"STUDIES ON THE SURVIVAL, POTENTIAL YIELD OF LAC INSECT *KERRIA LACCA* (KERR.) ON NUTRIENT MANAGED KUSUM (*SCHLEICHERA OLEOSA*) HOST IN KANKER DISTRICT OF CHHATTISGARH"

M.Sc. (Ag) Thesis

by

Damini Netam

DEPARTMENT OF ENTOMOLOGY
COLLEGE OF AGRICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (CHHATTISGARH)

2021

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M.Sc. (Ag) Thesis

Submitted to the

INDIRA GANDHI KRISHI VISHWAVIDYALAYA, RAIPUR

By

Damini Netam

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN

ENTOMOLOGY

V.V. ID No. 20192388 **ID No.20192388**

NOVEMBER, 2021

CERTIFICATE – I

This is to certify that the thesis entitled **"Studies on the survival, potential yield of the lac insect *Kerria lacca* Kerr. on nutrient managed Kusum (*Schleichera oleosa*) in Kanker district of Chhattisgarh."** submitted in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture (Entomology)** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Damini Netam** under my guidance and supervision. The subject of the thesis has been approved by student's Advisory committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (Certificate awarded etc.) or has been published / published part has been fully acknowledged. All the assistance and help received during the course of the investigation have been fully acknowledged by him.

Date: 15-11-2021

Chairman

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman	**(Dr. Piyush Kant Netam)**	.....
Member	**(Dr. Y.K. Yadu)**	.....
Member	**(Shri. D.C. Salam)**	.....
Member	**(Dr. (Smt.) G. Chandrakar)**	.....
Member	**(Dr. Y.K. Meshram)**	.....

CERTIFICATE – II

This is to certify that the thesis entitled **"Studies on the survival, potential yield of the lac insect *Kerria lacca* Kerr. on nutrient managed Kusum (*Schleichera oleosa*) in Kanker district of Chhattisgarh."** Submitted by **Damini Netam** to Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture (Entomology)** in the Department of Entomology has been approved by the external examiner and Student's Advisory Committee after oral examination.

Date: 07.12.2021

Signature of Head of the department

(Dr. V. K. Dubey)

MajorAdvisor .....

Faculty Dean .....

Approved/NotApproved .....

Directorof Instructions .....

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Netam

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Date: 15.11.2021

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

Symbol	Abbreviation	Stand for
@		At the rate of
&		And
%		Per cent
±		Plus or minus
^{o}C		Degree centigrade
	BLI	Brood lac inoculation
	CD	Critical Differences
	CG	Chhattisgarh
	Cm	Centimetres
	DABLI	Days after brood lac inoculation
	et al.	and co-workers or others
	Fig.	Figure
	g	Gram
	h	Hour
	i.e.	that is
	IPM	Integrated Pest Management
	Kg	Kilogram
	L	Litre
	m^2	Square meter
	Min	Minimum
	NS	Non-Significant
	RH	Relative humidity
	S.Em.±	Standard error of mean
	sp.	Species
	sq cm	Square centimetre
	viz.	Namely

THESIS ABSTRACT

Title of the thesis	**: "Studies on the survival, potential yield of lac insect *Kerria lacca* (Kerr.) on nutrient managed Kusum (*Schleichera oleosa*) host in Kanker District of Chhattisgarh".**
Full Name of Student	**: Damini Netam**
Major subject	**: Entomology**
Name and address of the Major Advisor	**: Dr. Piyush Kant Netam, Assistant Professor Entomology, College of Agriculture and Research station, Kanker (C.G)**
Degree to be awarded	**: Master of Science in Entomology (Agriculture)**

Signature of student

Signature of Major Advisor

Date- 15.11.2021

Signature of the Head of Department

ABSTRACT

Investigation entitled studies on the survival, potential yield of Lac insect *Kerria lacca* (Kerr.) on nutrient managed Kusum (*Schleicera oleosa*) was carried out in Kanker District of Chhattisgarh from January 2021 to July 2021.

During the investigation, application of nutrient in different treatments were done in one month before brood lac inoculation i.e. T1- N (Urea 220g), T2- N (Urea 220g) + P (SSP 1560g), T3- N (Urea 220g) + P (SSP 1560g) + K (Mop 125g), T4- N (Urea 220g) + K

(MoP 125g), T5 P (SSP 1560g) +K (MoP 125g) and Control i.e., no use of fertilizer (Lac grower practice). The mean brood lac inoculation per *S. oleosa* plant varied between 6000g to 7000g depending upon the height, branches per plants or canopy of the plants. After brood lac, the highest average survival of lac insect nymph per 2.5 sq. cm was obtained at 30, 45,60,70,90,110,130,150 and 172 days. At 30 days after brood lac inoculation, survivals of lac insects are T1(109.25), T2(106.83), T3(103.50), T4(104.61), T5(101.17), T6(94.89) which differ significantly from each other. At the maturity of lac crop (at harvest), the survivals of lac insect are T1(20.50), T2(18.50), T3(20.08), T4(18.08), T5(15.17), T6(12.83). 65-70 days after brood lac inoculation on Kusum (*S. oleosa*) host plant in *Kusmi Jethwi* lac crop., the maximum male and female sex ratio of 3.00 were detected, as well as the maximum average number of female lac insect 39.44 per 2.5 sq. cm lac twigs. The highest average number of stick lac in T3 (249.25) over T6 (233.75) with mean length of stick lac 56.62 cm in T3 over T6 52.58 cm, maximum mean fresh weight of stick lac in T3 (43.00g) over T6 (32.12g), maximum average weight of scraped lac in T3 (22.06g) over T6 (18.25g), highest mean fresh weight of 100 lac cells in T3 (8.5) over T6 (5.62) and the mean dry weight of 100 lac cells in T3 (7.62) over T6 (3.81) and highest yield (52.75kg)was recorded on T3 over T6 (34.25kg) in kusum host plant in *Kusmi, jethwi* (Summer) strain. Among the different treatments used in host plant, maximum yield from T3 (NPK).

The net profit was highest in case in T3 (Rs 13441.05/tree), T2 (Rs 12599.45/tree), T4 (Rs 11692.43/tree), T5 (Rs 10498.3/tree), T1 (Rs 9575.63/tree) and it was lowest in case of T6 (Rs 8243.1/tree).The Cost-Benefit ratio was highest (1:4.72) in case of T3 followed by T2 (1:4.52), T4 (1:4.31), T5 (1:4.00), T1 (1.:3.74) and lowest (1:3.35) in case of T6.

Incidence of various major predators with lac insect in *kusmi* strain of *Jethwi* (summer) crop were recorded at fortnightly interval. *E. amabilis*, its first appearance was recorded during 1st fortnight of March with the mean population of 4.01 insect per 30cm lac stick which suddenly increased and reached its peak in the 1st fortnight of June with the mean population 10.96 insect /30 stick lac, after that gradually decreased the population till harvest. Maximum mean population density of *E. amabilis* observed in north direction of the host plant. *P.*

pulverea mean population were recorded in 1st fortnight of February with the mean population 4.88 /30cm stick lac which increased in 1st fortnight of May and its peak were recorded with mean 11.46 insects/30cm stick lac, after that gradually decreased the population till harvesting. Maximum mean number of *P. pulverea* observed in north direction. *Chrysoperla* spp. first appeared in 1st fortnight of February with peak population of 2.75 insect per 30 cm stick lac, the population increases gradually with density of 8.01 during first fortnight of April.

Minimum relative humidity, maximum relative humidity, wind speed, minimum temperature with north population of *E. amabilis* showed significant positive correlation whereas non-significant positive correlation was noticed with maximum temperature and rainfall. Minimum relative humidity, maximum relative humidity, wind speed, minimum temperature, rainfall showed significant positive correlation whereas non-significant correlation was noticed with maximum temperature with East population. From South direction inoculated tree showed significant positive correlation with minimum relative humidity, maximum relative humidity, wind speed, minimum temperature, rainfall whereas non-significant correlation was noticed with maximum temperature were observed. Minimum relative humidity, maximum relative humidity, wind speed, minimum temperature with West population showed significant positive correlation whereas non-significant positive correlation was noticed with maximum temperature and rainfall were observed.

Pseudohypatopa pulverea population from North, South, East, West has showed negative non-significant with rainfall, maximum RH, minimum RH but positive non-significant correlation showed with maximum temperature, minimum temperature and wind speed.

Chrysoperla spp. population from North, showed significant positive correlation with maximum temperature and non-significant positive correlation with minimum temperature and maximum RH whereas negative non-significant correlation with rainfall, minimum RH, windspeed. Population from East, South, West showed significant positive correlation with maximum temperature and non-significant positive correlation with minimum temperature whereas negative non-significant correlation with maximum RH, minimum RH, rainfall and wind speed.

शोध सारांश

अ. शोध शीर्षक	छत्तीसगढ़ के कांकेर जिला में पोषक तत्व प्रबंधित कुसुम (स्क्लीसेरा ओलियोसा) पर लाख कीट केरिया लक्का की उत्तर जीविता , उत्पादकता के मानको पर अध्यन्न ।
ब.विद्यार्थी का पूरा नाम	दामिनी नेताम
स.मुख्य विषय	कीट विज्ञान
द.मुख्य सलाहकार का नाम व पता	डॉ. पीयूष कांत नेताम सहायक प्राध्यापक, कीट विज्ञान विभाग,कृषि महाविद्यालय एंव अनुसंधान केन्द्र कांकेर (छ.ग.)
इ.सम्मानित किये जाने वाली उपाधि	एम.एस.सी कृषि (कीट विज्ञान)

विद्यार्थी के हस्ताक्षर

मुख्य सलाहकार का हस्ताक्षर

दिनांक 15.11.2021

विभागाध्यक्ष के हस्ताक्षर

सारांश

वर्तमान जांच में पोषक तत्व प्रबंधित कुसुम (स्क्लीसेरा ओलियोसा) पर लाख कीट केरिया लक्का की उत्तर जीविता , उत्पादकता के मानको पर अध्यन्न जनवरी 2021 से जून 2021 तक छत्तीसगढ़ के कांकेर जिला में किया गया ।

जांच के दौरान विभिन्न उपचारों (पौधो) में पोशक तत्वों का प्रयोग बीहन लाख लगाने से एक महीने पहले किया गया था अर्थात टी1–एन (यूरिया 220 ग्राम), टी2–एन

(एमओपी 125 ग्राम),टी5 (एसएसपी 1560 ग्राम)+ के(एमओपी 125 ग्राम)और नियंत्रण अर्थात उर्वरक का कोई उपयोग नही । औसत ब्रूड लाख प्रति स्क्लीसेरा ओलियोसा पौधे की ऊंचाई, पौधों की शाखाओं या पौधों की छतरी के आधार पर 6000–7000ग्राम है।ब्रूड लाख संचारण के बाद लाख कीट की उच्चतम औसत उत्तरजीविता 30,45,60,70,90,110,130,150 और 172 दिनों में प्राप्त की गई। ब्रूड लाख संचारण के 30 दिनों बाद लाख कीट की उत्तरजीविता टी 1(109.25), टी 2 (18.50), टी 3 (20. 08), टी 4 (18.08), टी 5 (15.17), टी 6 मे (12.83) पायी गयी जो एक दूसरे से काफी भिन्न हैं । लाख फसल की परिपक्वता पर लाख कीट की उत्तरजीविता टी 1 (20. 50), टी 2 (18.50), टी 3 (20.08), टी 4 (18.08), टी 5 (15.17), टी 6 मे (12.83) पायी गयी। कुसमी जेठवी लाख फसल में ब्रूड लाख संचारण के 65–70 दिन बाद उच्चतम नर और मादा कीट का लिंग अनुपात.3.00 पता लगाया गया, साथ ही साथ मादा लाख कीट की उच्चतम औसत संख्या 39.44 प्रति 2.5 वर्ग पाया गया।

स्टिकलैक की उच्चतम औसत संख्या टी 3 (249.25) था और सबसे कम टी 6 (233. 75) था। स्टिकलैक की औसत लंबाई टी 3 (56.62 से.मी.) था और सबसे कम टी 6(52.58) था। अधिकतम औसत वजन 30 से.मी. स्टिकलैक टी 3 (43.00) था और सबसे कम टी 6(32.12) था। स्क्रैप किए गए लाख का अधिकतम औसत वजन टी 3 (22.06 ग्राम) था और सबसे कम टी 6 (18.25ग्राम) था।100 लाख कोषिकाओं का उच्चतम औसत ताजा वनज (8.50) टी 6 पर और (5.62) टी 3 में 100 लाख कोषिकाओं का औसत सूखा वजन। (7.62) टी 6 पर और (3.81) टी 3 पर दर्ज किया गया था। स्टिकलैक प्रति पौधे औसत उपज टी 3(52.75किलो ग्राम) और सबसे कम टी 6 (34. 25किलोग्राम) दर्ज किया गया था।मेजबान पौधों में उपयोग किए जान`वाले विभिन्न उपचारों में, टी 3 (एनपी के) से अधिकतम उपज प्राप्त हुए।.

शुद्ध लाभ अधिकतम टी3 (रू 13441.05 प्रति पेड), टी 2(रू 12599.45 प्रति पेड़)), टी 4(रू 11692.43 प्रति पेड़), टी 5(रू 12599.45 प्रति पेड़), टी 1(रू 12599.45 प्रति पेड़) और सबसे कम टी 6(रू 8243.1 प्रति पेड़) दर्ज किया गया था।लागत लाभ अनूपात अधिकतम (1:4.72) टी 3मे दर्ज किया गया था, उसके बाद टी 2(1:4.52), टी 4(1:4.31), टी 5(1:4.00), टी 1(1:3.74) और सबसे कम टी 6(1:3.35) में दर्ज किया गया था।

जेठवी (गर्मी) फसल में लाख कीट के विभिन्न प्रमुख शत्रु कीटो की घटना पखवाड़े के अंतराल पर दर्ज की गई थी। यूबलेमा एमाबिलिस, इसकी पहली उपस्थिति मार्च के 1 पखवाड़े के दौरान 4.01 कीट प्रति 30 सेमी स्टिक लाख की औसत आबादी के साथ दर्ज की गई थी जो अचानक बढ़ गई और जून के 1 पखवाड़े में औसत आबादी 10.96 कीट/ 30सेमी स्टिक लाख के साथ अपने चरम पर पहुंच गई।उसके बाद धीरे–धीरे कटाई तक आबादी कम हो गई। यूबलेमा एमाबिलिस अधिकतम औसत जनसंख्या घनत्व उत्तर दिशा में दर्ज की गई। पी. पुलवेरिया इसकी औसत जन संख्या 4.88/ 30सेमी स्टिक लाख के साथ फरवरी के पहले पखवाड़े में दर्ज की गई थी, जो मई के 1 पखवाड़े में बढ़ गई थी और इसकी औसत जनसंख्या 11.46 कीड़े/ 30 सेमी स्टिक लाख के साथ दर्ज किया गया था, इसके बाद धीरे–धीरे कटाई तक आबादी में कमी आई। क्राइसोपरला स्पीशीज पहली बार फरवरी के 1 पखवाड़े में 2. 75 कीट प्रति 30 सेमी स्टिक लाख की आबादी के साथ दिखाई दिया, अप्रैल के पहले पखवाड़े के दौरान जनसंख्या धीरे–धीरे 8.01 के घनत्व के साथ बढ़ गई।

न्यूनतम सापेक्ष आर्द्रता, अधिकतम सापेक्ष आर्द्रता, हवा की गति, न्यूनतमता पमान उत्तर आबादी के साथ महत्वपूर्ण सकारात्मक सह संबंध दिखाया, जब कि गैर–महत्वपूर्ण सकारात्मक सह संबंध अधिकतम तापमान और वर्षा के साथ देखा गया।. न्यूनतम सापेक्ष आर्द्रता, अधिकतम सापेक्ष आर्द्रता, हवा की गति, न्यूनतम तापमान, वर्षा ने महत्वपूर्ण सकारात्मक सह संबंध दिखाया, जब कि गैर–महत्वपूर्ण सह संबंध को पूर्वी आबादी के अधिकतम तापमान के साथ देखा गया था।. दक्षिण दिशा से टीकाकृत पेड़ ने न्यूनतम सापेक्ष आर्द्रता, अधिकतम सापेक्ष आर्द्रता, हवा की गति, न्यूनतम तापमान, वर्षा के साथ महत्वपूर्ण सकारात्मक सह संबंध दिखाया, जब कि अधिकतम तापमान के साथ गैर–महत्वपूर्ण सह संबंध देखा गया था।. न्यूनतम सापेक्ष आर्द्रता, अधिकतम सापेक्ष आर्द्रता, हवा की गति, पश्चिम आबादी के साथ न्यूनतम तापमान ने महत्वपूर्ण सकारात्मक सह संबंध दिखाया, जब कि गैर–महत्वपूर्ण सकारात्मक सह संबंध अधिकतम तापमान के साथ देखा गया और वर्षा देखी गई।.

उत्तर, दक्षिण, पूर्व, पश्चिम से स्यूडोहिपोटोपा पुलवेरिया आबादी ने वर्षा, अधिकतम सापेक्ष आर्द्रता, न्यूनतम सापेक्ष आर्द्रता के साथ नकारात्मक गैर–महत्वपूर्ण दिखाया है, लेकिन अधिकतम तापमान, न्यूनतम तापमान और हवा की गति के साथ सकारात्मक गैर–महत्वपूर्ण सह संबंध दिखाया गया है। क्राइसोपरला स्पीशीज की उत्तर के

जनसंख्या के साथ, अधिकतम तापमान और अधिकतम सापेक्ष आर्द्रता गैर–महत्वपूर्ण सकारात्मक सह संबंध दिखाया गया, जब कि वर्षा, न्यूनतम सापेक्ष आर्द्रता, हवा की गति के साथ नकारात्मक गैर–महत्वपूर्ण सह संबंध दिखाया गया है। पूर्व, दक्षिण, पश्चिम की जनसंख्या ने न्यूनतम तापमान अधिकतम तापमान के साथ गैर–महत्वपूर्ण सकारात्मक सह संबंध दिखाया, जब कि अधिकतम सापेक्ष आर्द्रता, न्यूनतम सापेक्ष आर्द्रता, वर्षा और हवा की गति के साथ नकारात्मक गैर–महत्वपूर्ण सह संबंध।

CHAPTER-I

INTRODUCTION

Kerria lacca (Kerr), the Indian lac insect of the family Tachardiidae (Kerriidae) order Hemiptera detailed by (Sharma *et al.,* 2006), is the most vital beneficial creepy crawlies used for commercial utilize. These sucking bugs produces encrustation by emitting a resinous substance across their bodies which is commonly referred to as lac, the only natural resin of animal origin. Lac insect completes its life cycle on a variety of host taxa where it exclusively feeds on phloem sap from which *Schleichera oleosa* (Lour.) Oken, *Butea monosperma* (Lam.) and *Zyziphus mauritiana* (Lam.) are its major host. While feeding on host trees the lac insect *K. lacca* produces lac, which could be a minor forest product (Ogle *et al.,* 2006).

The cultivation of lac dates back to Vedic period (1500-500 BC) and the Atharva Veda commits a complete chapter containing portrayal of laksha and additionally depict within the *Mahabharata* that *Kauravas* was build the intensively combustible *'lakhshagriha'* or lac house with a objective of physically kill *Pandavas* by setting the lac royal residence on flame (Chattopadhyay, 2011). Scientific study of lac started much afterward. Father Tachard discovered the insect that produced lac in 1709. To being with of all Kerr (1782) gave the name *Coccus lacca* which was also agreed by Ratzeburi (1833) and Carter (1861). Afterward Green (1922) and Chatterjee (1915) called the ac-insect as *Tachardia lacca* (kerr). At last, the title was given as *Kerria lacca.*

Cultivation of lac is broadly practised in Jharkhand, West Bengal, Chhattisgarh, Madhya Pradesh, Odisha, Maharashtra and some parts of Uttar Pradesh, Andhra Pradesh, Gujarat and the NEH area of India. It could be a exceedingly productive crop that gives the farmer a high return on venture as well as a bringing outside trade into country through export. Lac is produced in number of countries, including India, Thailand, Myanmar, China, Indonesia, Vietnam and Laos. India and Thailand are the largest producers followed by China. India alone, accounts for approximately 70% of global lac production.

Cultivation of lac could be an auxiliary occupation for the majority of tribal households in the lac growing area. Cultivation of lac gives employment opportunities, particularly aimed the off-agricultural season (Pal *et* al.,2012).

Cultivation of lac is being carried out by all types of farmers, including marginal, small and large farmers (Pal,2009). The state of Jharkhand represents the 1st rank followed by Madhya Pradesh, Chhattisgarh, Maharashtra and Odisha. All these five states allow around 93 per cent of the overall lac production whereas 32.31 % was contributed by *Aghani, Jethwi 26.36%, Baisakhi 23.57%,* and *Katki* crop 17.76% (Yogi *et al.,* 2017).

