravarthy, A. K., Nagamani, M. K. and Prabhakar, M. S. 2011. Management of thrips, *Scirtothrips dorsalis* Hood, on rose under open – field and protected conditions. *Journal of Horticultural Science* **6**(2): 118-122.
- Herrin, B. and Warnock, D. 2002. Resistance of impatiens germplasm to western flower thrips feeding damage. *HortScience* **37**(5): 802-804.
- Hole, U. B. and Salunkhe, G. N. 1997. Incidence of mites in relation to meteorological parameters on rose. *Journal of Maharashtra Agricultural University* **22**(2): 226-230.
- Hole, U. B. and Salunkhe, G. N. 2005. Studies on the relative resistance of rose cultivars to two spotted spider mite (*Tetranychus urticae* Koch.). *Journal of Maharashtra Agricultural University* **30**(3): 316-317.
- Hole, U. B. and Salunkhe, G. N., 1997. Evaluation of certain insecticides against rose thrips, *Rhipiphorothrips cruentatus* Hood. *Pestology* **21**(4): 34-36.

- Jaganmohan, N., Krishnaiah, K. and Prasad, V. G. 1980. Evaluation of insecticides for the control of pests of sweet pepper (*Capsicum annum* var. *grossum* Linn.). *Pestology* **4**: 13-18.
- Jamuna, B., Bheemanna, M., Hosamani, A. C., Timmanna and Naveen, R. 2017. Screening of tomato cultivars (hybrids/varieties) for whitefly, *B. tabaci* in field condition. *International Journal of Current Microbiological Applied Science* **6**(7): 903-908.
- Janakiram, T. 2018. Doubling farmers income through technological interventions in flower crops. *Advances in Floriculture and Urban Horticulture* pp. 3-10.
- Jayanthi, P. D. K. and Abraham, V. 2008. Within plant distribution of pomegranate thrips, *Scirtothrips dorsalis* Hood: Implications for pest population sampling. *Emerging Trends of Researches in Insect Pest Management and Environmental Safety* **4**(1): 65-70.
- Jhansi-Rani, B. and Eswara-Reddy, J. G. 2001. Efficacy of selected insecticides against thrips, *Scirtothrips dorsalis* Hood on rose in polyhouse. *Pest Management of Horticultural Economic* **7**(1): 54-58.
- Jhansi-Rani, B. J. and Sridhar, V. 2003. Screening of polyhouse grown rose varieties for resistance to thrips, *Scirtothrips dorsalis* Hood. *Journal of Ornamental Horticulture*. New Series **6**(3): 165-171..
- Kedar, S. C. Saini, R. K. and Kumaranag, K. M. 2015. Seasonal incidence of whitefly, *Bemisia Tabaci* on some cultivated host plants. *Journal of Insect Science* **28** (2): 231-235.
- Kiran, C. M., Jayalaxmi, N. H., Chakravarthy, A. K., Thippesha, D. and Kalleshwaraswamy, C. M. 2017. Seasonal Incidence of Major Insect and

Mite Pests of Jasmine. *International Journal of Current Microbiology and Applied Sciences* **6**(10): 5060-5070.

\*Kmiec, K. 2007. The occurrence of *Macrosiphum rosae* (L) (Hemiptera: Aphididae) on rose shrubs in Lublin. *Electronic Journal of Polish Agricultural Universities. Series: Horticulture* **10**(2): 23-25.

Kumar, B., Uikey, B. L., Gharde, S. K., Gupta, S. D and Pal, P. K., 2016. Seasonal incidence of White fly and Jassids along with impact of weather parameter on their population builds up in brinjal. *Environment and Ecology* **34**(4A): 1503-1507.

Kumar, G. K. P., Pradeep, S., Sridhara, S. and Manjunatha, M., 2012. Incidence of sucking pests on promising traditional paddy cultivars in organic situation. *Plant Archives* **12**(1): 23-26.

Lee, H. S. and Wen, H. C., 1982. Seasonal occurrence and injury caused by thrips and their control on mangoes. *Plant Protection Bulletin, Taiwan* **24**(3): 179-187.

Mali, A. R., Gandhale, D. N. and Patil, A. S., 1983. Heavy incidence of two spotted spider mite (*Tetranychus urticae*) (Acarina: Tetranychidae) on grape vines and roses. *Acarology News Letter* **12**: 6-7.