Lac creepy crawlies live on twigs of certain plant species where they settle, suck the plant sap and expand over there and secret resin from its body. The plant chosen for nourishing and development is called host plant. Despite of the fact that lac insect is a natural pest on host plant, these insects are generally given the benefit of not being regarded as pest, this is often because: 1. The yield a valuable product, 2. The host plant are economically not so important, and 3. The insect causing only temporary and recoverable harm to the host plant.

More than 400 lac hosts have been detailed across the world to carry lac host (Roonwal *et al.,*1958; Varshney and Teotia 1967; Varshney 1968; Sharma *et al.,*1997). Palash (*Butea monosperma*), Ber (*Zizyphus mauritiana*) and Kusum (*Schleichera oleosa*) are the most frequent common hosts commercial for lac production in India (Roonwal, 1962; Pal, 2009; Mohanta *et al*., 2012). Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, besides a few others are the state where lac host are found (Pal *et al*., 2011). The different lac host plants in China are *Dalbergias zemaoensis*, *Dalbergias obtusifolia*, *Ficus altissima* and *ficus racemosa* (Chen *et al*., 2010) whereas *Z. mauritiana, Samanea saman, B. monosperma, Acacia nilotica* and *Acacia catechu* are the major lac host plants in Bangladesh (Ferdousee *et al*., 2010). It is also vital to indicate that the quality of lac is particularly related to the host plant and to the strain of lac insects.

In plant growth, Nutrient plays a crucial part is broadly recognized (Oskarsson *et al.,* 2006; Dianda *et al.,* 2009). Plants that are nutrient deficient are weak and more vulnerable to insect pest attack and plant disease (Marschner,1995; Huber and Thompson 2007). Mineral nutrition status is a factor that influences the development

and yield of harvest plant as a result of a alter in growth pattern, plant morphology, anatomy and particularly chemical composition. The degree of lignification, Thickness of epidermal cells sugar concentration, amino corrosive substance in phloem sap and levels of defensive compounds are all influenced by nutritional status of the plant (Marschner, 1995). The nutritional status of plant influences on population dynamics, resulting in higher survival rates, longer adult lifespans, and longer regenerative periods (Bi *et al.*, 2001). The destitute nutritional quality of the lac insect's host tree can have a negative effect on the insect's performance and fitness. Pholem feeders antagonistically influence both development and amino-nitrogen profile of their host plants (Cook and Denno, 1994). Therefore, any application of nutrients to the host tree of lac insect is likely to extend the growth of the tree and lac productivity.

Kerria lacca (Kerr), the Indian lac insect is commercially vital, reliable with the difference in life cycle and host preference, quality of lac produced, it can advance be recognized into two strain or infra-subspecies that is *Rangeeni* and *Kusmi*. The *Rangeeni* strain has an unequal duration of biovoltine life cycle and does preference of *kusum* as a host whereas the *kusmi* strain has more or less equi-durational life cycle and *kusum* as a host. As far as the *Kusmi* strain, is concerned the two crops are *Jethwi* (harvested in June/July) and *Aghani* harvested in(January/February), so the duration of each having six month, where as in case of *Rangeeni*, The two crops are *Katki* (harvested in October/November) and *Baishakhi* (in May/June) (Chattopadhyay, 2011) each with a duration of four and eight month (Kumar *et al.*, 2002; Sharma, 2007 and Sharma *et al.*, 2007).

Aghani and *Baisakhi* of *Rangeeni* strain are considered to be the main crops accounting for more than 90% of total lac production and remaining 10% of the *Kusmi* crops. Compare with *Rangeeni* lac insects, *Kusmi* lac insects produce higher quality resins. Furthermore, significant quantitative and qualitative variations in various biological attributes of the lac insect, such as resin yield, fecundity, sex ratio and body colour, have more over been found (Chauhan and Teotia 1973; Chauhan and Mishra 1977; Varshney 1977; Mishra *et* al. 2000).

An appropriate lac host plant, cultivation practices and appropriate management of bio agents during cultivation are all essential for good lac production. Natural enemies of the lac crop are predicted to damage up to 30-35 per cent of lac cells on average. The attacks of enemies are sometimes be so severe that they result in crop failuers. Lac insects are known to be preyed upon by predatory insects and parasitoids. Among them *Eublemma amabilis* Moore (Lepidoptera: Noctuidae) and *Pseudohypato pulverea* Mayr. (Lepidoptera: Blastobasidae) are the two lepidopteron predators were the foremost destructive key pests, resulting 30-40% decrease in lac production (Glower, 1937, Narayanan,1962, Jaiswal *et al.,* 2008) conjointly their incidence may vary depending on the season difference, place to place and crop to crop (Chattopadhyay, 2011; Khobragade *et al.,* 2012).

The *Eublemma amabilis* Moore (Lepidoptera: Noctuidae) is considered the foremost devastating predator of lac insect. During the several instar preceding pupations, a single larva can destroy up to 40-60 lac cells. Rahman *et al.,* (2009) detailed that a single *E. amabilis* larva can devastate up to 42-50 developed lac cells before pupation, causing more destruction to the *Katki* crop than to the *Baishakhi* crop. *Pseudohypatopa pulverea* Meyr (Lepidoptera: Blasstobasidae) can kill 45 to 50 mature lac cells with a single predator. The sporadic neuropteran predator *Chrysoperla* spp, are the most ubiquitous predators within the lac environment causing considerable losses, particularly within the winter crop of *Kusmi* lac. A severe infestation by *Chrysoperla* spp. may lead to the loss of entire winter season crop if not overseen appropriately (Singh *et al.,* 2011b). The first instar larvae of *Chrysoperla zastrowi arabica*, a new neuropteran predator reported by (Singh *et al.,* 2011a) attack *Kusmi* lac culture soon after settlement of lac insect on tendor shoot of *S. oleosa* host tree. In Summer season *Kusmi* lac crop each *S. oleosa* tree recorded approximately 150-200 adults of *C. zastrowi* arabica. The larvae of this pest have a high predation potential, feeding on 160-195 and 425-485 lac insect before pupation during the second and third instar stages, respectively.

Kanker is major lac cultivated area and second largest production after Korba, in Chhattisgarh. District has large number of Kusum, Palas, Ber and Semialata, all are in forest and non-forest area suitable for cultivation of lac. These are the major host plant which was used by the people of district. As application of nutrient is very important factor, they increase not only growth but also phloem feeder is an established scientific fact (Embden 1973). Therefore, the application of nutrient not only increases the growth of tree as well as the lac productivity. Looking to the above facts present investigation is aimed to investigate the host survivability, yield potential and incidence of major predators in lac growing regions in Kanker District under fallowing objectives:

Objectives of the Investigation:

1. To study the survival of Lac insect on Kusum host plant.
2. To study the potential yield of lac insect on Kusum host plant.
3. To study the incidence of major predators of lac insect on Kusum host plant.

CHAPTER - II

REVIEW OF LITERATURE

A brief overview on the existing research entitled, **"Studies on the survival, potential yield of Lac insect *Kerria lacca* (Kerr.) on nutrient managed Kusum (*Schleichera oleosa*) host in Kanker District of Chhattisgarh"** was presented under the subsequent heads.

1) **To study the survival of Lac insect on Nutrient managed Kusum host plant.**
2) **To study the potential yield of lac insect on Kusum host plant.**
3) **To study the incidence of major predators of lac insect on Kusum host plant.**

2.1 To study the survival of Lac insect on Nutrient managed Kusum host plant.

Negi (1956) reported that the lac insect *K. lacca* (Kerr.) can thrive on succulent branches of shrubs and plants. The good cultivation of lac can be getting over a continuous throughout the years on different host plants viz., Kusum (*Scheichera oleosa* Lour), Ber (*Zizyphus mauritiana*), Palas (*Butea monosperma* Lamk), Khair (*Acacia catechu* Willd), Ghont (*Z. xylophora* Willd) and Arhar (*Cajanas cajan* Linn) host plants.

Roonwal and Singh (1958) revealed that the variant host plants of regional importance but most frequently used host plants for the lac cultivation was *B. monosperma, Z. mauritiana* and *S. oleosa*.

Choudhary *et al.* (1982) reported that the nourished to lac insect more than 400 species of plants have been recorded, various biological characteristics such as survival, fecundity and resin production are differed extensively with the different host species.

Coltan (1984) revealed that lac insect, *K. lacca* was a valuable gift of nature to mankind, (Order- Hemiptera and family- Tachardiidae). It having a mouth parts piercing and sucking type through which suck the plant sap, in these processes the scale insect secrets resinous substance from its highly specialized lac glands.

Ghosal (2007) revealed that ber (*Z. mauritiana*) may be a promising lac host among the farmers. Since lac growers obtain lac and also harvest fruits from this host. Pruning could be a basic operation in lac cultivation. Studies were performed to examine how pruning time and lac insect (*K. lacca*) infestation influence development and fruit production of ber trees. There was essentially a less number of fruits produced which plant carrying lac, that is the reduction was 68.9 and 21.4% on branches with and without lac encrustation, respectively, while the number of secondary branches was recorded decreased significantly, ranged from 33.9 and 12.6 per cent, respectively. Late pruned (May) brought about in diminished in length and breadth of branches as compared to pruned in February.

Kumar *et al.* (2007) carried out a overview within the southern region of Rajasthan, where 13 host plants of lac insect were recorded among, them palas and ber plant were found prevailing in numbers to other host plants. Distinctive host plants of lac insect namely, Palas (*B. monosperma*), Ber (*Z. mauritiana*), Pipal (*Ficus religiosa*), Bargad (*F. bengalensis*), Arhar (*Cajanus cajan*) and Bhalia (*F. semialata* and *F. macrophylla*) were examined to the amount of lac production and other parameters. The Ber was taken note to be the good host for lac cultivation as highest quantity was observed on (165.5 g per m). Besides high fecundity was recorded (525.2 and 450.6 per female), female cell diameter (3.52 and 3.06 mm) and cell weight (14.21 and 10.12 mg) were observed in both the crops viz. *Baisakhi* summer season and *Katki* rainy season of crop.

Ghosal (2008) observed that pruning schedule (February and May 2005) of *Z. mauritiana* (ber) for *aghani* winter season lac culture, which comes about that the pruning was not appropriate at Purulia, West Bengal, India. Predators, *E. amabilis* and *P. pulverea* population density in the lac were observed to be minimum in February on pruned plants (5.11 times less than the former practice). Within the month of May pruned plant exhibit the minimum yield ratio, which was 2.17 times less than the farmer's practice.

Sharma and Ramani (2010) revealed that approximately brood lac required for inoculation on palas (0.75 to 1 kg), kusum (4 kg) and ber (1.5 kg) host plants. Different lac insect host plants showed extended settlement of lac insect (average 48-131 per sq cm in *rangeeni* and 81-140 per sq cm in *kusmi*) determined by the quality of brood lac inoculation. Average lac insect settlement of *rangeeni* under sub optimum condition was essentially less than that of *kusmi.*

Kaushik *et al.* (2012) revealed that the lac insect *K. lacca* was phytophagous (sap-suckers) insect thriving on mostly woody dicotyledonous plants. More than 400 plants species likely to be known as host plants for the lac insect, about 113 host species are noticed to be well-turned survived by the lac insect in India. Architecture of the plant tissue might be a crucial factor for these sap suckers, because of successful settlement, the insect has to penetrate the plant tissue and suck the plant juice.

Paul *et al.,* (2013) observed that the most important traditional host plants in Bastar forest division for lac cultivation were viz, palas (*B. monosperma*), ber (*Z. mauritiana*), kusum (*S. oleosa*), babul (*A. nilotica*), khair (*A. catachu*), pipal (*F. religeosa*), Gular (*F. glomureta*), and bargad (*F. bengalensis*).

Mohanta *et al.* (2014) revealed that the initial settlement of lac insect extended from 92.58 to 126.74 larvae/sq cm and 93.12 to 109.62 larvae/sq cm in *kusmi* strain on kusum and ber plants, respectively. In *rangeeni* it was 82.67 to 118.32 larvae/sq cm. The sex ratio (male and female) was found to be 1:3 for all the crops, strains and host plants. The range of resin yield per cell was 17.00 to 21.40 mg in *aghani* (winter) crop and 19.00 to 25.60 mg in *jethwi* (summer) crop of *kusmi* strain on kusum and ber host plants. For *rangeeni* strain on palas plant, it was 5.30 to 11.20 mg in *katki* (rainy) crop and 18.72 to 23.00 mg in *baisakhi* summer crop.

Pal and Yogi (2014) reported that the host utilization rate was higher on kusum (56.2 per cent) followed by palas (44.6 per cent) and (ber 13.1 per cent).

Namdev (2014) reported that the performance of *kusmi* lac strain on *aghani* crop and nutrient management in *Z. mauritiana* host plant under heavy rainfall condition. The average brood lac was inoculated from 400-500 g. The mean number of lac insect settlement per 2.5 sq cm varied from 79.93 to 90.02 in different treatments in 30 days after BLI. After 172 days at harvest it varied 15.57 to 18.43 per 2.5 sq cm. There was a significant increase in number of settlement lac insect per 2.5 sq cm as compared to control. The mean number of stick lac varied from 13.16 to 18.00. Mean fresh weight of 100 cells varied from 6.14 to 80.2 g and dry weight of 100 cells varied from 4.25 to 7.90. The mean yield of stick lac per plant ranged from 3.83 to 5.08 kg per plant at harvest. It was maximum on NPK followed by N, NP and control.

Kumar *et al.* (2017) suggested that the population density of lac insect per 2.5 sq cm on three branches viz., upper, middle and lower per branch at 50, 62, 76 and 94 days after BLI in application of micronutrients on palas host tree in *rangeeni*. At 50 days it extended from 44.95 to 50.28 in different treatments. At 62 days it varied from 37.05 to 39.34. At 76 days of BLI it varied from 28.37 to 33.46. The mean population density per 2.5 sq cm at 92 days after BLI extended from 20.86 to 26.05.

Meshram *et al.* (2018) reported that Performance of different hosts of lac insect was studied during year 2014-15 and 2015-16 at Korba District of Chhattisgarh. During the course of study, Mean number of lac insect settlement on 2.5 sq. cm succulent branch varied between 14.66 to 21.70 insects. The highest number of lac insect per 2.5 sq cm was reported on Kusum (21.70) followed by Semialata in *kusmi* strain and maximum number of lac insect per 2.5 sq cm was noticed in ber (18.05) followed by palas (14.66) in *rangeeni* strain.

Netam *et al.* (2019) revealed that Performance of different hosts of lac insect was studied during 2015-16 and 2016-17 at Kanker District of Chhattisgarh. During the course of study, Mean number of lac insect settlement on 2.5 sq. cm succulent branch varied between 15.78 to 17.63 insects. The highest number of lac insect per 2.5 sq cm was reported on Kusum (17.63) followed by Semialata (15.78) in *kusmi* strain.

Khichi *et al.* (2021) reported that the survival of Lac Insects on Pigeonpea Genotypes. A field trial was conducted to consider the survival of lac insect *Kerria lacca* on ten genotypes of *Cajanus cajan* (L.) Millsp. The experiment was conducted in JNKVV, Jabalpur, Madhya Pradesh from May 2019 to June 2020.

2.2 To study the potential yield of lac insect on Kusum host plant.

Witt (1901) was the first to study the general life history of *Eublemma amabilis* Moore and referred to its injurious nature with regard to the lac insect.

According to Mishra *et al.* (1930) in the year 1884 George Hampson listed 128 species of Genus *Eublemma*, of which 44 species were found in India and Srilanka. Six species of the Genus *Eublemma* have been recorded as coccidophagus. The larvae of *E. amabilis* after hatching from the eggs on the surface of lac colonies lead a cryptic mode of life by burrowing and tunneling within the lac encrustation feeding exclusively on lac insects. This predator undergoes three overlapping generation in both summer and rainy season lac crop. The larvae moult ten times before pupating.

Mishra *et al.* (1999) reported that the distinctive productivity parameters of lac insect, *K. lacca* viz., fecundity, live cell, fresh weight and dry weight of lac cell on *Flemingia semialata* and *F.macrophylla*. On *F. semialata*, live cell weight, *phunki* (dry) cell weight and fecundity were extended from 13.16 to 38.33 mg, 8.00 to 19.00 mg and 253 to 565 eggs, respectively, whereas on *F. macrophylla* it was extended between 16.83 to 31.67 mg, 9.33 to 18.83 mg and 297 to 477 eggs. There was significant difference between fecundity and lac cells.

Sharma *et al.* (2007) reported that the resin yield of *rangeeni* and *kusmi* strains of *K. lacca* on various host plants and taken note that it was maximum yield on *S. oleosa* (22.84 mg), followed by *Acacia auriculiformis* (18.9 mg), *F. macrophylla* (9.43 mg) and *Cucurbita moschata* fruits (6.11 mg) for *kusmi*, whereas, *rangeeni* strain *A. auriculiformis* (9.09 mg), followed by *B. monosperma* (8.76 mg), *F. macrophylla* (7.49 mg) and *C. moschata* fruits (6 mg). A strong and positive relationship was observed among the cell size and weight of resin yield. A higher resin weight to cell size ratio of 6.452 in *S. oleosa* for *kusmi* strain and 2.932 in *A. auriculiformis* for *rangeeni* strain appeared appropriateness of the host plant for lac culture**.**

Bhargava *et al.* (2008) observed that the yield of stick lac annually cultivated on different host plants ranged from 6 to 10 kg on Kusum (*S.oleosa*), 1.5 to 6 kg on Ber (*Z. mauritiana*) and 1 to 4 kg on Palas (*B.monosperma*).

Jaiswal and Singh (2012) revealed that the potentiality of *F. semialata* was about 7-8 times in *kusmi* that is 40-50 g brood lac produced 250 g brood lac and 50 g scraped lac per plant from six month in *aghani* (winter season) lac crop in semialata host plant.

Bhagirath (2013) reported that the mean fresh weight (g) of 100 mature lac cells was 4.88g in *Kusmi* lac and 3.38g in case of *Rangeeni* lac, while in the present study it varied from 6.14 to 8.02g in various treatments.

Bhagirath (2013) reported that the mean dry weight of 100 cells was 4.66g in case of *Kusmi* lac and 2.63g in case of *Rangeeni* lac.

Patel *et al.* (2014) recorded that the comparative performance of *kusmi* and *rangeeni* strain of lac insect. The execution of *kusmi* strain crop was better than *rangeeni* strain crop. The mean fresh weight (g) of 100 mature lac cells was higher 4.88g in *kusmi* followed by 3.61 g in *rangeeni* it varied from 2.97 to 3.38 g. There was 20.17 per cent more abdicate per plant in case of *kusmi* over *rangeeni* lac.

Namdev *et al.* (2015) reported that the lac production on *B.monosperma* and *Z. mauritiana*. The production was low due to no nutrient management of these host trees. The mean weight of 100 fresh cells of lac at harvest as well as dry cell weight increased significantly in nutrient treated *Z. mauritiana* plant as compared to control. The yield of *kusmi* lac per plant was 5.08, 4.54, 5.33 and 3.33 kg, respectively, among the different treatments. Nutrient management of *Z. mauritiana* for lac crop significantly increase lac yield. Also result that the mean weight of 100 fresh cells ranged from 6.14 to 8.02 g in various treatments. The mean fresh weight of 100 cells of lac insect was maximum (8.02).

Kumar *et al.* (2015) revealed that the normally *kusmi* lac strain is appropriate in rain- fed areas and the productivity is about 7-8 times more which means one-unit input of brood lac produce around 7-8 unit output in the brood lac inoculated. By inoculation of 40-50 g brood lac per plant approximately 250 g brood lac and 50 g scraped lac per plant can be harvested from 6-month of winter season (*aghani*) lac crop (July to December-January). Under irrigated condition, *kusmi,* summer crop can

also be taken where maximum temperature does not exceed 42ºC. However, 35-40°C temperature would be ideal. Lac cultivation can be effectively introduced in new areas on semialata if irrigation facility has been developed. The recurrence of irrigation depends on environmental temperature, humidity and soil condition. Around 400kg of brood lac is required for inoculation on 8,000 plants; accommodated in one hectare and around 2000 kg brood lac can be harvested after six months of inoculation.

Meshram *et al.* (2018) studied that the mean fresh weight of 100 lac cells varied from 4.09 to 7.31 g. The mean fresh weight of 100 lac cells was highest 7.31 g on kusum followed by semialata 6.52 g in *kusmi* strain and 6.73 g on ber followed by palas 4.09 g in *rangeeni* strain.

Netam *et al.* (2019) studied that the mean fresh weight of 100 lac cells varied from 5.61 to 8.68 g. The mean fresh weight of 100 lac cells was highest 8.68 g on kusum followed by semialata 7.50 g in *kusmi* strain and 7.61g on ber followed by palas 5.61 g in *rangeeni* strain.

2.3 To study the incidence of major predators of lac insect on Kusum host plant.

Glower (1937) suggested that two predators which are the key pests of lac crop viz., *Eublemma amabilis* (Moore) Lepidoptera Noctuidae and *Pseudohypatopa pulverea* (Meyr) Lepidoptera: Blastosidae, that decreased yield about 30 to 40 per cent.

Narayanan (1962) reported that the predator of lac insect, *E. amabilis* as a monophagous insect that caused considerable losses to the lac crop about 20 to 25 per cent.

Jaiswal *et al.,* (2001) reported that the lac insect associated predators and parasitoids in lac cultivated areas of Orissa. The abundance of lac insect predators were high in village Chikli block of Jharigram followed villages Baidpara, Bhattipada and Rajkot block of Chandahandi district Navrangpur. Few parasitoid species of lac insects and parasitoid of predators were found in constrained numbers.Kumar *et al.,* (2007) studied that the key predator lac insect namely, *Eumlemma amabilis* and *Pseudohypatopa Pulverea.*

Rahman *et al.,* (2009) revealed that the adult moth of *E. amabilis* is normally white-pinkish in colour and lays grey to white coloured eggs that depression in the centre. The newly hatched larvae enter in the cell by tunnelling a hole in the lac encrustation or by opening the cell. Damage caused by single larvae about 42 to 50 matured cells of lac insect before pupation. It passes six descents in years and accounts relatively more damage to the *katki* as compared to *baisakhi crop.*

Bhattacharya (2011) suggested that the lac insect *Kerria lacca* (Kerr.) predator *Eublemma amabilis* eating on the lac larvae and made spins a loose web and destroyed 45 to 50 mature lac cells by a single predator.

Chattopadhyay (2011) revealed that the *P. pulverea* predator of lac insect was potential destructive predator noticed in all lac growing regions of the country. It observed eating on the live and dead cells of lac insects and caused qualitative and quantitative deterioration of stored lac.

Singh *et al.* (2011 a) studied that the major predators of *K. lacca* Chrysopids was one of the key restricted factors in the potential productivity of lac crop. After settlement of lac insect on kusum (*S. Oleosa)* host plant in *kusmi* strain, noticed to attack the first instar larvae of *C. zastrowi.* About 150-200 adults of *C. Zastrowi* were recorded on kusum in *jethwi* (summer) season *kusmi* strain. The potential of *C. zastrowi* was maximum predation during second and third instar stages with the larva feeding on 160-195 and 425-485 lac insects, respectively.

Khobragade *et al.* (2012) reported in Anuppur district of M. P that the *E. Amabilis was* a predominance predator of *K. lacca* that convey yield losses up to 35.31 per cent, recorded in *baisakhi* (summer)crop of *rangeeni* lac strain during November 2009 to May 2010.

Daharia and Katlam (2013) reported that the survey was performed in variant lac cultivated districts of Chhattisgarh, during the studies *Eublemma amabilis* appeared as potential predator of lac insect as compared to *P. pulverea*. The number of *E. amabilis* was noticed in district Mahasamund followed by Jashpur and Raipur district whereas *P. pulverea* was most existing in winter crop at Raipur, followed by Jashpur. In district Kanker, the parasitoids of *T. tachardiae* was observed as potential parasitoids fallowed by Jashpur district.

Soni *et al.* (2013) observed in Kanker of district Chhattisgarh under forest division during the survey *E. amabilis, P. pulverea, H. pulverea* and *Chrysopa sp.* were recorded as major predators and *E. scitula, Pyroperces falcatella* and *Ephestica sp.* as minor predator of lac insect.

Uike (2015) reported that investigation was undertaken in Gariyaband district of Chhattisgarh in *jethwi* (summer) lac crop, major predator *E. amabilis* and *P. pulverea* were recorded as from different lac growing areas with population up to 11 per 30 cm stick lac, whereas *Chrysopa sp.* with population 0-3 was noticed as minor predator. Among parasitiods, major parasitoids are T. tachardiae with population 0-9 and *Eupelmus tachardiae* with population 0-4 and *Aprostocetus purpureus* with population 0-7 as minor parasitoids of *kusmi* strain in *jethwi* (summer) season crop.

Meshram *et al*. (2018) studied during year 2014-15 and 2015-16 in Korba District of Chhattisgarh. The predators viz. *Eublemma amabilis* and *Pseudohypatopa pulverea* were recorded as major predator fauna of lac reached peak first fortnight of May with 9.30 and 10.10 insects/ 30 cm lac stick, whereas the incidence of *Chrysopa mandestes* was noticed minor.

Meena and Sharma (2018) reported the lac insect associated predators *E. amabilis, P. pulverea, C. zastrowi*; primary parasitoids *T. tachardiae, A. purpureus, T. clavicarnis, E. dewitzi* and hyper-parasitoids *A. fakhrulhajiae, E. tachardiae, B. greeni, B. tachardiae*. *E. amabilis* had maximum density among all predators, *E. dewitzi* is the most abundant parasitoid in western part of India whereas in eastern part of India where lac cultivation is practiced *T. tachardiae and A. purpureus* are most destructive parasitoids of lac insect. *T. tachardiae* is more abundant during October than *A. purpureus* in July. Hyper-parasitoid *E. tachardiae* is most predominant in October whereas *A. fakhrulhajiae* during July.

Netam *et al.* (2019) studied during year 2015-16 and 2016-17 at Kanker District of Chhattisgarh. The predators viz. *Eublemma amabilis* and *Pseudohypatopa pulverea* were recorded as major predator fauna of lac. *E. amabilis* it reached peak first fortnight of August to 2nd fortnight of December with 8.85 insect/ 30 cm lac stick, *P. pulverea* was first appeared with 2.93 per 30 cm stick lac which active from 1st fortnightly of August to 2nd fortnight of October whereas the incidence of *Chrysopa mandestes* was noticed minor reached peak density with 4.23 insect per 30 cm stick lac in first fortnight of August, which active active from 1st fortnight of August to 1st fortnight of November in Semialata bushy host plant *Kusmi, aghani* (winter) strain.

CHAPTER- III
MATERIAL AND METHODS

The present research work entitled **"Studies on the survival, potential yield of Lac insect *Kerria lacca* (Kerr.) on nutrient managed Kusum (*Schleichera oleosa*) host in Kanker District of Chhattisgarh"** was carried out from January 2021 to July 2021.

3.1 Location of study area

3.1.1 District profile

Uttar Bastar Kanker district is located in the southern region of Chhattisgarh within the longitude of 20.6-20.24 and the latitude is 80.48-81.48. It has an elevation range of 412 meters to 325 meters. The total geographical area of Uttar Bastar Kanker is 6506 sq. km, out of which 3094 sq. km area is under forest land that means 47.55 per cent area of Kanker district is covered with forest. The physical area of Kanker is heterogeneous and is a mix between flat land and undulating hills. Majority of the land is between 300 and 600 meters above sea level, and around 80% of the land is flat. The Mahanadi Plane and the Kotri Plane are the two portions of these flat lands. Kanker inhabited mainly by tribal. Kanker is blessed with lush green forest cover, where a sizable number of tribal populations are found. The seven blocks of Uttar Bastar Kanker are Antagarh, Bhanupratapur, Charama, Durgkondal, Kanker, Narharpur and Pakhanjur.

Forest plays an important role in the social and financial structure of Kanker. This district has rich in forest wealth. District administrative head quarter is Kanker and located 128km away from State capital Raipur.

3.1.2 Mardapoti village

Mardapoti is a village of Kanker Tehsil in Kanker district of Chhattisgarh state, India. It is located 12 km away from district head quarter Kanker. The total geographical area of village is 463.3 hectares. Mardapoti has a total population of 617 peoples. There are about 133 houses in village.

3.1.3 Soil

The soil in Kanker originates from granite, gneiss, sand and Khedar. The majority of the land is covered with red soil. The soil in the higher region of the hilly tract, whereas the soil in the river valleys is smooth and fertile. The soils of this district are divided into four categories.

Table-3.1 Major Soils

S.No.	Major Soils (common names like red sandy loam deep soils (etc.,)	Major crops grown
1.	Entisol (Bhata -gravely)	Kodo, Kulthi,
2.	Inceptisol (Matasi -Sandy loam)	Maximum area of Rice crop Kanker region
3.	Alfisols (Dorsa-clay loam)	Kharif and Rabi crops
4.	Vertisols (Kanhar -clayey)	Kharif and Rabi crops

Source - (data source: Soil Resource Maps of NBSS & LUP)

3.1.4 Agriculture

The economy of Kanker is based on agriculture and also it is a main job of tribes. The land is not plane surface and is forest based. So, the farmer who live in the forest, cut the trees before the rainy season, and plough the land for agriculture, and sow seeds of rice or other grains, this type of agriculture is called marhan or dippa. After one and two years, they prepare a new farm and leave the old one. On the plane land, the agriculture is done each and every year. People divide their farms by constructing the small partitions. Rice is the main crop of area but wheat, chickpea, green gram, sesame, maize are the other important crops. People also grow many types of vegetables. A lot of fruits like Mangoes, Bananas, Custard apple, Anola etc are also produced.

Table-3.2 Agro-Climatic/Ecological Zones

District Agriculture profile				
S.No.	**Agro-Climatic/Ecological Zone**			
1.	Agro Ecological Sub Region (ICAR)	Eastern (Chota nagpur) plateau and eastern ghats sub humid eco-region (12.1		
2.	Agro-Climatic Zone (Planning Commission)	Eastern plateau and hill region (VII)		
3.	Agro Climatic Zone (NARP)	Bastar plateau zone		
4.	List all the districts falling under the NARP Zone* (*>50% area falling in the Zone	Bastar, Dantewada, Bijapur, Narayanpur, Sukma, Kondagaon & Kanker,		
5.	Geographic coordinates of district headquarters	**Latitude**	**Longitude**	**Altitude**
		21.27 N	**81.49 E**	**387 M**

Table-3.3 Agricultural land use pattern

S.No.	**Agricultural land use pattern**	**Area ('000 ha)**	**Cropping intensity %**
1.	Net sown area	**210.708**	
2.	Area sown more than once	**17.363**	
3.	Gross cropped area	**228.071**	**108**

Table-3.4 Weekly meteorological data of Kanker during *Jethwi* (summer) crop 2020-21

SMW	Date	Rainfall (mm)	Temperature (°C)		Humidity (%)		Wind speed (kmph)
			Maximum	Minimum	Maximum	Minimum	
05-06	Feb 01- Feb 15	0.00	29.49	12.47	31.53	11.20	6.80
07-08	Feb 16- Mar 02	0.00	31.40	16.61	47.27	19.00	6.40
09-10	Mar 03- Mar 17	0.00	35.89	19.25	29.40	10.73	7.47
11-12	Mar 18- Apr 01	0.00	36.37	20.71	30.67	11.60	8.07
13-14	Apr 02- Apr 16	0.94	38.07	21.99	40.60	11.27	9.07
15-16	Apr 07-May 01	0.53	38.64	24.75	55.13	24.27	5.40
17-18	May 02May 16	0.86	36.89	23.41	59.53	20.81	10.07
19-20	May 17-May31	0.17	36.72	25.07	53.33	19.27	12.07
21-22	June01-June 15	9.59	33.47	23.60	73.60	40.87	11.93
23-24	June 16- June 30	21.69	29.98	22.45	84.33	56.07	12.53
25-26	July 01- July 15	25.43	32.64	23.93	90.64	64.43	12.50

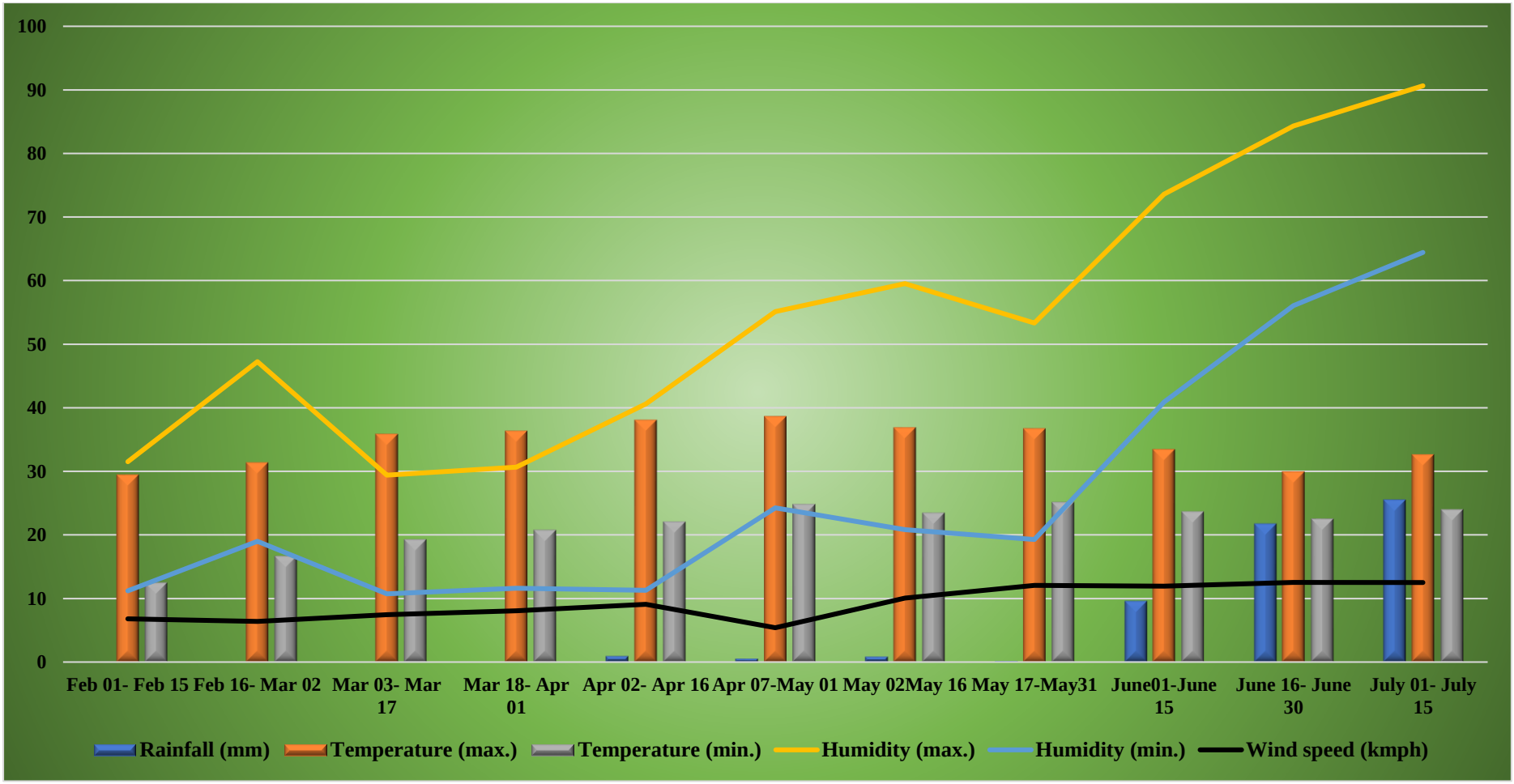


Fig 3.1 Weekly meteorological data of Kanker during *Jethwi* (Summer) 2020-2021

3.2 Experimental details

The study was planned under RBD with four replication and six treatments. The details are mentioned in Table- 3.5.

Table-3.5 Details of the Experiment

Host trees	Kusum (*S.oleosa*)
Season	Summer
Design	RBD
Number of Replication	04
Number of Treatment	06
Total number of *Schleicera oleosa* tree per replication	06

	Treatment details (Application of fertilizer per *Schleicera oleosa* tree)
T1	Application of Nitrogen (Urea 220g/plant)
T2	Application of Nitrogen (Urea 220g/plant) and Phosphorus (SSP 1560g/plant)
T3	Application of Nitrogen (Urea 220g/plant), Phosphorus (SSP 1560g/plant) and Potassium (MoP 125g/plant)
T4	Application of Nitrogen (Urea 220g/plant) and Potassium (MoP 125g/plant)
T5	Application of Phosphorus (SSP 1560g/plant) and Potassium (MoP 125g/plant)
T6	Control i.e. no use of fertilizers (Lac grower practice)

Table-3.6 Details of major operation

S.no.	Operations	Scale	Period
1.	Brood lac Inoculation	Depending on the size of the branches	3rd January 2021
2.	*Phunki* removal	-	24th January 2021
3.	Weighing of *phunki*	-	24th January 2021
4.	Weighing of scrapped *phunki*	-	24th January 2021
5.	Larval settlement	Lac insect / 2.5 sq. cm	1st February 2021
6.	Predator count from four cardinal directions	Predator/4 lac bearing stick	2nd February 2021
7.	Sex ratio	Male and female count / 2.5 sq. cm	After 71 days of BLI
8.	Number of stick lac per plant	In number	8th July 2021
9.	Length of stick/ plant in cm	In cm	8th July2021
10.	Weight of 30 cm lac stick in(g)	In g	8th July 2021
11.	Weighing of 30 cm scrapped lac stick in (g)	In g	8th July 2021
12.	Yield of stick lac in kg	In kg/plant	8th July 2021
13.	Cost of fertilizer	Per tree	8th July 2021

3.3 Fertilizer application

All the marked *S. oleosa* tree except control (T_6) were applied with basal dose of fertilizer as per treatment (Table-3.5) one month before Brood lac inoculation.

3.4 To study the survival of lac insect *Kerria* lacca (Kerr.) on Kusum host plant

The survival of lac Insect *Kerria lacca* (Kerr.) on Kusum (*Scheleicera oleosa*) in *kusmi* strain of *Jethwi* crop at Kanker district of Chhattisgarh was recorded during 2020-21. The experiment was carried out in Randomized Block Design (RBD) with the four replications.

3.4.1 Brood lac Inoculation

A. Brood lac Inoculation- Healthy brood lacs after weighing were used per tree of Kusum (*Scheleicera oleosa*). Depending on the size of tree, the brood lacs were divided into 6000g to 7000g inoculated in season *Kusmi Jethwi* for 2020-21.

B. Shifting- After 7-8 days of inoculation, the brood lac bundles were carefully shifted to separate branches on the same tree. This was done to ensure that the brood was distributed evenly on branches with no or insufficient lac larval settlement.

C. *Phunki* removal- Larva (Crawlers) of lac insect from brood lac were settled on the trees in three weeks from the date of inoculation. After the larvae settled on the twigs of inoculated host, remain the brood lac called *Phunki. Phunki* usually consists of predators which were removed after 21 days of brood lac inoculation and scraped and sold. Removal of *Phunki* was the process to check the spreading of predator and parasitoids to newly settled lac insect as well as get the raw scraped lac product.

3.4.2 Observation recorded

All the marked *Scheleicera oleosa* except control (T_6) were applied with basal dose of fertilizer as per treatment (Table-3.4) one month before Brood lac Inoculation and then the population density of *Kerria lacca* (Kerr.) was recorded by counting the insect (later lac cell) with the help of hand lense in per 2.5 sq cm area (The area was measured with the help of Vernier Calipers) on three randomly selected branchs of Kusum (*Scheleicera oleosa*) plant from upper, middle, lower at 30, 45, 60, 90, 110, 130, 150, 170, 172 day intervals, consecutively after BLI till the harvest.

3.5 To study the potential yield of lac insect *Kerria lacca* (Kerr.) on Kusum host plant.

Potentiality of host plant Kusum (*S.oleosa*) for lac production in season viz. *Kusmi Jethwi* (Summer) at Kanker district of Chhattisgarh was recorded during 2020-21.

The experiment was conducted in a Randomised Block Design (RBD) with four replications, six plants were selected in each replication.

3.5.1 Observation recorded

Potentiality of host plants viz, Kusum (*S.oleosa*) of lac insect was recorded for the lac production in cropping seasons namely *Kusmi ,jethwi* (summer). It was observed in terms of different productivity parameters like, number of stick lac per plant, length of stick lac per plant (cm) (length be converted by using formula or Vernier scale), fresh weight of
stick lac per 30 cm of length in (gram), weight of scraped lac per 30 cm stick lac in (gram), weight of stick lac per plant (kg), fresh weight of 100 lac cells (gram) and dry weight of 100 lac cells (gram) was recorded with the help of Electronic balance at the time of harvest. The potential of yield was calculated with the help of the following formula.

$$\text{Yield potential} = \frac{\text{Total raw lac per tree (g)}}{\text{Total inoculated brood lac per tree (g)}}$$

3.5.2 Sex ratio

Sex ratio is an important factor of the lac production, because female lac insect produces the lac. Numbers of male and female lac were counted per 2.5 sq. cm stick lac, 2.5 sq. cm lengths were measure by using the Vernier caliper scale and sex ratio was calculated with the help of following formula.

Sex ratio = Number of female lac insect/ Number of male lac insect

3.6 To study the incidence of major predators of lac insect on Kusum host plant.

The untreated host plant Kusum (*S. oleosa*), 24 plants (8 twigs each plant) were randomly selected for survey of associated predator of lac insect in season *Kusmi Jethwi* at Mardapoti village in Kanker district of Chhattisgarh, was recorded during 2020-21.

3.6.1 Observation recorded

The incidence of major predators of lac insect *K. lacca* (Kerr.) whereas measured on Kusum host plant at fortnightly interval in Kanker district of Chhattisgarh. Collection of infested encrusted branch (15cm twig) of Kusum host plant and it was done from different directions (N, S, E and W) and kept in 60 mesh nylon basket (bag) for 10-15 days till the emergence of predators. As per method suggested by Mohanasundaram *et al.*,2016.