Manjula, B. 2005. Performance of rose cultivars under naturally ventilated polyhouse. *M. Sc. Thesis*, Univ. Agril. Sci., Dharwad pp. 98.

Mastoi, A. H., Memon, S. A and Haq, W., 2013. Varietal resistance of okra against whitefly (*Bemisia tabaci*) and fruit borer (*Earias spp*). *Scholarly Journal of Agricultural Science* **3**(3): 78-82.

\*Matsui, T., Ueda, M., Saito, M. and Yosida, A., 2006. Damage to rose flower buds by cotton bollworm, *Helicoverpa armigera* in Ibaraki prefectural

flower park. *Annual Report of the Kanto-Tosan Plant. Protection Society* **53**: 145-147.

Maurya, N. A., Singh, R., Singh, J., Nigam, R., Husain, W. and Kumar, A., 2018. Screening of rapeseed-mustard varieties against mustard aphid (*Lipaphis erysimi*). *South Asian Journal of. Food Technology. and Environment* **4(2)**: 709-716.

Mehrparvar, M., Mobli, M. and Hatami, B., 2008. Seasonal population fluctuations of the rose aphid, *Macrosiphum rosae* (L.) (Hemiptera: Aphididae), on different cultivars of roses and Nastaran. *Journal of Science and Technology of Agriculture and Natural Resources* **12(45B)**: 711-719.

Moanaro and Choudhary, J. S. 2018. Seasonal incidence of major sucking pests complex of Capsicum in relation to weather parameters in Eastern Plateau and Hill region of India. *Journal of Entomology and Zoology Studies* **6(2)**: 270-273.

Mohammad-Munib., Muneer-Ahmad and Arshad-Abass 2015. Survey and screening of different rose cultivars against rose aphid (*Macrosiphum rosae*). *Journal of Eco-friendly Agriculture* **10(2)**: 175-179.

Murugan, D. P. 2000. Host range, bio-ecology and management of *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) damaging rose around Bangalore. M. Sc. Thesis, University of

Murugan, D. P. and Jagadish, A. 2004. Evaluation of suitable technique and determination of appropriate stage for sampling thrips in rose flowers. *International journal of Food, Agriculture and Environment* **2(2)**: 187-189.

- Murugan, D. P. and Jagadish, A. 2004. Population fluctuation of *Scirtothrips dorsalis* Hood on rose in Karnataka. *Insect Environment* **10**(3): 112-113.
- Murugan, D. P. and Jagadish, A. 2006, Screening of rose cultivar to *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae). *Journal of Applied Zoology Research* **17**(2): 204-205.
- Nair, M. R. G. K. 1975. *Insect and mites of crops in India*, ICAR, New Delhi pp. 408.
- Nair, V. V., Reghunath, P. and Visalakshi, A. 1991. Control of thrips *Scirtothrips dorsalis* Hood on rose. *Entomology* **16**(4): 327-329.
- Naqvi, J. 2011. Editorial. Indian flower exports. *Floriculture Today* **16**(2): 8.
- Ningappa, M. S., 1972. Studies on the role of *Scirtothrips dorsalis* Hood (Thysanoptera) and *Polypaghotarsonemus latus* (Banks) (Acarina: Tarsonemidae) in causing chilli leaf curl and their control. *M. Sc. (Agri) Thesis*, University of Agricultural Sciences, Bangalore pp. 60.
- Okada, T. and Kudo, I. 1982. Relative abundance and phenology of Thysanoptera in a tea field. *Japanese Journal of Applied Entomology and Zoology* **26**(2): 96-102.
- Onkara-Naik, S. and Sridhar, V. 2015. Efficacy of colour sticky traps for monitoring chilli thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) on rose. *Pest Management in Horticultural Ecosystems* **21**(1): 101-103.
- Onkarappa, S. and Mallik, B. 1998. Distribution and management of *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) on rose. *Proceeding of National System and Pest Management of Horticultural Crops*, Bangalore pp. 165-167.

- Pal, B. P. 1972. *The rose in India*. Indian Council of Agricultural Research, New Delhi pp. 330.
- Pal, S. and Sarkar, I. 2010. Studies on the pest incidence and varietal reaction of spray type carnation under mid-hill conditions of Kalimpong, West Bengal. *Journal of Ornamental Horticulture* **13**(2): 127-132.
- Pal, S. and Sarkar, I., 2009. Pests infesting ornamental plants in hilly region of West Bengal. *The Journal of Plant Protection Sciences* **1**(1): 98-101.
- Park, J. D., Kim, S. G., Kim, D. and Cho, K. 2002. Population dynamics of *Frankliniella occidentalis* on different rose cultivars and flowering stages. *Journal of Asia-Pacific Entomology* **5**(1): 97-102.
- Patnaik, H. P. and Mohapatra, S., 1997. Effect of fertilizers on the incidence of thrips and leaf curl in chilli under protected and unprotected conditions. *Mysore Journal of Agricultural Sciences* **31**: 159-163.
- Patnaik, N. C., Behera, P. K. and Dash, A. N., 1986. Some bio-ecological observations on the chilli thrips, *Scirtothrips dorsalis* Hood in Orissa. *Orissa Journal of Horticulture* **14**: 25-28.
- Pritesh-Patel. 2015. Seasonal Abundance, Screening of Genotypes and Chemical Control of Gerbera Aphid. M. Sc. (Agri) Thesis, Navsari Agricultural University, Gujarat.
- Puttarudriah, M. 1977, Alankara Sasyagalige Beeluva Keetaga Hagu Avugala Hathoti, U. A. S., Bangalore pp. 137.
- \*Raizada, U. 1965. Life history of *Scirtothrips dorsalis* Hood with detailed external morphology of its immature stages. *Bulletin Entomology* **6**: 30-49.

- Rajkumar, E. 2003. Biology, seasonal incidence and management of red spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) on jasmine. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka.
- Rajkumar, M., Reddy, K. L. and Gour, T. B. 2004. Thrips and mites infesting roses. *Insect Environment* **10**(1): 27-28.
- Rangarajan, A. V., Mahadevan, N. R. and Iyemperumal, S., 1975. Pest complex of sunflower (*Helianthus anus* L.) in Tamil Nadu. *Indian Journal of Entomology* **37**(2): 188-191.
- Reddy, P. V. R. and Aswath. C. 2008. Resistance of exotic collections of gerbera (*Gerbera jamesonii*) against whitefly (*Bemisia tabaci*) and thrips (*Thrips palmi*) under polyhouse conditions. *Indian Journal of Agricultural Sciences* **78**(5): 449-52.
- Reddy, S. K. M. 1997. Insect pests of rose with special reference to bio ecology and management of rose aphid, *Macrosiphum rosae* (Linnaeus) (Homoptera: Aphididae). *M. Sc. Thesis*, University of Agricultural Sciences, GKVK, Bangalore pp. 113.
- Reddy, V. T. and Nagaraju, C. G. 2004. Protected cultivation of roses. Department of Horticulture, Lal bagh Bangalore. Sreeman Printex, Bangalore pp. 180.
- Rinkikumari, C. and Shukla, A. 2017. Varietal Screening of French Bean (*Phaseolus vulgaris* L.) Varieties against Spider Mite, *Tetranychus urticae* Koch under Field Condition. *International Journal of Current Microbiological Applied Science* **6**(4): 1416-1422.
- \*Sakakibara, N. and Nishigaki, J. 1988. Seasonal abundance of the chilli thrips *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) in a Kiwi [*Actinidia*

*chinensis*] fruit Orchard. *Bulletin of the Faculty of Agriculture-Shizuoka University* **38**: 1-6.

Sanap, M. M., Nawale, R. N. and Ajri, D. S. 1985. Seasonal incidence of chilli thrips and mites. *Journal of Maharashtra Agricultural University* **10**: 345-346.

Sanjta, S., Chauhan, U. and Mehta, P. K. 2018. Thrips and their natural enemies in different ornamental plants of Himachal Pradesh. *Journal of Biological Control* **32**(1): 20-24.

Sathyan, T., Dhanya, M. K., Aswathy, T. S., Preethy, T. T., Manoj, V. S. and Murugan, M. 2017. Contribution of weather factors to the population fluctuation of major pests on small cardamom (*Elettariacar damomum* Maton). *Journal of Entomology and Zoology Studies* **5**(4): 1369-1374.

Senapati, B. and Mohanty, G. B. 1980. A note on the population fluctuation of sucking pests of cotton. *Madras Agricultural Journal* **67**(9): 624-630.