3.7 Statistical analysis

3.7.1 The skeleton of the analysis of variance

In present investigations, field experiments were laid out in Randomized Block Design. The data obtained were analysed statistically after using appropriate transformation. The mean numbers of larval population of lac insect from the data obtained were transformed using square root transformation by the formula √ (X+0.5) to the original values. The survivals of lac insect data were converted into percentage. The percentage data ranging from 0 to 100 % were processed under Arcsine transformation Sin-1 *(√x / 100)* but when data ranged from 0 to 30 per cent, it was subjected to square root transformation before statistical analysis. The transformed data was then analysed by the method of analysis of variance as described by Gomez and Gomez (1984). The "F" test was used at 5 per cent level of significance.

Source of variation	DF	SS	MSS	F cal	F tab	CD 5%
Replication (R)	(R-1)					
Treatment (T)	(T-1)					
Error	(R-1) (T-1)					

The following formulae were used for standard error, critical difference and coefficient of variance estimations.

(a) C.D. = $\sqrt{\frac{2EMS}{R}} \times t$ (D.F. at 5%)

Where,

R = Number of Replications, D.F = Degrees of Freedom

T = Number of Treatments, S.S. = Sum of Square

C.D. = Critical Difference, EMS = Error Mean Square

M.S.S= Mean Sum of Square, GM = Grand Mean

CHAPTER-IV
RESULTS AND DISCUSSION

The experimental findings on various aspects of the study entitled "Studies on the survival, potential yield of lac insect *Kerria lacca* (Kerr.) on nutrient managed Kusum (*Schleichera oleosa*) host in Kanker district of Chhattisgarh" are present below.

4.1 Nutrient application

The basal application of nutrients was done in *S. oleosa* from 1st December to 2nd December 2020. The Nitrogen, Phosphorus and Potash were applied through basal application of Urea, SSP and MoP respectively. The nutrient is different treatments were in T1 – N (Urea 220g), T2- N (Urea 220g), P (SSP 1560g), T3- N (Urea 220g), P (SSP 1560g), K (MoP 125g), T4- N (220g), K (MoP 125g), T5- P (SSP 1560g), K (MoP 125g), T6- Control i.e., No use of fertilizer (Lac grower practice).

Table 4.1: Basal application of fertilizers per *S. oleosa* tree

T1	Application of Nitrogen (Urea 220g)	N
T2	Application of Nitrogen (Urea 220g) + Application of Phosphorus (SSP 1560 g)	NP
T3	Application of Nitrogen (Urea 220g) + Application of Phosphorus (SSP 1560g) + Application of Potassium (MoP 125g)	NPK
T4	Application of Nitrogen (Urea 220g) + Application of Potassium (MoP 125g)	NK
T5	Application of Phosphorus (SSP 1560g) + Application of Potassium (MoP 125g)	PK
T6	Control i.e. No use of fertilizers (Lac grower practice)	None

It is widely acknowledged that nutrients play an important role in the plant growth (Oskarsson *et al.* 2006; Dianda *et al.* 2009), and have recorded positive response of NPK fertilization to wheat crop growth (Bearg and Hamid, 1976). Nitrogen is the most critical element of plant growth, yield and quality of the products in crop (Nori *et al.* 2012). It comprises seven per cent of total dry matter of plants and is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes and photosynthetic pigments (Bungard *et al*. 1999).

Phosphorus- The second most important macronutrient next to nitrogen is required for plant growth (Ragothama, 1999). It has an important role in photosynthesis, respiration, energy generation, nucleic acid biosynthesis and as an integral component of several plant structures such as phospholipids (Vance et al., 2003). Potassium is an essential element for the growth of plant and takes part in various physiological processes (Yoshida, 1981).

Veeresh (2003) and Jennifer (2000) reported that the increase in total dry matter production of common bean plant due to increase phosphorus.

Phloem feeding insects adversely affect both growth and amino nitrogen profile of their host plants (Willings and Dixon, 1987), while poor plant nutrition can have adverse effects on the performance and fitness of sap feeders (Cook and Denno, 1994).

The experimental findings have been carried out on various aspects of the study entitled “Studies on the survival, potential yield of Lac insect *Kerria lacca* (Kerr.) on nutrient managed Kusum (*Schleichera oleosa*) host in Kanker District of Chhattisgarh”. During year 2020-2021, the research finding has been presented under the following heads.

4.2 To study the survival of lac insect Kerria lacca (Kerr.) on Kusum host plant.

4.2.1 Brood lac Inoculation (BLI)

Inoculation is the first stage of lac cultivation. It is the process by which transfer of newly hatched nymph/larvae (brood) of *K. lacca* from brood lac to the branches of trees. It was done from 3rd January to 4th January 2021 on *S. oleosa* trees. The mean brood lac inoculated varied from 6000g to 7000g per tree depending upon the size of host tree. There was no significant difference among the different treatments.

Present finding is in agreement with Kumar *et al.* (2015) who reported the requirement of brood lac for different host plant is different host plant is differed due to its size, normally required on Kusum 5-10 kg, Ber 1.5 kg, Palas 0.75 – 1.0 kg and Semialata needed 40-50 g brood lac.

Meshram (2018) who reported the requirement of brood lac for different host plant is 0.556, 0.466, 7916 and 46.92 g which is used for palas, ber, kusum and semialata respectively.

4.2.2 Shifting

Shifting was done on seven days after BLI i.e. to ensure uniform distribution of the brood on all the branches of *S. oleosa*, where there was no insufficient lac larval settlement.

Present finding is in accordance with Khobragade *et al.* (2012) revelled that the shifting process is efficient use of brood lac. Since then shifting has become popular and the operation followed by many workers (Kunal 2013, Janghel,2013 and Bhagirath,2013)

4.2.3 *Phunki* removal

Phunki was removed in 21 days after BLI i.e. from 24th January to 25th January 2021. The mean weight of *phunki* lac was 3600g, 3825g, 3870g, 3775g, 3700g and 3475g respectively in case of T1, T2, T3, T4, T5 and T6. There was no significant difference in the mean weight of *phunki* among four treatments.

Phunki removal after 3 weeks of BLI was suggested by Sharma and Jaiswal (2011).

Phunki removal is a cultural and mechanical approach for removal of predators and parasites from the lac production systems. This was followed by earlier workers namely Khoragade (2012), Janghel (2013) and Bhagirathi (2013). *Phunki* removal is a labour-intensive operation, but the scrapped lac provides them a cash income after 30 days of BLI.

Non-significant difference of the raw lac obtained from *phunki* among different treatment indicates that brood lac used was of high quality. Kunal *et al.* (2013) also found no significant difference in weight of *phunki* on the same host.

4.2.4 Scrap lac from *phunki*

Phunki was scrapped to obtained raw lac from it. The mean weight of the raw lac obtained after scrapping of *phunki* was 1088.75g, 1147.5g, 1152.5g, 1132.5g, 1110g and 1078.75g respectively among T1, T2, T3, T4, T5 and T6. There was no significant difference among the raw lac from *phunki.*

Table 4.2: Weight of *phunki* (g) per plant and weight of scrap lac from *phunki* (g) per plant

Treatments	Mean weight of *phunki* (g) per plant	Mean weight of scrap lac from *phunki* (g) per plant
T1	3600.00	1088.75
T2	3825.00	1147.50
T3	3870.00	1152.50
T4	3775.00	1132.50
T5	3700.00	1110.00
T6	3475.00	1078.75
S.Em.	**175.46**	**47.46**
C.D at 5 %	**NS**	**NS**

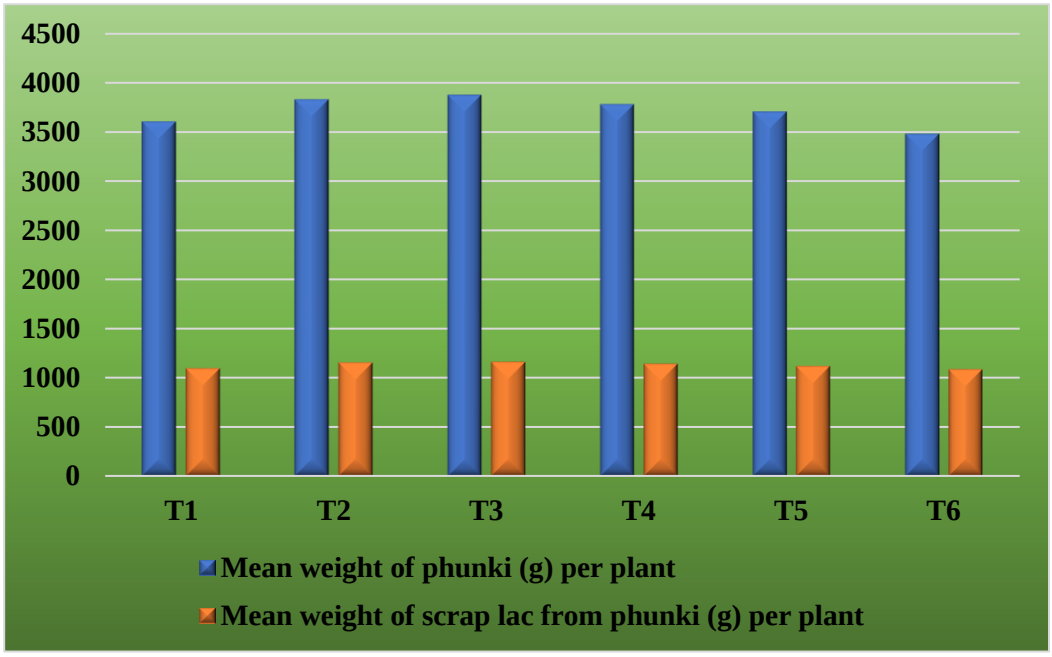


Fig 4.1: Weight of *phunki* (g) per plant and weight of scrap lac from *phunki* (g) per plant

4.2.5 Population density of *Kusmi* lac

The mean larval settlement count of *Kusmi* lac insects was observed per 2.5 sq. cm of the succulent branches after BLI till the harvest i.e. at 30, 45, 60, 70, 90, 110, 130, 150 and 172 days of BLI (Table – 4.3 & Fig- 4.2)

30 days after BLI

The lac insects were recorded on 2.5 sq. cm branches, mean number of lac insects varied from 94.89 to 109.25 in the six treatments T1, T2, T3, T4, T5 and T6 of strain *Kusmi*, during the year 2020-21. The maximum number of lac insect's survival was noticed on T1 (109.25), T2 (106.83), T4 (104.61), T3 (103.50), T5 (101.17) and T6 (94.89). There was significant difference in mean number of lac insect survival in 2.5 sq. cm on host plants.

Fertilizer application, especially nitrogen fertilizer, results in serious herbivores occurrence resistance (Bi *et al.,* 2001; Ge *et al.,* 2003). plant nutritional quality and plant defences that directly act on herbivores are altered by N fertilization and herbivorous insects can distinguish between plants receiving different N applications (Prudic *et al.*, 2005 and Chen et al., 2008). Low nitrogen contents in the plant enhance the resistance of plants against pest, but high nitrogen content vigorous growth along with consequent decrease in resistance against pest (Bhinde, 1993; Huber and Thompson, 2007).

Skinner and Cohen., (1994) reported that higher phosphorus level is associated with higher insects' level.

Potassium (K) has been considered a key component of plant nutrition that significantly influences crop growth and some pest's infestation. Increased K levels in foliage can reduce insect pressure (Facknath and Lalljee, 2005; Walter and DiFonzo, 2007). These findings are in agreement with a compilation of studies by the International Potash Institute (cited in Amtmann *et al.* 2008)

Amtmann *et al.* (2008) provide a potential mechanism to explain the relationship between K deficiency and increased insect attack. K deficiency results in reduced synthesis of proteins, starch and cellulose and increased accumulation of lower molecular weight compounds such as amino acids, nitrate, soluble sugars and organic acids. These lower weight molecular compounds are more easily utilized as nutrient sources by sucking insects. Thus, insect attacks, but the subsequent impact of K deficiency on plants, makes plants more readily attacked by sucking insects. This is better explained by Walter and Difonzo, (2007) who reported that low K fertility was associated with high foliar levels of the amino acid serine and higher aphid infestations. However, in the present study, the significant difference in the settlement is due to the impact of nutrient management. Thus, the present findings are in agreement with those of the earlier workers.

Present finding is in accordance with Meshram *et al.* (2018) reported that the highest settlement of lac insect crawler per 2.5 cm in succulent branch recorded in *Aghani* (Winter) crop of *Kusmi* lac on kusum tree (110.48) followed by semialata (94.88) whereas in *Baisakhi* (Summer) crop of *Rangeeni* lac on ber (100.58) followed by palas (91.25).

Netam (2019) reported that the number of lac insect's survival on 2.5 sq. cm branches was varied from 70.96 to 101.01. The maximum survival of lac insect was recorded on kusum (101.01) followed by semialata (93.30) in *kusmi* (*aghani*) strain. While in *rangeeni* (*katki*) it was maximum on ber (99.44) followed by palas (70.96) host plants.

45 days after BLI

Lac insect after secretion of resin over its body grows into individual lac cell. The mean number of lac insect count per 2.5sq cm at 45 days after BLI varied from 69.50 to 83.58 in the six treatments T1, T2, T3, T4, T5 and T6 of *kusmi* strain during the year 2020-2021. The maximum number of lac insect's survival was noticed on T1 (83.58), T2 (81.17), T4 (79.80), T3 (77.92), T5 (75.92), T6 (69.50). There was significant difference in mean number of lac insect survival among the six treatments.

Present finding is in agreement with Meshram *et al.* (2018) reported that the highest settlement of lac insect crawler per 2.5 cm in succulent branch recorded in *Aghani* (Winter) crop of *Kusmi* lac on *kusum* tree (78.60) followed by semialata (64.42) whereas in *Baisakhi* (Summer) crop of *Rangeeni* lac on ber (69.91) followed by palas (61.86).

Netam (2019) reported that the number of lac insect's survival on 2.5 sq. cm branches was varied from 51.58 to 76.32. The maximum survival of lac insect was recorded on kusum (76.32) followed by semialata (60.93) in *kusmi* (*aghani*) strain. While in *rangeeni* (*katki*) it was maximum on ber (68.60) followed by palas (51.58) host plants.

60 days after BLI

The mean survival of lac cell count per 2.5 sq.cm at 60 days after BLI varied from 50.50 to 64.58 in different treatments. The mean live lac cell was highest in T1 (64.58), T2 (62.17), T4 (60.25), T3 (58.83), T5 (56.92), T6 (50.50). There was significant difference among the six treatments.

Present finding is in agreement with Meshram (2018) reported that the highest settlement of lac insect crawler per 2.5 cm in succulent branch recorded in *Aghani* (Winter) crop of *Kusmi* lac on kusum tree (60.46) followed by semialata (46.55) where as in *Baisakhi* (Summer) crop of *Rangeeni* lac on ber (50.23) followed by palas (44.47).

Netam (2019) reported that the number of lac insect's survival on 2.5 sq. cm branches was varied from 70.96 to 101.01. The maximum survival of lac insect was recorded on kusum (101.01) followed by semialata (93.30) in *kusmi* (*aghani*) strain. While in *rangeeni* (*katki*) it was maximum on ber (99.44) followed by palas (70.96) host plants.

70 days after BLI

The adult male of *Kerria lacca* emerged at 70 days after BLI. The adult male moves after its while emerges the female lac insect remains sedentary cell count per 2.5 sq. cm. The measurvival of lac insect at 70 days after BLI reduced in comparison to that on 60 days after BLI during the 2020-21. It varied from 38.50 to 52.58 per 2.5 sq. cm. The maximum number of lac survival was noticed on T1 (52.58), T2 (50.17), T4 (48.25), T3 (46.83), T5 (44.95) and T6 (38.50). There was a significant difference in the lac cell among all the treatments.

Present finding is in agreement with Meshram *(*2018) reported that the highest settlement of lac insect crawler per 2.5 sq. cm in succulent branch recorded in *Aghani* (Winter) crop of *kusmi* lac on kusum tree (49.88) followed by semialata (32.72) whereas in *Baisakhi* (Summer) crop of *rangeeni* lac on ber (35.90) followed by palas (31.40).

Netam (2019) reported that the number of lac insect's survival on 2.5 sq. cm branches was varied from 31.28 to 46.72. The maximum survival of lac insect was recorded on kusum (46.72) followed by semialata (32.84) in *kusmi* (*aghani*) strain. While in *rangeeni* (*katki*) it was maximum on ber (35.06) followed by palas (31.28) host plants.

90 days after BLI

The male emergence between 65- 75 days after BLI. After the male emergence, the remaining lac cell were that of female lac insects. The mean female lac cell count per 2.5 sq cm at 90 days after BLI varied from 32.50 to 46.58 in different treatments. The female lac cell count was highest in T1 (46.58), T2 (44.25), T4 (42.25), T3 (40.83), T5 (38.92) and T6 (32.50). There was a significant difference among the treatments.

Present finding is in agreement with Netam (2019) reported that the number of lac insect's survival on 2.5 sq. cm branches was varied from 21.52 to 40.82. The maximum survival of lac insect was recorded on kusum (40.82) followed by semialata (26.70) in *kusmi* (*aghani*) strain. While in *rangeeni* (*katki*) it was maximum on ber (26.99) followed by palas (21.52) host plants.

110 days after BLI

The mean female lac cell count per 2.5 sq.cm at 110 days after BLI it varied from 21.25 to 34.42 in different treatments. It was highest in T1 (34.42) followed by T2 (32.25), T3 (30.42), T4 (28.83), T5 (26.83) and lowest in the case of T6 (21.25). There was a significant difference among the treatments.

Present finding is in agreement with Meshram (2018) reported that the highest settlement of lac insect crawler per 2.5 sq. cm in succulent branch recorded in *Aghani* (Winter) crop of *kusmi* lac on kusum tree (32.26) followed by semialata (21.44) whereas in *Baisakhi* (Summer) crop of *rangeeni* lac on ber (24.21) followed by palas (20.68).

Netam (2019) reported that the number of lac insect's survival on 2.5 sq. cm branches was varied from 16.81 to 31.01. The maximum survival of lac insect was recorded on kusum (31.01) followed by semialata (20.40) in *kusmi* (*aghani*) strain. While in *rangeeni* (*katki*) it was maximum on ber (19.64) followed by palas (16.81) host plants.

130 days after BLI

The mean cell count per 2.5 sq. cm at 130 days after BLI varied from 17.42 to 29.42 in different treatments. It was highest in T1 (29.42) followed by T2 (27.08), T4 (25.50), T3 (24.00), T5 (21.83) and T6 (17.42). There was significant difference in the mean number of lac cell count among the treatments.

Present finding is in agreement with Meshram (2018) reported that the highest settlement of lac insect crawler per 2.5 sq. cm in succulent branch recorded in *Aghani* (Winter) crop of *kusmi* lac on kusum tree (27.98) followed by semialata (20.52) whereas in *Baisakhi* (Summer) crop of *rangeeni* lac on ber (22.65) followed by palas (19.20).

Netam (2019) reported that the mean number of lac insect's survival on 2.5 sq. cm stick lac was recorded maximum number survival on kusum (25.92) followed by semialata (19.67) in *kusmi* (*aghani*) strain.

150 days after BLI

The mean lac cell count per 2.5 sq. cm at 150 days after BLI varied from 14.67 to 23.25 in different treatments. It was highest in T1 (23.25) followed by T3 (22.42), T2 (21.50), T4 (21.17), T5 (18.00) and T6 (14.67). There was a significant difference in the mean number of lac cell count among the treatments.

Present finding is in agreement with Meshram (2018) reported that the highest settlement of lac insect crawler per 2.5 sq. cm in succulent branch recorded in *Aghani* (Winter) crop of *kusmi* lac on kusum tree (24.87) followed by semialata (18.98) whereas in *Baisakhi* (Summer) crop of *rangeeni* lac on ber (20.19) followed by palas (17.27).

Netam (2019) reported that the mean number of lac insect's survival on 2.5 sq. cm stick lac was recorded maximum number survival on kusum (22.78) followed by semialata (17.61) in *kusmi* (*aghani*) strain.

172 days after BLI (At harvest)

The *Jethwi* crop of *Kusmi* lac matured in the 4th week of June 2021. It was harvested from 26th June to 28th June 2021. i.e. 172 days after BLI. The mean la cell count at harvest/maturity varied from 12.83 to 20.50. The live lac cell count was highest in T1 (20.50), followed by T3 (20.08), T2 (18.50), T4 (18.08), T5 (15.17) and T6 (12.83). There was a significant difference in the mean female lac cell count in different treatments.

Present finding is in agreement with Meshram (2018) reported that the highest settlement of lac insect crawler per 2.5 sq. cm in succulent branch recorded in *Aghani* (Winter) crop of *kusmi* lac on kusum tree (21.70) followed by semialata (17.59) whereas in *Baisakhi* (Summer) crop of *rangeeni* lac on ber (18.05) followed by palas (14.66).