Sharma, D., Maqbool, A., Jamwal, V. V. S., Srivastava, K and Sharma, A. 2017. Seasonal dynamics and management of whitefly (*Bemesia tabaci* Genn.) in tomato (*Solanum esculentum* Mill.). *Brazilian Archives of Biology and Technology*, Vol 60 <https://doi.org/10.1590/1678-4324-2017160456>

Shereef, G. M., Hanna, M. A. and Megali, M. K. 1980, Population densities of important phytophagous and predaceous mites on verbiscum, rose and peppermint. *Bulletin de la Societe Entomologique Egypte* **63**: 63-71.

Sood, A. K. 2010. Integrated pest management under protected environment: principles and practices. *Agropedia* **29**: 13-21.

\*Sredkov, I. 2008. Green rose chafer may surprise you. *Rastitelna Zashita* **47**(4): 32-33.

- Sudharma, K., Nair, G. M. and Kuriyan, K. J. 1995, Phytophagous mites on ornamental plant occurrence and seasonal incidence in Kerala. *5<sup>th</sup> National Symposium in Acarology Abstracts*, Bangalore, India, September, 20-25.
- \*Suris, M. and Gonzalez, C. 2008. Thrips species associated with hosts of interest in Havana provinces in ornamental plants. *Revista de Protección Vegetal* **23**(2): 80-84.
- Thanlass, N., Hafeez, A., Suheel, A. G., Nadeya, K., Divya, C., Stanzin, L. and Sonika, S. 2017. Seasonal incidence and management of thrips, *Scirtothrips dorsalis* (Hood) Infesting Rose. *International Journal of Current Microbiology and Applied Sciences* **6**(8): 101-106.
- Thanlass, N., Hafeez, A., Uma, S., Suheel, A. G., Divya, C., Mangla-Ram, B. and Stanzin, L. 2017. Screening for resistance in rose against aphid, *Macrosiphum rosae* (linn.) and rose thrips, *Scirtothrips dorsalis* (Hood.). *Journal of Entomology and Zoology Studies* **5**(6): 1960-1962.
- Thanlass, N., Hafeez, A., Uma, S., Suheel, A. G., Mahesh, K., Bindu, K. and Stanzin, L. 2018. Screening for resistance in rose against red spider mite, *Tetranychus urticae* (linn.). *Journal of Entomology and Zoology Studies* **6**(3): 897-899.
- Thanlass, N., Hafeez, A., Uma, S., Suheel, A. G., Nadeya, K. and Amit, M. 2017. Seasonal Incidence and Management of Red Spider Mite, *Tetranychus urticae* Koch. Infesting Rose. *International Journal of Current Microbiology Applied Science* **6**(9): 2723-2729.
- Vashisth, S., Chandel, Y. S. and Kumar, S. 2013. Observations on insect-pest problems of polyhouse crops in Himachal Pradesh. *Journal of Entomological Research* **37**(3): 253-258.

- Velayudhan, R., Gopinathan, K. and Bakthavatsalam, M. 1985. Pollination potential, population dynamics and dispersal of thrips species (Thysanoptera: Insecta) infesting flowers of *Dolichos lablab* (Fab.). *Proceedings of the Indian National Science Academy, B (Biological Sciences)* **51**(5): 574-580.
- Vevai, E. J. 1969, Know your crop, its pest problem and control. *Pesticides* **3**(5): 29-35.
- Wenjer, W. 1997. Occurrence and control of thrips in rose. *Bulletin of Taichung District Agricultural Improvement Station* **57**: 23-36.
- Yadav, T., Acharya, V. S., Yadav, R. and Singh, V. 2017. Seasonal incidence of aphid, *Myzus persicae* (Sulzer) on cumin, *Cuminum cyminum* Linn. *Journal of Pharmacognosy and Phytochemistry* **7**(1): 1084-1086.
- \*Yamaguchi, T. 2007. Seasonal prevalence of *Scirtothrips dorsalis* Hood and *Selenothrips rubrocinctus* (Giard) on the flower buds, inflorescences and fruits of mango (*Mangifera indica*) plants cultivated in greenhouses on Amami-Oshima Island, Japan. *Kyushu Plant Protection Research* **53**: 103-106.
- ZhiMin, L., Jun, Y., Yanqiu, C. and Chengxing, H. 2009, Population dynamics and spatial distribution of western flower thrips *Frankliniella occidentalis* (Pergande) of rose in Kunming. *Southwest China Journal of Agricultural Science* **22**(4): 966-971.