Netam (2019) reported that the mean number of lac insect's survival on 2.5 sq. cm stick lac was recorded maximum number survival on kusum (17.63) followed by semialata (15.78) in *kusmi* (*aghani*) strain.

Table-4.3: Number of lac insect/ 2.5 sq. cm from BLI to harvest during 2020-21.

Treatments	Mean number of lac insects/2.5 sq. cm stick lac								
	Number of days after BLI								
	30	**45**	**60**	**70**	**90**	**110**	**130**	**150**	**172**
	2020-21								
N	109.25 (10.45)	83.58 (9.14)	64.58 (8.04)	52.58 (7.25)	46.58 (6.83)	34.42 (5.87)	29.42 (5.42)	23.25 (4.82)	20.50 (4.53)
NP	106.83 (10.34)	81.17 (9.01)	62.17 (7.88)	50.17 (7.08)	44.25 (6.65)	32.25 (5.68)	27.08 (5.20)	21.50 (4.64)	18.50 (4.30)
NPK	103.50 (10.17)	77.92 (8.83)	58.83 (7.67)	46.83 (6.84)	40.83 (6.39)	28.83 (5.37)	24.00 (4.90)	22.42 (4.73)	20.08 (4.48)
NK	104.61 (10.23)	79.08 (8.89)	60.25 (7.76)	48.25 (6.95)	42.25 (6.50)	30.42 (5.52)	25.50 (5.50)	21.17 (4.60)	18.08 (4.25)
PK	101.17 (10.06)	75.92 (8.71)	56.92 (7.54)	44.92 (6.70)	38.92 (6.24)	26.83 (5.18)	21.83 (4.67)	18.00 (4.24)	15.17 (3.89)
CONTROL	94.89 (9.74)	69.50 (8.34)	50.50 (7.11)	38.50 (6.20)	32.50 (5.70)	21.25 (4.61)	17.42 (4.17)	14.67 (3.83)	12.83 (3.58)
S.E.m.	**0.59**	**0.56**	**0.55**	**0.55**	**0.55**	**0.62**	**0.67**	**0.44**	**0.47**
C.D. at 5 %	**1.77**	**1.67**	**1.66**	**1.66**	**1.67**	**1.86**	**2.03**	**1.32**	**1.40**

Note: Figures in parentheses are root square transformed value, * BLI-Brood lac inoculation

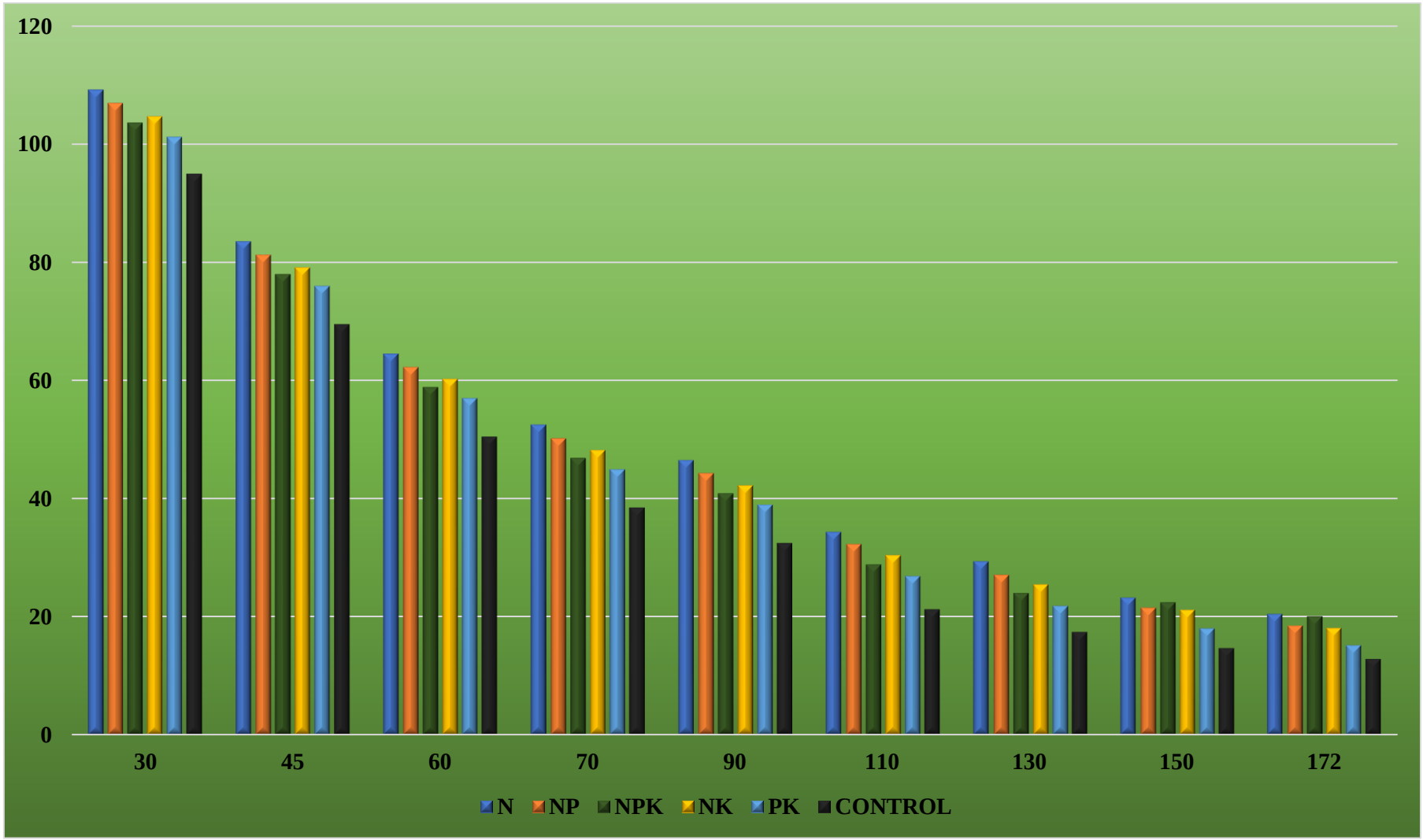


Fig 4.2 Number of lac/ 2.5 sq. cm from BLI to harvest during 2020-

4.2.6 Transmission loss of lac insects

Transmission loss (TL) defined as the loss in the number of lac insect per 2.5 sq. cm from BLI to harvest. There was a significant loss of insect from BLI to harvest among different treatments (Table-4.4) as observed from 30 days after BLI to harvest. It was 23.50, 40.89, 51.88, 57.37, 68.50, 73.08, 78.72 and 81.24 per cent at 30, 40, 60, 70, 90, 110, 130, 150 and 172 days in case of T1. In case of T2, the TL was 24.02, 41.81, 53.04, 58.58, 69.83, 74.66, 79.88 and 82.69 per cent at 30, 40, 60, 70, 90, 110, 130, 150 and 172 days respectively. In case of T3, the TL was 24.72, 43.16, 54.76, 60.56, 72.15, 76.82, 78.34 and 80.60 per cent at 30, 40, 60, 70, 90, 110, 130, 150 and 172 days respectively. In case of T4, the TL was 24.41, 42.41, 53.88, 59.62, 70.93, 75.63, 79.77 and 82.72 per cent at 30, 40, 60, 70, 90, 110, 130, 150 and 172 days respectively. In case of T5, the TL was 24.96, 43.74, 55.60, 61.54, 73.49, 78.43, 82.21 and 85.01 per cent at 30, 40, 60, 70, 90, 110, 130, 150 and 172 days respectively. In case of T6, the TL was 26.76, 46.79, 59.43, 65.75, 77.61, 81.65, 84.54 and 86.48 per cent at 30, 40, 60, 70, 90, 110, 130, 150 and 172 days respectively. The highest TL was in case of T6 (86.48 %) followed by T5 (85.01 %), T4 (82.72 %), T2 (82.69 %), T1 (81.24 %) and T3 (80.60 %). Thus, the survival per cent of lac insect from BLI to harvest was highest in T3 (19.40) followed by T1 (18.76 %), T2 (17.31 %), T4 (17.28 %), T5 (14.99 %) and T6 (13.52 %).

Table-4.4 Transmission loss of lac insect

	Transmission loss of number of lac insect from BLI to harvest (Lac insect per 2.5 sq. cm succulent branch)											
	Survival (%)						Transmission loss (%)					
Treatments	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
Number of days after BLI												
30												
45	**76.50**	**75.98**	**75.28**	**75.59**	**73.04**	**73.24**	**23.50**	**24.02**	**24.72**	**24.41**	**24.96**	**26.76**
60	**59.11**	**58.19**	**56.84**	**57.59**	**56.26**	**53.21**	**40.89**	**41.81**	**43.16**	**42.41**	**43.74**	**46.79**
70	**48.12**	**46.96**	**45.24**	**46.12**	**44.40**	**40.57**	**51.88**	**53.04**	**54.76**	**53.88**	**55.60**	**59.43**
90	**42.63**	**41.42**	**39.44**	**40.38**	**38.46**	**34.25**	**57.37**	**58.58**	**60.56**	**59.62**	**61.54**	**65.75**
110	**31.50**	**30.18**	**27.85**	**29.07**	**26.51**	**22.39**	**68.50**	**69.82**	**72.15**	**70.93**	**73.49**	**77.61**
130	**26.92**	**25.34**	**23.18**	**24.37**	**21.57**	**18.35**	**73.08**	**74.66**	**76.82**	**75.63**	**78.43**	**81.65**
150	**21.28**	**20.12**	**21.66**	**20.23**	**17.79**	**15.46**	**78.72**	**79.88**	**78.34**	**79.77**	**82.21**	**84.54**
172	**18.76**	**17.31**	**19.40**	**17.28**	**14.99**	**13.52**	**81.24**	**82.69**	**80.60**	**82.72**	**85.01**	**86.48**

4.3 To study the potential yield of lac insect on Kusum host plant

4.3.1 Sex Ratio

The female lac insects *Kerria lacca* (Kerr.) secreted the resin, therefore sex ratio is important factor for lac yield. The mean number of male lac cell was recorded. It was varied from 10 to 13.66 insects in the *kusmi* strain during the year 2020-21, which was given in Table – 4.5 & Fig -4.3. It was maximum on T3 (13.14) followed by T5 (13.00), T2 (12.54), T3 (12.50), T4 (12.06) and T6 (10.31). There was significant difference in mean number of male lac cell on host plant in *kusmi* strain. The mean number of female lac insect *Kerria lacca* (Kerr.) cell was recorded it varied from 27.61 to 39.44 insects in the *kusmi* strain given in Table - & Fig- during the year 2020-21. It was maximum on T1 (39.44) followed by T2 (37.63), T4 (36.13), T3 (34.13), T5 (31.11) and T6 (27.61) in *kusmi, jethwi* (Summer) strain. There was significant difference in mean number of female lac cell on different host plants in *kusmi* strain.

The mean sex ratio of lac insect was recorded it was varied from 2.41 to 3.00. The maximum sex ratio observed in T1 (3.00) followed by T2 (3.00) at par with T4 (3.00), T3 (2.73), T6 (2.68) and T5 (2.41) respectively. The difference among the treatments was shown in (Table-4.5 & Fig-4.3).

Table 4.5 Numbers of male, female lac insect per 2.5 sq. cm and sex ratio per 2.5 sq. cm

Treatments	Mean number of male lac insect per 2.5 sq. cm	Mean number of female lac insect per 2.5 sq. cm	Mean Sex ratio per 2.5 sq. cm
T1	13.14	39.44	3.00
T2	13.00	37.63	2.89
T3	12.50	34.13	2.72
T4	12.54	36.13	2.87
T5	12.06	31.11	2.57
T6	10.31	27.61	2.68
S.E.m.	0.34	0.98	0.07
C.D. at 5 %	1.05	2.95	0.22

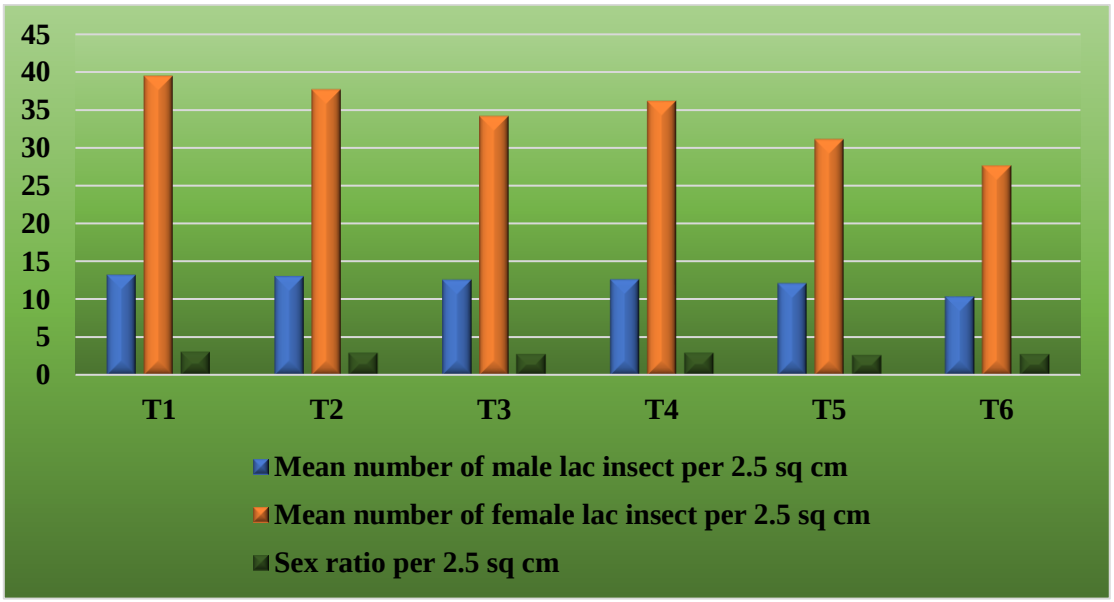


Fig 4.3 Numbers of male, female lac insect per 2.5 sq. cm and sex ratio per 2.5 sq. cm

A. Female lac cell

B. Male lac insect

Plate-01: Male lac insect and Female lac cell

4.3.2 Number of Stick lac

Branches of the lac host tree with lac encrustation of mature lac insect when ready to harvest are called stick lac. The mean number of stick lac was highest in T3 (249.25) followed by T2 (247), T4 (244.75), T5 (240.5), T1 (236.25) and T6 (233.75). There was a significant difference in the number of stick lac in different treatments.

In present research work, the number of stick lac in the *S. oleosa* with nutrient management was more comparison to control. Availability of nutrient may cause more number of stick lac. The quality of food dependent upon the nutrient available on host plant. Thus, settlement of *K. lacca* depends on many reasons other than availability of succulent shoots. Higher density of the lac insect means higher competition of food.

4.3.3 Length of stick lac

The mean length of stick lac varied from 52.58 to 56.62 cm. The maximum mean length of stick lac was recorded on T3 (56.62), T2 (55.75), T4 (54.25), T5 (53.37), T1 (53.31) and T6 (52.28). There was a significant difference in the mean length of stick lac among different treatments.

4.3.4 Fresh Weight of stick lac

The mean weight of stick lac per 30 cm varied from 41.56g to 50.81g. The mean weight of stick lac per 30 cm was highest in T3 (43.00), followed by T2 (40.37), T4 (36.50), T5 (35.75), T1 (33.25) and T6 (32.12). There was a significant difference in the mean weight of stick lac among different treatments.

More or less similar findings where obtained by Meshram (2018) who reported a fresh weight of lac insect per 30 cm stick varied from 33.96 to 47.68 g per 30 cm stick. It was highest in kusum with 47.68 g per 30 cm stick followed by ber, semialata and palas with 44.21, 42.20 and 33.96 g per 30 cm stick respectively, in both the strain *Kusmi, aghani* (Winter) and *Rangeeni, Baisakhi* (Summer).

Netam (2019) reported a fresh weight of 30 cm per stick lac varied from 35.27 to 49.88 g per plant. The maximum mean fresh weight of 30 cm stick lac was recorded on ber (47.04 g), and palas (35.27 g) per host plant in *Rangeeni* strain. While the maximum fresh weight of 30 cm stick lac was recorded on Kusum (49.88 g) and Semialata (42.76 g) per host plant in *Kusmi* strain.

4.3.5 Weight of scraped lac from 30 cm stick lac (g)

The mean weight (g) of scraped lac from 30cm stick lac differed significantly among the treatments. It varies from 18.25 g to 22.06 g. It was highest in T3 (22.06) followed by T2 (21.00), T4 (20.62), T5 (19.87), T1 (19.18) and T6 (18.25).

Present finding is more or less similar to those of Meshram (2018) also reported the mean fresh weight of scraped lac from 30cm length stick varied from 16.06 to 23.96 g. The mean fresh weight of scraped lac was highest on kusum with 23.96 g followed by ber, semialata and palas with 22.49, 20.51 and 16.06 g in both the strains, respectively.

4.3.6 Fresh weight of 100 lac cells

The mean fresh weight of 100 lac cells of lac insect differed significantly among the treatments. It varied from 6.37 to 10.37. The mean fresh weight of 100 cells of lac insect was highest in T3 (8.5) followed by T2 (8.37), T4 (7.75), T5 (6.87), T1(6.57) and T6 (5.62). There was a significant difference among the mean fresh weight of 100 lac cells in all treatments.

The present finding is in agreement with Meshram (2018) reported that the mean fresh weight of 100 lac cells varied from 4.09 to 7.31 g. The mean fresh weight of 100 lac cell was highest 7.31 g on kusum followed by semialata 6.52 g in *kusmi* strain and 6.73 g on ber followed by palas 4.09 g in *rangeeni* strain.

Netam (2019) reported that the mean fresh weight of 100 lac cells was varied from 5.61 to 8.68 g. The maximum was recorded on kusum (8.68 g) and semialata (7.50 g) in *kusmi* strain. While the maximum mean fresh weight was recorded on ber (7.61 g) and palas (5.61 g) in *rangeeni* strain.

4.3.7 Dry weight of 100 lac cells

The mean dry weight of 100 lac cells of lac insect differed significantly among the treatments. It varied from 5.25 g to 9.19 g. The mean dry weight of 100 lac cells was highest in T3 (7.62) followed by T2 (6.50), T4 (5.75), T5 (5.50), T1 (4.56) and T6 (3.81). There was a significant difference with T1, T2, T3, T4, T5 and T6.

Present findings are more or less similar to Meshram (2018) reported that the mean dry weight of 100 lac cells varied from 3.72 to 6.86 g. The mean dry weight of 100 lac cells was highest 6.86 g on kusum followed by semialata 5.87 g in *kusmi* strain, while 6.02 g on ber followed by palas 3.72 g in *rangeeni* strain.

Netam (2019) reported that mean dry weight of 100 lac cells was varied from 4.17 to 7.15 g. The maximum mean dry weight of 100 lac cells was recorded on kusum (7015 g) and semialata (6.38 g) in *kusmi* strain. While the maximum mean dry weight of 100 lac cells was recorded on ber (6.29 g) and palas (904.17 g) in *rangeeni* strain.

4.3.8 Yield of raw lac

The mean yield of raw lac (kg) per plant obtained after harvesting of lac crop was 39.00 kg, 49.75 kg, 52.75 kg, 46.50 kg, 42.25 kg and 34.25 kg respectively among the treatments T1, T2, T3, T4, T5 and T6 .There was a significant difference in the mean yield of raw lac among all the treatments. Application of fertilizer significantly increased the mean yield of lac per plant.

Similar findings by Meshram (2018) reported that mean yield of stick lac per plant varied from 0.305 to 54.94 kg per plant. The yield of raw lac per plant was maximum on Kusum with 5.32 kg per plant followed by Palas 3.72 kg in *rangeeni* strain.

Netam (2019) reported that mean yield of stick lac varied from 0.30 g to 59.25 kg per host plant. The maximum mean yield of stick lac was recorded on Kusum (59.25 kg) and Semialata (0.30 kg) per host in *kusmi* strain. Whereas the minimum yield recorded on Ber (6.03 kg) and Palas (2.88 kg) per host in *rangeeni* strain.

Table-4.6: Yield potential of lac insect on Kusum host plant

Yield potential of lac insect on Kusum host plant							
Treatments	**Mean number of stick lac/plant**	**Mean length of stick lac/plant (cm)**	**Fresh weight of 30 cm stick lac (g)**	**Mean weight of scrap lac from 30 cm stick lac (g)**	**Mean fresh weight of 100 lac cell (g)**	**Mean dry weight of 100 la cell (g)**	**Mean raw lac yield per plant (kg)**
T1	236.25	53.31	33.25	19.18	6.57	4.56	39.00
T2	247.00	55.75	40.37	21.00	8.37	6.50	49.75
T3	249.25	56.62	43.00	22.06	8.50	7.62	52.75
T4	244.75	54.25	36.50	20.62	7.75	5.75	46.50
T5	240.50	53.37	35.75	19.87	6.87	5.50	42.25
T6	233.75	52.58	32.12	18.25	5.62	3.81	34.25
S.E.m.	**3.01**	**0.87**	**0.99**	**0.38**	**0.27**	**0.26**	**0.91**
C.D. at 5 %	**9.07**	**2.62**	**3.00**	**1.14**	**0.81**	**0.79**	**2.74**

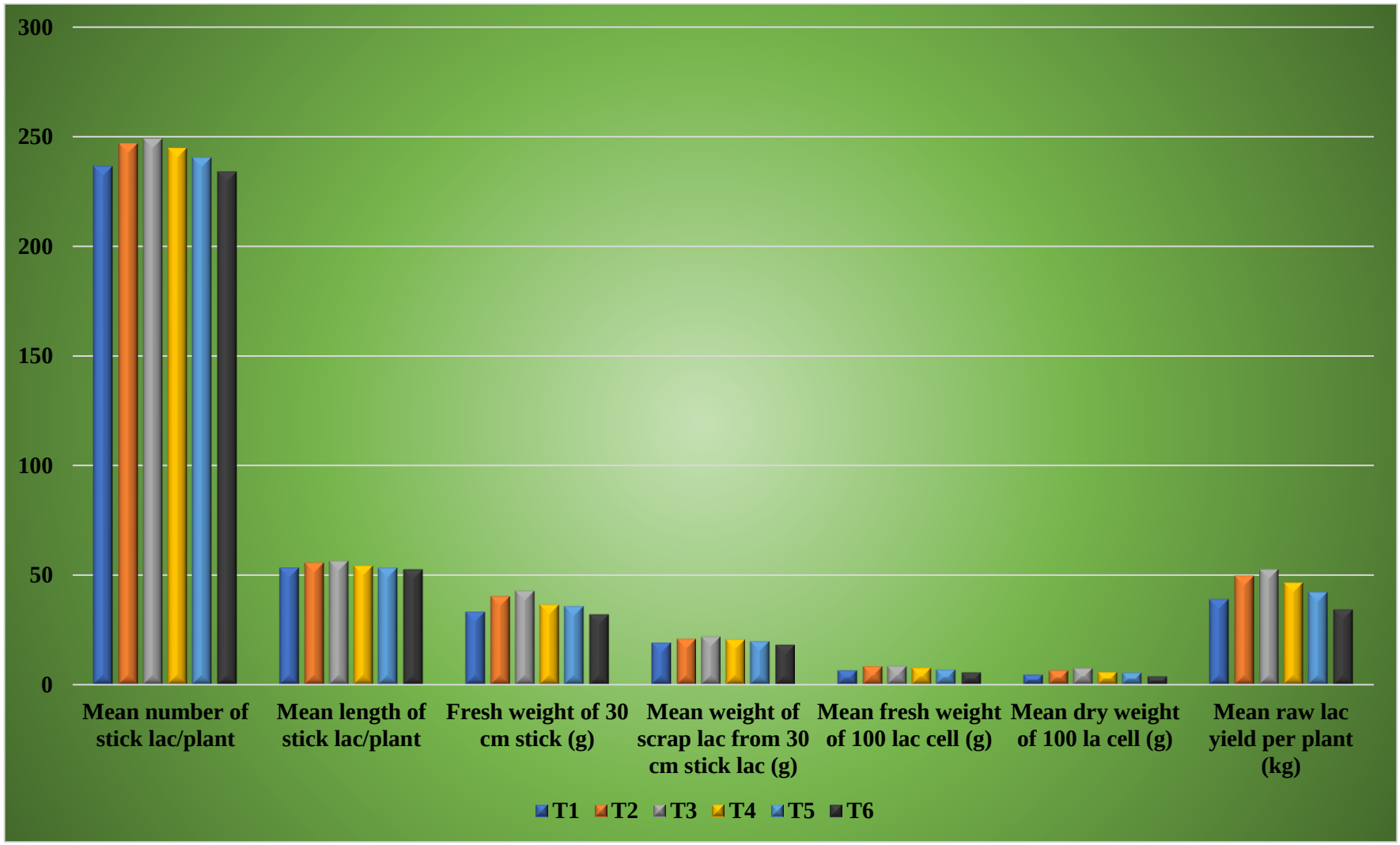
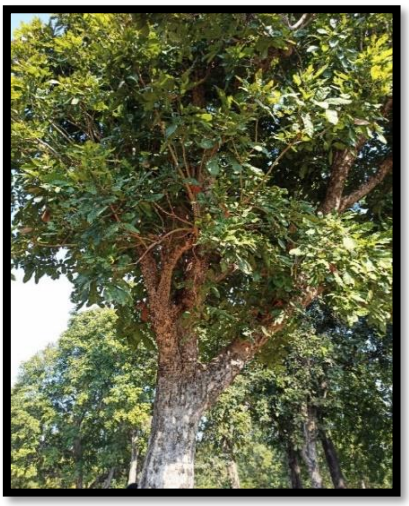
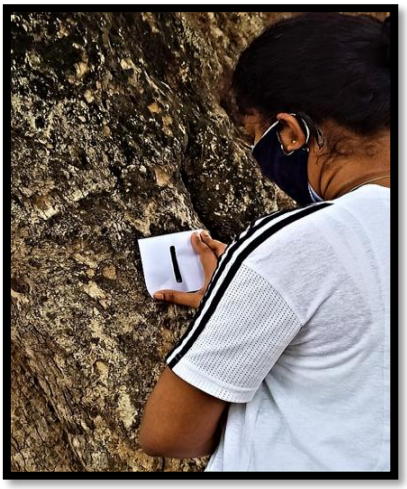


Fig 4.4 Yield potential of lac insect on Kusum host plant



A. Selection of host tree Kusum

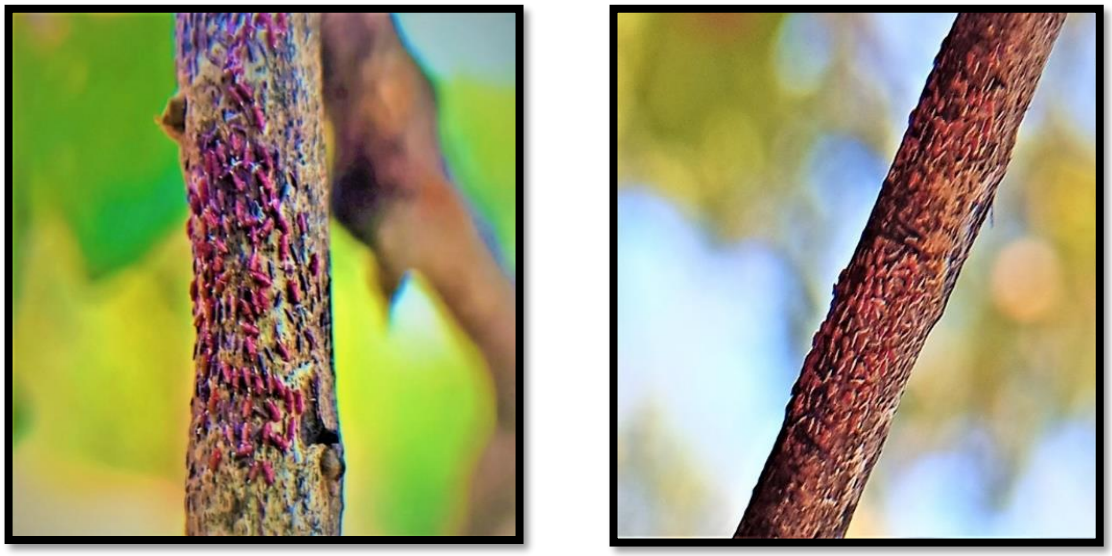


B. Marking of host tree Kusum

Plate-02: Selection and Marking of host tree Kusum

Plate-03: Brood lac used for Inoculation

Plate-04: Brood lac inoculation of lac insect *Kerria lacca* (Kerr.) on host plant Kusum



A. Larval initial settlement

B. Larval settlement at maturity stage

Plate-05: Larval settlement

A. Weighing of 30 cm stick lac

B. Weight of 100 lac cell

C. Stick lac

D. Lac cell

E. Shorting for broodlac

Plate-06: Photographs of yield potential of lac insect *K. lacca* (Kerr.)

4.3.9 Production cost of *Jethwi* crop of *kusmi* lac on Kusum (*S. oleosa*)

The production cost of *Kusmi* lac crop on *S. oleosa* tree was highest in case of T3 (2843.95) followed by T2 (2781.55), T4 (2709.57), T5 (2631.8), T1 (2556.37) and T6 (2459.9). The mean yield per s. oleosa was highest in T3 (52.75kg) followed by T2 (49.75kg), T4 (46.50kg), T5 (42.25kg), T1 (39.00kg) and lowest in T6 (34.25kg).

4.3.10 Net Profit

The net profit was highest in case in T3 (Rs 13441.05/tree), T2 (R12599.45/tree), T4 (Rs 11692.43/tree), T5 (Rs 10498.3/tree), T1 (Rs 9575.63/tree) and it was lowest in case of T6 (Rs 8243.1/tree).

The Cost-Benefit ratio was highest (1:4.72) in case of T3 followed by T2 (1:4.52), T4 (1:4.31), T5 (1:4.00), T1 (1.:3.74) and lowest (1:3.35) in case of T6.

Table-4.7: Production cost of *Kusmi* lac on Kusum (*S. oleosa*)

Particulars	**A. Operational cost (Rs) per plant**							
Operation	**Operational cost**	**Total cost**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
Pruning	@ Rs 150/ labour	1500/24 tree	62.5	62.5	62.5	62.5	62.5	62.5
Brood lac	@Rs 200/kg	-	1274	1274	1274	1274	1274	1274
Inoculation	@ Rs 150/ labour	750/24 tree	31.25	31.25	31.25	31.25	31.25	31.25
Phunki removal	@ Rs 150/ labour	750/24 tree	31.25	31.25	31.25	31.25	31.25	31.25
Scrapping of *phunki* lac	@ Rs 20/kg	-	21.6	22.8	23	22.6	22.2	21.4
60 mesh Nylon bags	@ Rs 4/-	73 bag/tree	292	292	292	292	292	292
Harvesting	@ Rs 150/ labour	1500/24 tree	62.5	62.5	62.5	62.5	62.5	62.5
Yield scrapping	@ Rs 20/kg	-	780	995	1055	930	845	685
Sub Total (A)			**2555.1**	**2771.3**	**2831.5**	**2706.1**	**2620.7**	**2459.9**
	B. Input cost (Rs) per plant							
Fertilizer application								
Urea	@ Rs 295 / 50 kg bag	217g /tree	1.27	1.27	1.27	1.27	0	0
SSP	@ Rs 919 / 50 kg bag	1562.5 g / tree	0	8.98	8.98	0	8.98	0
MoP	@ Rs 288 / 50 kg bag	125.25 g / tree	0	0	2.20	2.20	2.20	0
Sub Total (B)			**1.27**	**10.25**	**12.45**	**3.47**	**11.1**	**0**

C. Total (A+ B)		**2556.37**	**2781.55**	**2843.95**	**2709.57**	**2631.8**	**2459.9**
C. Gross return (Rs) per plant							
Mean yield	Kg	39	49.75	52.75	46.50	42.25	34.25
Value	@ Rs 300/kg	11700	14925	15825	13950	12675	10275
Phunki yield	Kg	1.08 (1088.7 g)	1.14 (1147.5 g)	1.15 (1152.5 g)	1.13 (1132.5 g)	1.11 (111.0 g)	1.07 (1078.7 g)
Value	@ Rs 400/kg	432	456	460	452	444	428
Total		**12132**	**15381**	**16285**	**14402**	**13119**	**10703**
D. (D= A + B) Net Return (Rs)							
Gross Return (D)		**12132**	**15381**	**16285**	**14402**	**13119**	**10703**
Total cost (A +B)		**2556.37**	**2781.55**	**2843.95**	**2709.57**	**2620.7**	**2459.9**
Net Profit		**9575.63**	**12599.45**	**13441.05**	**11692.43**	**10498.3**	**8243.1**
B.C Ratio		**1:3.74**	**1:4.52**	**1:4.72**	**1:4.31**	**1:4.00**	**1:3.35**

4.4 To study the incidence of major predator of lac insect on Kusum host plant

Major predator of lac insect *K. lacca* (Kerr.) were recorded from 15 cm lac bearing twigs of Kusum tree from four cardinal direction and kept in 60 mesh nylon bag and observation was taken at each 15 days interval from Kanker district of Chhattisgarh during the *jethwi* crop of 2020-21 are presented in (Table-).

An observation of predators was recorded from 1st fortnight of February to 1st fortnight of June. *Eublemma amabilis* and *Pseudohypatopa pulverea* were recorded as key predators from Kanker district throughout the crop period where as *Chrysopa spp.* observation was also taken from 1st fortnight of February to 1st fortnight of June, it was noticed that the last week of month April is most sensitive period for *E. amabilis* and in case of *P. pulverea* and *Chrysopa spp.* May month was observed as its peak active period in *jethwi* crop.

4.4.1 *Eublemma amabilis*

The major predator of lac insect *Kerria lacca* (Kerr) was *E. amabilis,* its first appearance was recorded during 1st fortnight of march (07-08 SMW) with the mean population of 4.01 insect per 30 cm lac stick, after that there is an fluctuation in the population of *E. amabilis* in the month of April which was increased and reached its peak in the 1st fortnight of June (21-22 SMW) with the mean population 10.96 insect per 30 stick lac. It was associated with data presented in Table no.-4.8 and Fig- 4.5.

Table-4.8: Population density of *Eublemma amabilis* in *Kusmi* strain of lac insect during 2020-21

SMW	Date of observations	Mean number of *Eublemma amabilis*/30 cm stick lac				
		2020-21				
		North	East	South	West	Mean
05-06	02-Feb	-	-	-	-	-
07-08	17-Feb	-	-	-	-	-
09-10	04-Mar	5.00	4.54	3.70	2.80	**4.01**
11-12	19-Mar	7.00	6.58	5.70	4.87	**6.03**
13-14	03-Apr	9.00	8.58	7.62	6.80	**8.00**
15-16	18-Apr	10.16	9.50	8.79	7.75	**9.02**
17-18	03-May	5.00	4.87	4.75	3.83	**4.61**
19-20	18-May	8.00	8.00	7.75	7.50	**7.81**
21-22	02-June	12.00	11.66	10.58	9.62	**10.96**
23-24	17-June	11.00	11.25	10.5	9.08	**10.45**
25-26	02- July	10.75	11.00	10.25	8.00	**10.00**

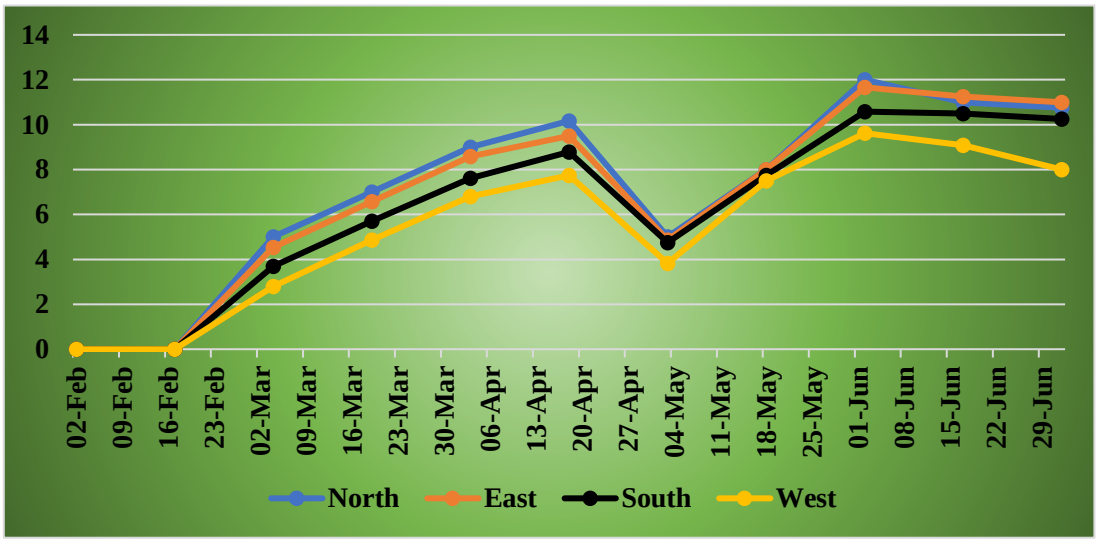


Fig- 4.5 Population density of *Eublemma amabilis* in Kusmi strain of lac insect during 2020-21

Present study is more or less similar to Mohansundram *et al.* (2018) reported that the variation of lac insect associated with predators and parasitoids on different host plants for both *kusmi* and *rangeeni* strains, during year 2012-2015. During *jethwi* crop of *kusmi* strain, *T.tachardidiae* and *E. amabilis* population were maximum 12.5 and 8.6 respectively. The number of *E. amabilis* were recorded higher on semialata during *aghani* crop. Similar studies were also conducted by Meena and Sharma (2018).

Uike (2015) The incidence of *Eublemma amabilis* population was recorded at different locations varied from 0-10 number in 30 cm twigs during the crop period in *jethwi* (Summer) lac crop. Block wise observation indicates that 45 numbers of *E. amabilis* was recorded in field of Devbhog followed by Chhura, Mainpur and Gariyaband with 44, 41 & 39 numbers during the investigation.

Table-4.9 Correlation between *Eublemma amabilis* population and weather parameter

Weather parameters	North	East	South	West
Rainfall	0.57	0.62*	0.63*	0.57
Max. temp	0.30	0.25	0.24	0.26
Min. temp	0.84*	0.84*	0.85*	0.85*
Max. RH	0.64*	0.69*	0.72*	0.68*
Min. RH	0.62*	0.66*	0.68*	0.63*
Wind speed	0.61*	0.65*	0.68*	0.67*

Significant at 5% Table value (.602)

4.4.1.1 Correlation of the population of *Eublemma amabilis* in four cardinal direction with weather parameter

The population of *Eublemma amabilis* from North direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.62*), maximum relative humidity (r= 0.64*), wind speed (r= 0.61*), minimum temperature (r=0.84*) whereas non-significant positive correlation was noticed with maximum temperature (r=0.30) and rainfall (r=0.57) were observed.

The population of *Eublemma amabilis* from East direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.66*), maximum relative humidity (r=0.69*), wind speed (r=0.65*), minimum temperature (r=0.84*), rainfall (r=0.62*) whereas non-significant correlation was noticed with maximum temperature (r=0.25*) were observed.

The population of *Eublemma amabilis* from South direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.68*), maximum relative humidity (r=0.72*), wind speed (r=0.68*), minimum temperature (r=0.85*), rainfall (r=0.63*) whereas non-significant correlation was noticed with maximum temperature (r=0.24*) were observed.

The population of *Eublemma amabilis* from West direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.63*), maximum relative humidity (r= 0.68*), wind speed (r= 0.67*), minimum temperature (r=0.85*) whereas non-significant positive correlation was noticed with maximum temperature (r=0.26) and rainfall (r=0.57) were observed.

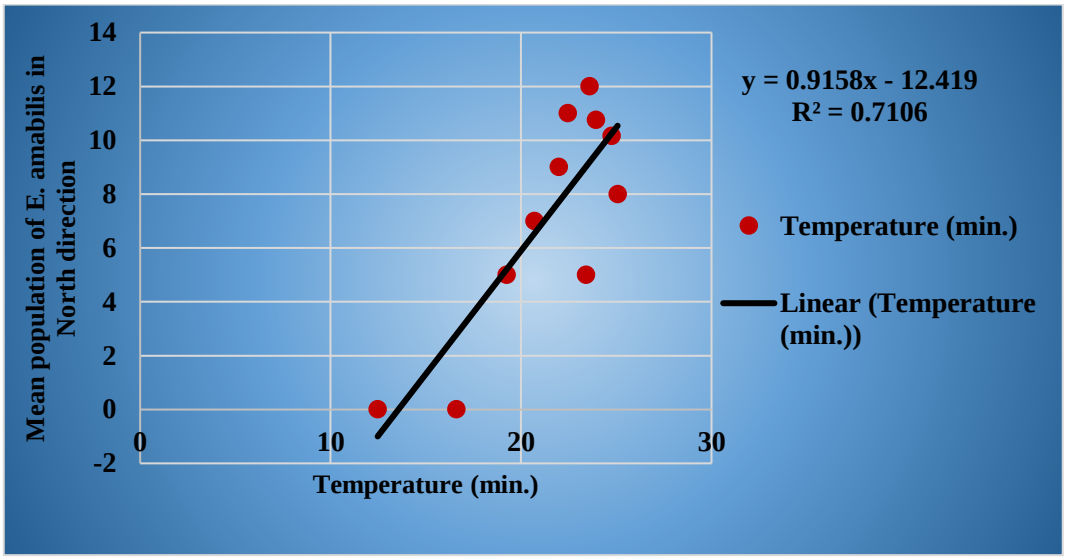


Fig -4.6 Regression equation between mean population of *E. amabilis* in North direction and Temperature (min.)