\* Original not seen

**Appendix I****A Meteorological data taken during seasonal incidence at Shalimar at polyhouse, 2019**

<b>Standard Meteorological Week</b>	<b>Max Temp</b>	<b>Min Temp</b>	<b>RH (max)</b>	<b>RH(min)</b>
16	24.6	16.8	69.4	59.7
18	28.8	15.6	66.3	57.7
20	30.6	23.2	62.7	53.7
22	33.8	20.7	58	52.4
24	33.5	24.9	59.6	46.9
26	36.4	26.1	53.1	45.2
28	37.0	24.9	51.2	45.5
30	36.7	30.7	48.3	39.8
32	35.9	22.1	57.5	47.5
34	34.6	21.3	58.9	44.7
36	34.8	21.9	60.1	49.7
38	28.9	20.6	63	53.6
40	26.2	15.5	60.8	56.4
42	24.2	10.4	63.6	52.6

**B. Meteorological data taken during seasonal incidence at Shalimar at Field, 2019**

<b>Standard Meteorological Week</b>	<b>Max Temp</b>	<b>Min Temp</b>	<b>RH (max)</b>	<b>RH(min)</b>	<b>Rainfall (mm)</b>
16	25	5	81.6	53.3	0
18	23.5	4	85	49.3	4.6
20	25.5	5	81.3	46	0
22	27.5	8.5	80.6	44	0
24	29.5	9.5	79.6	41.3	12.8
26	30.5	15	77	38	0
28	33	16.5	78.6	40	0
30	34.5	18	75	36.3	0
32	30	17.4	79.6	42.6	13.6
34	31.2	18.5	80.3	45	0
36	28.5	13	80	43.6	0
38	27	11.5	82	47.6	0
40	14	9.5	83	52.3	7
42	17	8	84.3	54	13

**C. Meteorological data taken during seasonal incidence at Ganderbal at polyhouse, 2019**

<b>Standard Meteorological Week</b>	<b>Max Temp</b>	<b>Min Temp</b>	<b>RH (max)</b>	<b>RH(min)</b>
16	27.4	14.3	78	62
18	32.7	19.9	74.6	59.6
20	35.1	24	72	58.6
22	40.2	25.8	68	58
24	33	19.2	76	62.3
26	36.2	24.5	69.6	52.6
28	38.9	21.1	68	55
30	42.8	21.5	64.6	47.3
32	30.2	21.3	74.3	58.3
34	31.7	21.9	66.6	51.3
36	29.6	21.4	63.3	47.6
38	28.8	20.4	67.6	53.3
40	25.2	14.7	69	57.6
42	21.4	9.7	71	61.3

**D. Meteorological data taken during seasonal incidence at Ganderbal at Field, 2019**

<b>Standard Meteorological Week</b>	<b>Max Temp</b>	<b>Min Temp</b>	<b>RH (max)</b>	<b>RH(min)</b>	<b>Rainfall (mm)</b>
16	22.6	4	78.3	50.6	0
18	24.5	6	77	47.3	15.2
20	25.6	6	76.6	43.6	0
22	26.3	8.8	71.6	43.8	1.8
24	25.3	8.5	71.6	42	0
26	26.8	12	70.3	42.3	1
28	28.3	11.5	70.6	40.6	0
30	31.8	13.3	67.6	40.5	0
32	28.5	15	71	43	0
34	27.3	15.2	73.6	44.6	0
36	29	12	68.6	45.3	0
38	27.3	12	68.6	50.6	0
40	19.3	6.8	84.3	58.3	0
42	15.3	6.2	89	67	0

**Sher-e-Kashmir**  
**University of Agricultural Sciences & Technology of Kashmir**  
**Faculty of Horticulture, Division of Entomology**

**CERTIFICATE**

Certified that all the corrections/amendments as suggested by External Examiner Dr. Hafeez Ahmad, Professor and Head, Division of Entomology, SKUAST-Jammu during Viva-Voce examination held on 03-04-2021 have been incorporated in the manuscript entitled **“Studies on Population Dynamics and Spatial Distribution of Insect Pest Complex of Rose with special reference to sucking pests”** submitted by **Mr. Azhan Reyaz (Regd. No. MSH-2018-196)**

**(Dr. Asma Sherwani)**  
Chairperson  
Advisory Committee