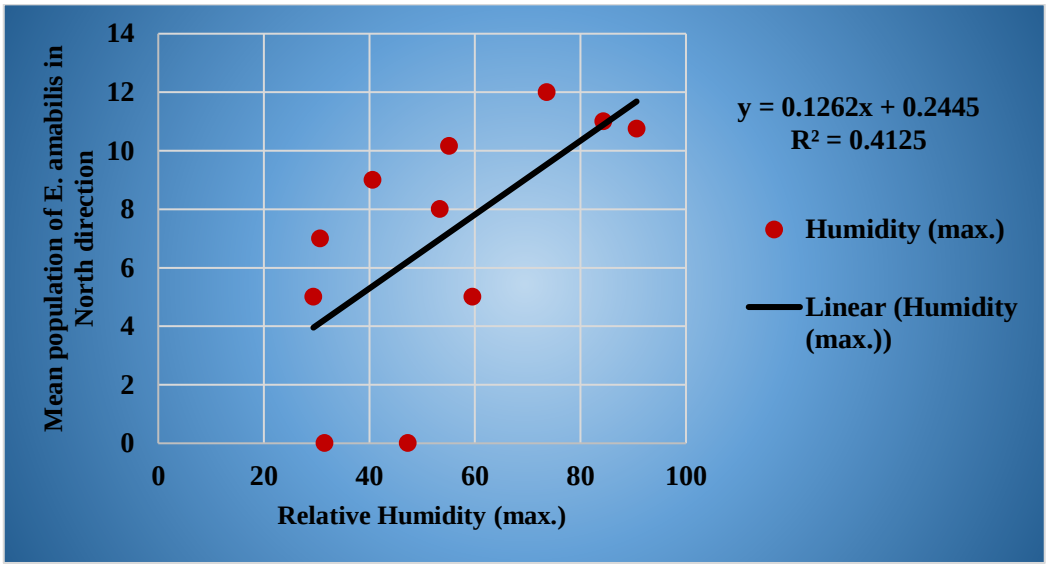
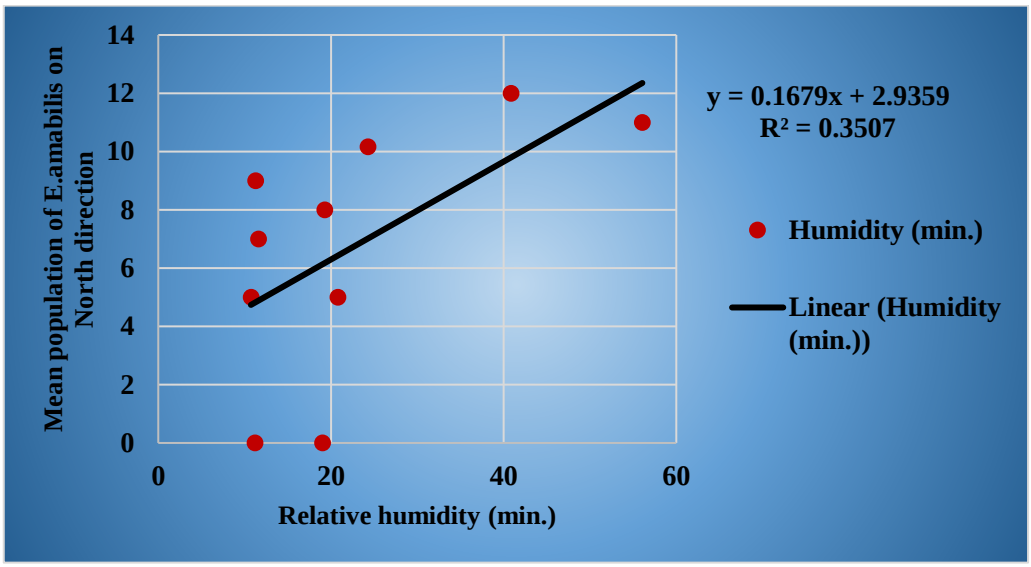


Fig-4.7 Regression equation between mean population of *E. amabilis* in North direction and Relative Humidity (max.)



Fig–4.8 Regression equation between mean population of *E.amabilis* in North direction and Relative Humidity (min.)

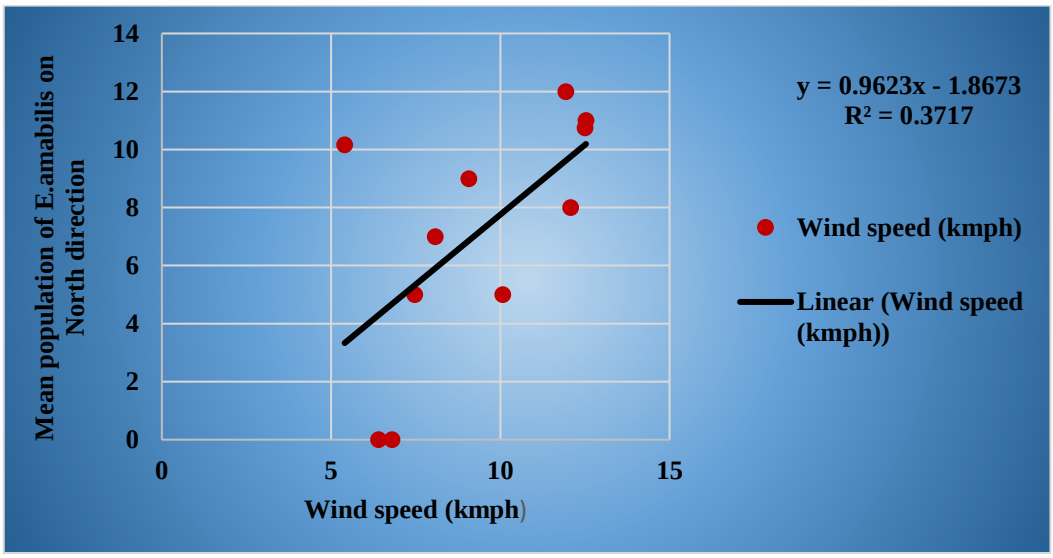


Fig –4.9 Regression equation between mean population of *E. amabilis* in North direction and Wind speed (kmph)

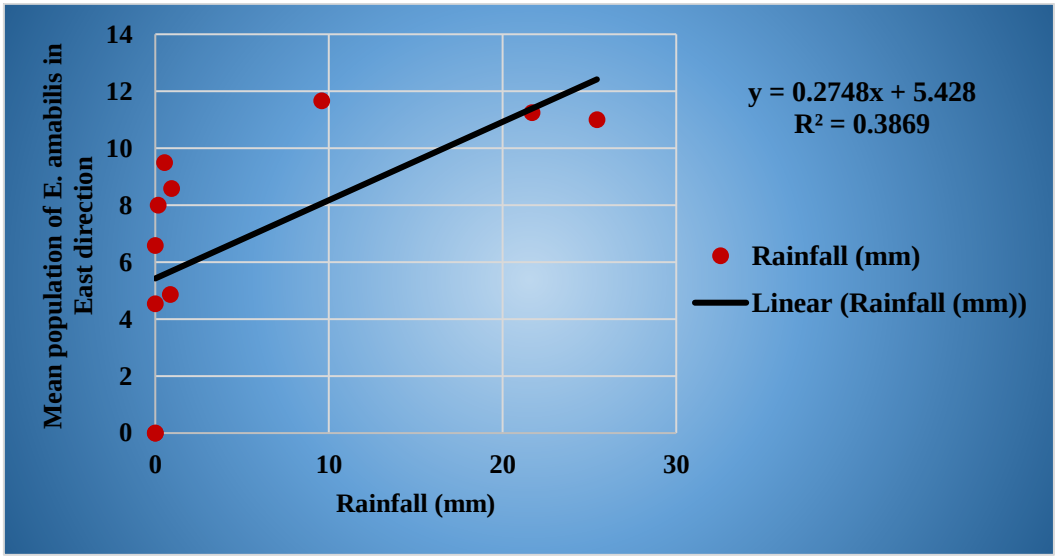


Fig-4.10 Regression equation between mean population of *E. amabilis* in East direction and Rainfall (mm)

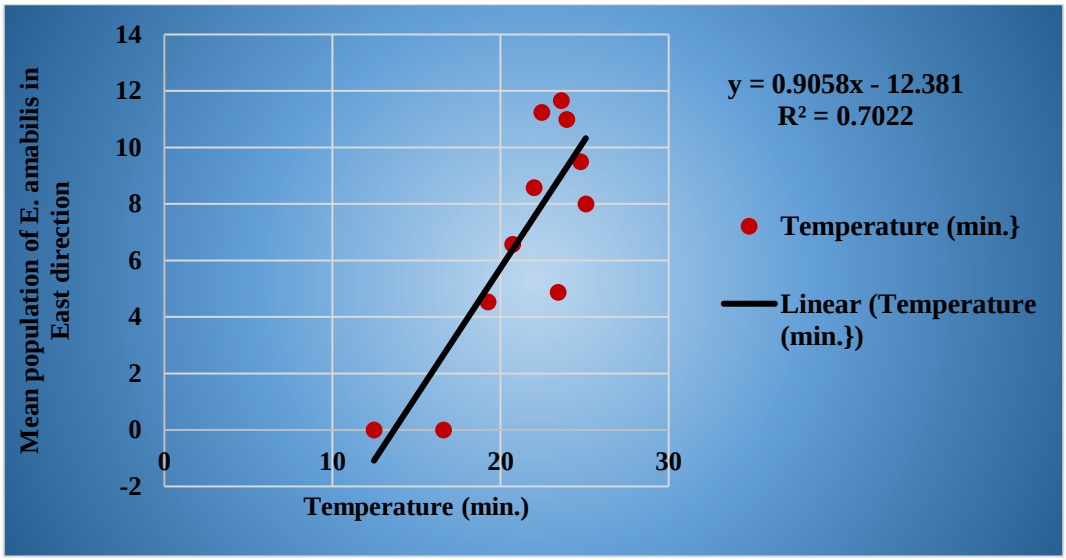


Fig-4.11 Regression equation between mean population of *E. amabilis* in East direction and Temperature (min.)

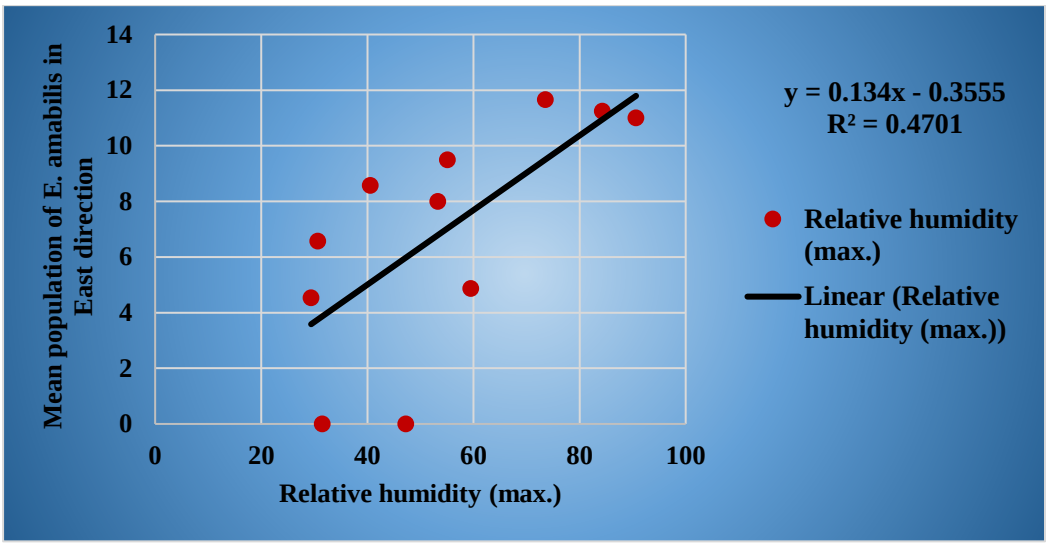


Fig-4.12 Regression equation between mean population of *E. amabilis* in East direction and Relative humidity (max.)

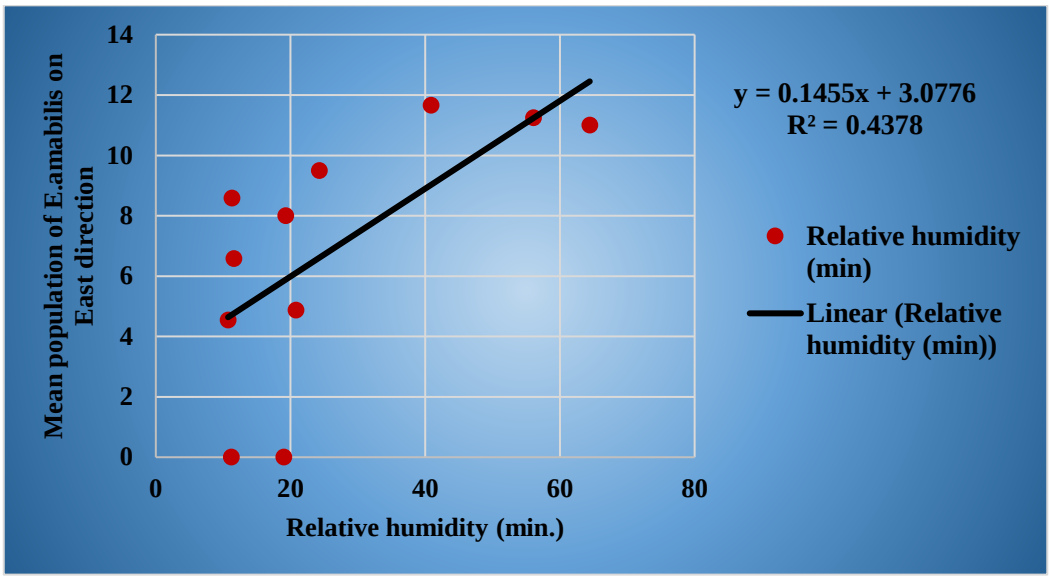


Fig- 4.13 Regression equation between mean population of *E. amabilis* in East direction and Relative humidity (min.)

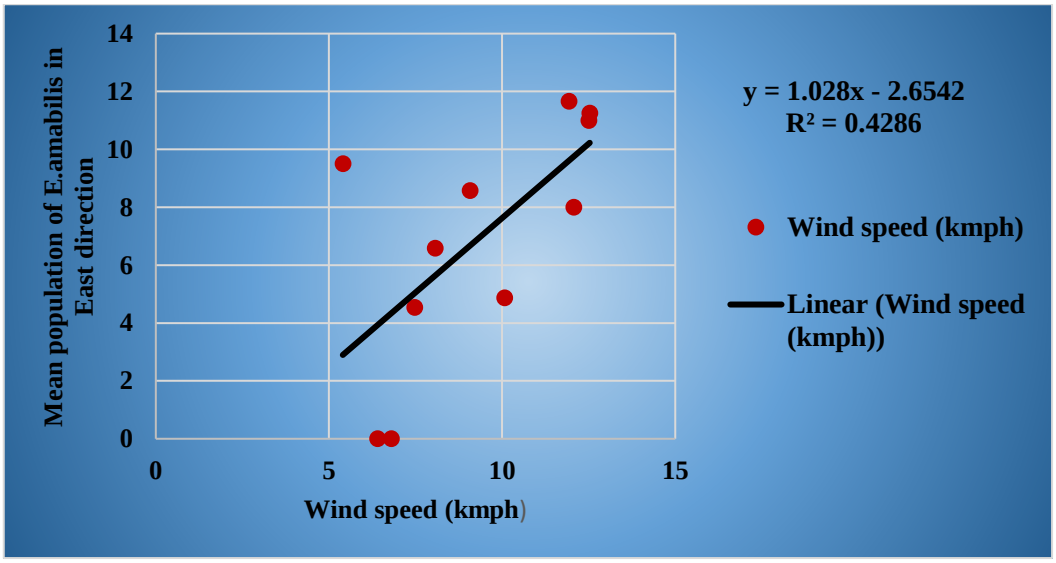


Fig-4.14 Regression equation between mean population of *E. amabilis* in East direction and Wind speed (kmph)

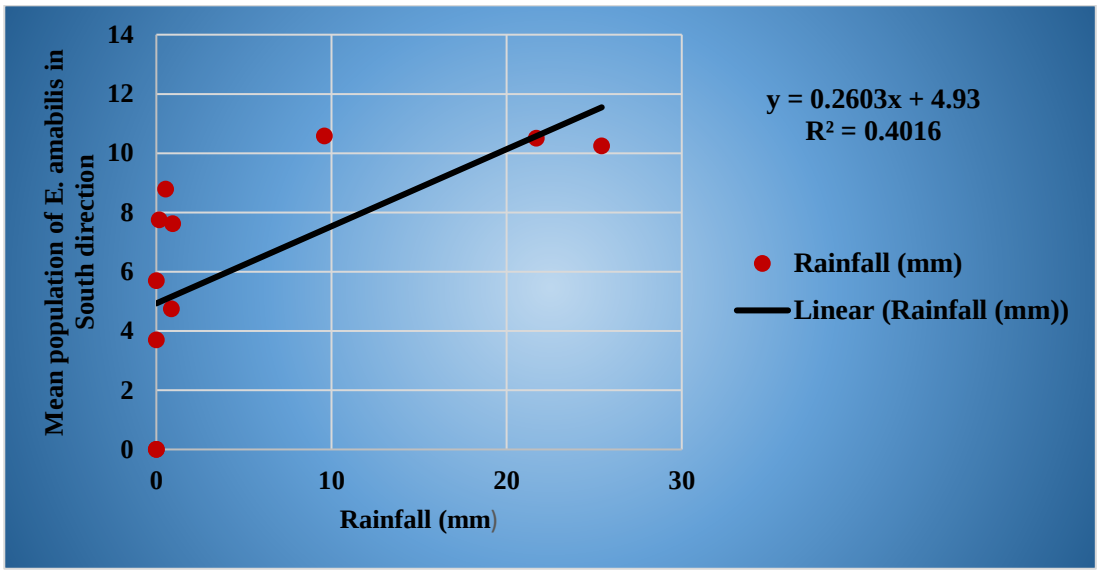


Fig-4.15 Regression equation between mean population of *E. amabilis* in South direction and Rainfall (mm)

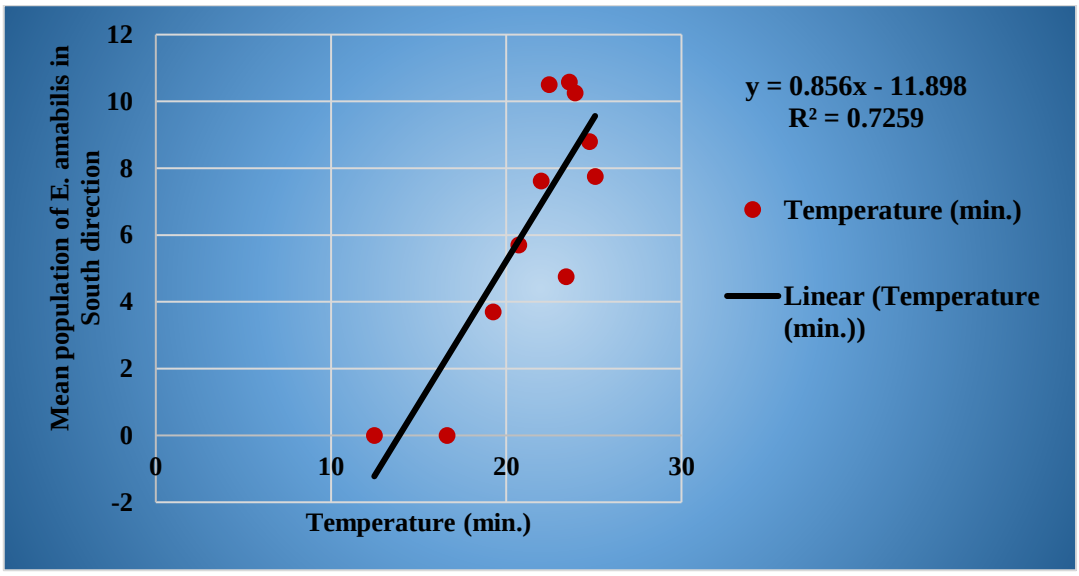


Fig-4.16 Regression equation between mean population of *E. amabilis* in South direction and Temperature (min.)

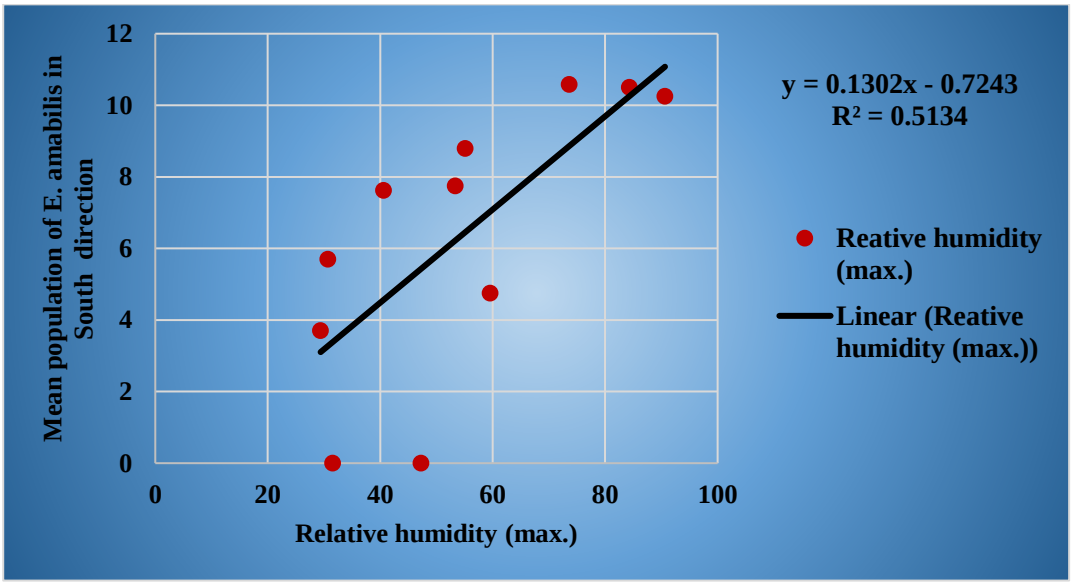


Fig-4.17 Regression equation between mean population of *E. amabilis* in South direction and Relative humidity (max.)

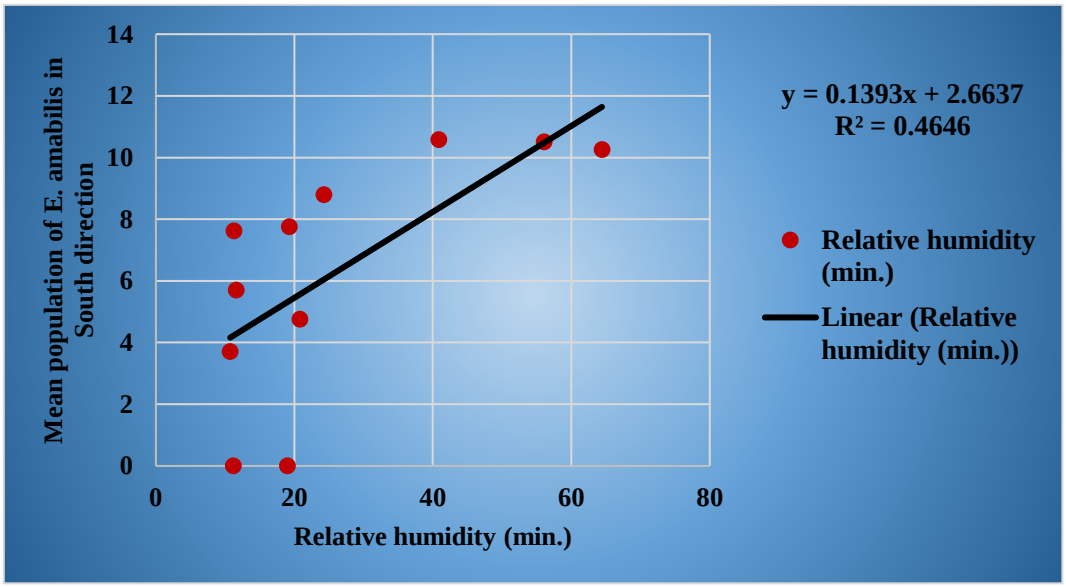


Fig-4.18 Regression equation between mean population of *E. amabilis* in South direction and Relative humidity (min.)

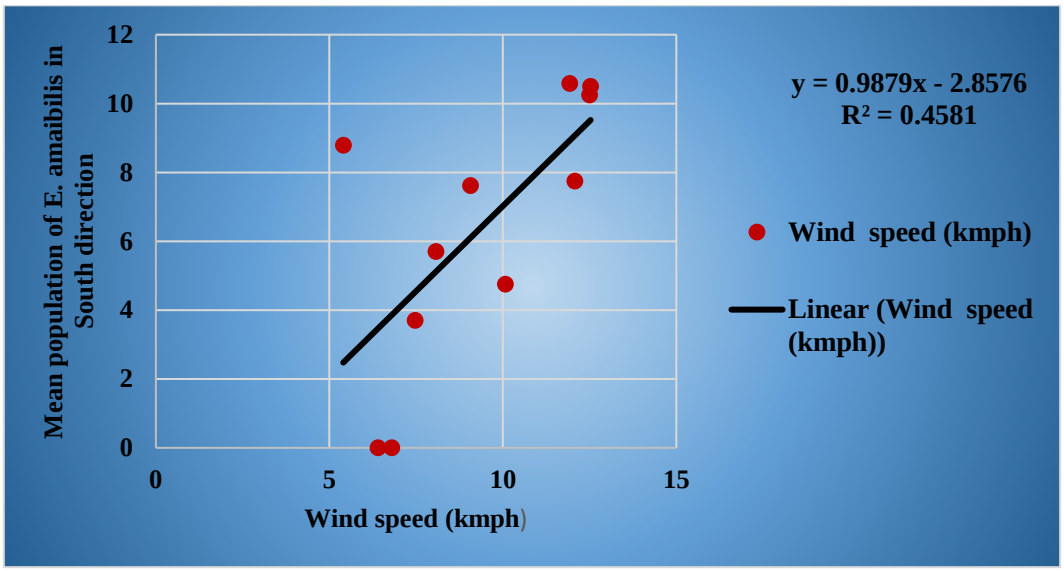


Fig-4.19 Regression equation between mean population of *E. amabilis* in South direction and Wind speed (kmph)

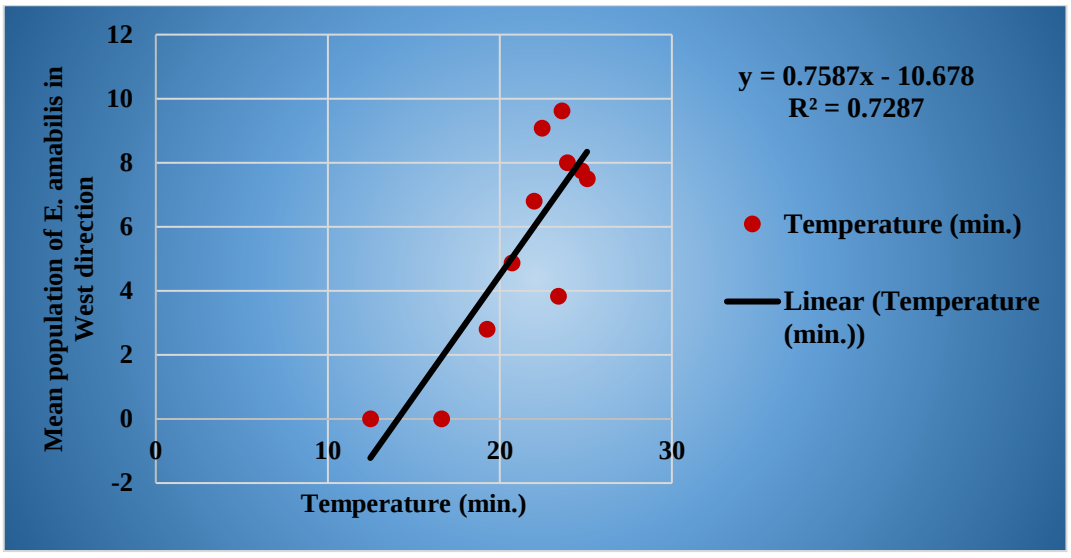


Fig-4.20 Regression equation between mean population of *E. amabilis* in West direction and Temperature (min.)

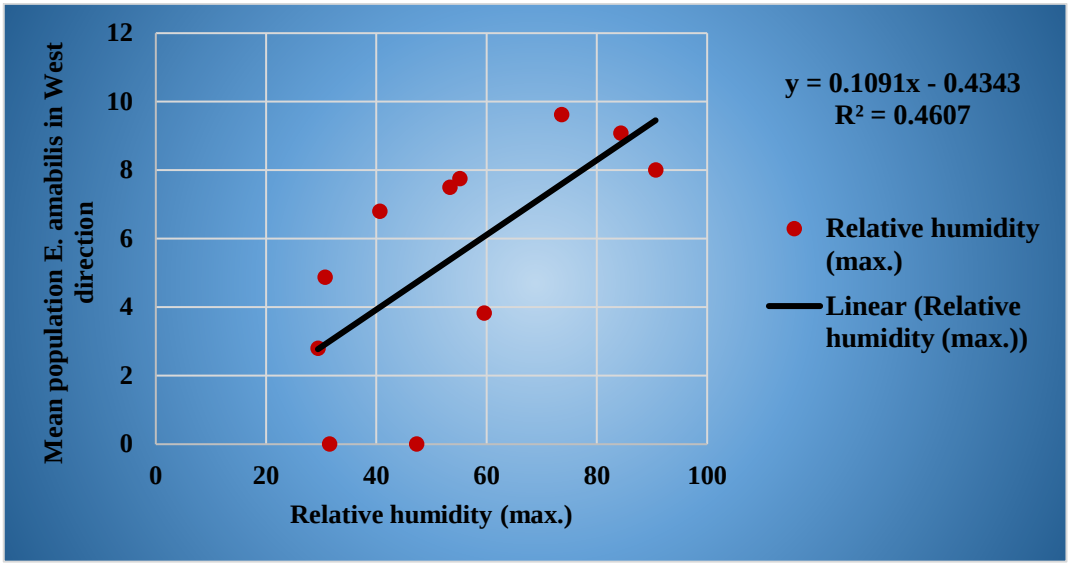


Fig-4.21 Regression equation between mean population of *E. amabilis* in West direction and Relative humidity (max.)

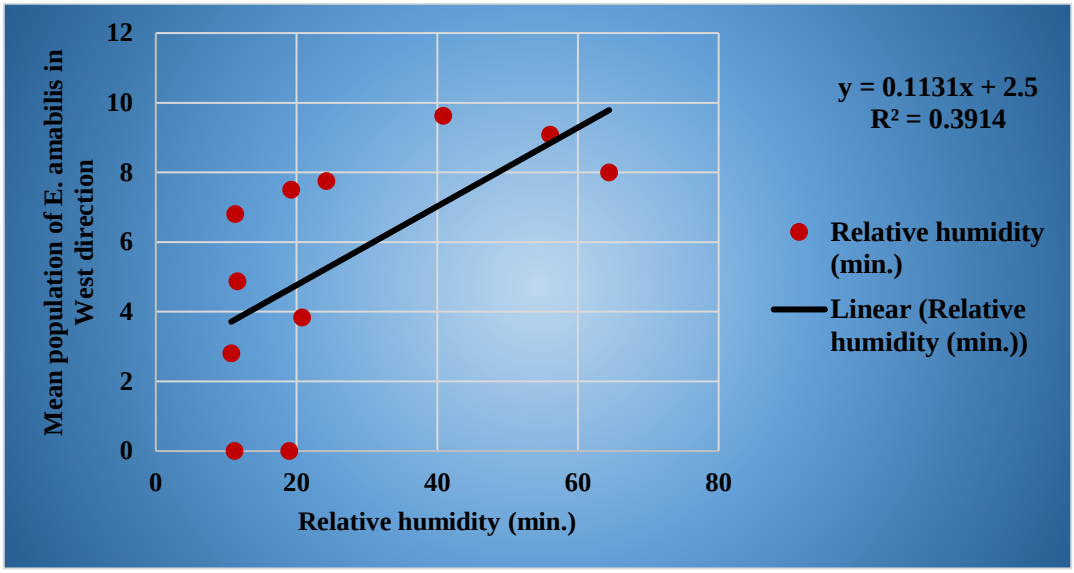


Fig- 4.22 Regression equation between mean population of *E. amabilis* in West direction and Relative humidity (min.)

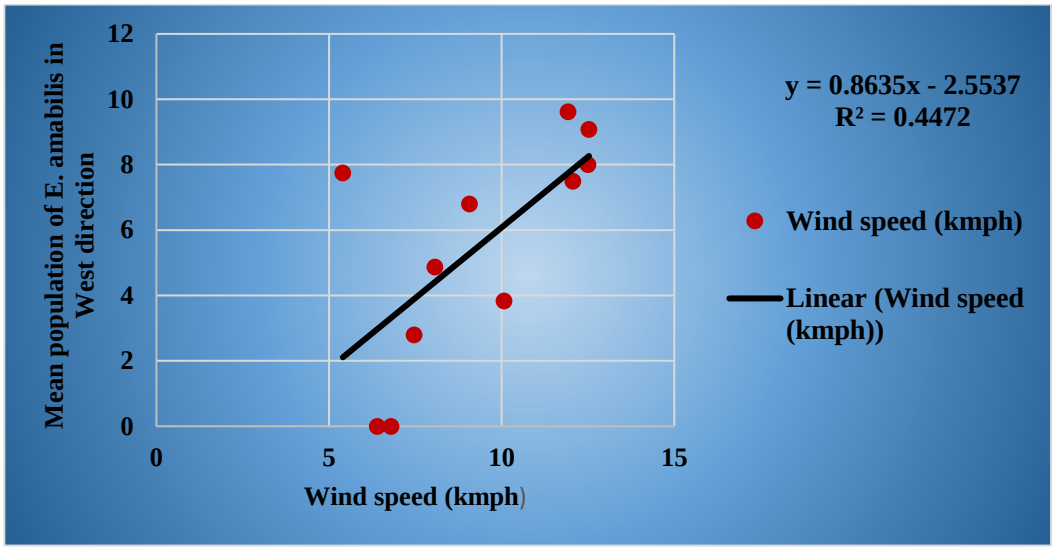


Fig-4.23 Regression equation between mean population of *E. amabilis* in West direction and Wind speed (kmph)

4.4.2 *Pseudohypatopa pulverea*

The lac insect *Kerria lacca* (Kerr.) associated predator *P. pulverea* mean population was recorded its first appearance was in first fortnight of February (05-06 SMW) with the mean population 4.88/30cm stick lac which increased in 1st fortnight of May (17-18 SMW) and its peak was recorded with mean 11.46/30cm stick lac, data present in Table no. it was associated with 36.89°C maximum temperature, 23.41°C minimum temperature and 56.53 per cent relative humidity, after then gradually decreased the mean population till the crop harvest during the year 2020-21.Data is presented in Table no.-4.10 & Fig- 4.24 .

Present research findings were more or less similar to Uike (2015) The incidence of *Pseudohypatopa pulverea* population was recorded at different locations varied from 2-11 number in 30 cm twigs during the crop period in jethwi (Summer) lac crop. Block wise observation indicates that 41 numbers of *P. pulverea* was recorded in field of Chhura, Gariyaband followed by Devbhog, Mainpur with 37 and 36 numbers during the crop period.

Table 4.10: Population density of *Pseudohypatopa pulverea* in *Kusmi* strain of lac insect during 2020-21

SMW	Date of observations	Mean number of *Pseudohypatopa pulverea*/30 cm stick lac				
		2020-21				
		North	East	South	West	Mean
05-06	**02-Feb**	5.00	5.00	4.95	4.58	**4.88**
07-08	**17-Feb**	5.00	5.00	4.75	4.00	**4.69**
09-10	**04-Mar**	6.00	5.90	5.70	5.45	**5.76**
11-12	**19-Mar**	9.00	8.83	8.45	7.87	**8.54**
13-14	**03-Apr**	7.00	6.83	6.45	5.87	**6.54**
15-16	**18-Apr**	5.00	5.00	4.62	4.29	**4.73**
17-18	**03-May**	12.00	11.58	11.16	11.08	**11.46**
19-20	**18-May**	12.00	11.58	11.16	10.70	**11.36**
21-22	**02-June**	5.00	5.00	5.00	4.75	**4.94**
23-24	**17-June**	4.00	4.00	3.79	3.75	**3.89**
25-26	**02-July**	4.00	3.79	3.15	3.00	**3.50**

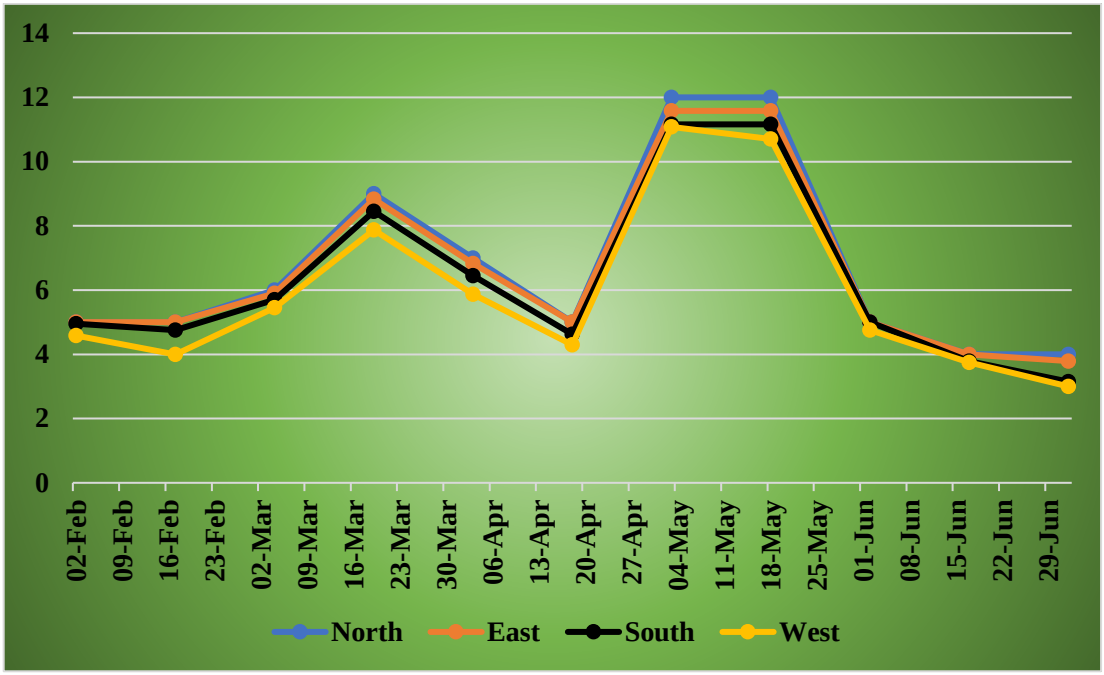


Fig-4.24: Population density of *Pseudohypatopa pulverea* in *Kusmi* strain of lac insect during 2020-21

4.4.2.1 Correlation of the population of *Pseudohypatopa pulverea* in four cardinal direction with weather parameter

The population of *Pseudohypatopa pulverea* from North direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.50), maximum relative humidity (r= -0.29), minimum relative humidity (r= -0.46) where as positive non-significant correlation with maximum temperature (r= 0.57), minimum temperature (r= 0.30), wind speed (r= 0.14).

The population of *Pseudohypatopa pulverea* from East direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.52), maximum relative humidity (r= -0.30), minimum relative humidity (r= -0.48) where as positive non-significant correlation with maximum temperature (r= 0.57), minimum temperature (r= 0.29), wind speed (r= 0.12).

The population of *Pseudohypatopa pulverea* from South direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.54), maximum relative humidity (r= -0.32), minimum relative humidity (r= -0.50) where as positive non-significant correlation with maxim um temperature (r= 0.55), minimum temperature (r= 0.26), wind speed (r= 0.11).

The population of *Pseudohypatopa pulverea* from West direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.50), maximum relative humidity (r= -0.28), minimum relative humidity (r= -0.45) where as positive non-significant correlation with maximum temperature (r= 0.54), minimum temperature (r= 0.29), wind speed (r= 0.16).

Table-4.11: Correlation between *Pseudohypatopa pulverea* population and weather Parameter

Weather parameter	North	East	South	West
Rainfall	-0.50	-0.52	-0.54	-0.50
Max. temp	0.57	0.57	0.55	0.54
Min. temp	0.30	0.29	0.26	0.29
Max. RH	-0.29	-0.30	-0.32	-0.28
Min. RH	-0.46	-0.48	-0.50	-0.45
Wind speed	0.14	0.12	0.11	0.16

Significant at 5% Table value (.602)

4.4.3 *Chrysoperla* spp.

The lac insect *Kerria lacca* (Kerr.) associated predator *Chrysoperla spp.* first appeared in first fortnight of February (05-06 SMW) with its mean population of 2.75 insect per 30 cm stick lac which increased in first fortnight of April (11-12 SMW) and its peak was recorded with mean 8.01/30 cm stick lac. The maximum temperature 38.64 °C, minimum temperature 24.75°C and 55.13 per cent R.H., then gradually decreased the mean population lowest mean population was recorded in second fortnight of June with mean 3.01 insect /30 cm stick lac during 2020-21, data presented in Table no.-4.12 & Fig- 4.25.

Present research findings were more or less similar to Uike (2015) The incidence of *Chrysoperla* spp. population was recorded at different locations in jethwi (Summer) lac crop. Block wise observation indicates that maximum number of *Chrysoperla* spp. was recorded in field of Devbhog (07) followed by Chhura (06), Gariyaband (03), Mainpur (03) during the crop period.

Table-4.12: Population density of *Chrysoperla spp.* in Kusmi strain of lac insect during 2020-21

SMW	Date of observations	Mean number of *Chrysoperla*/30 cm stick lac 2020-21				
		North	East	South	West	Mean
05-06	**02-Feb**	4.25	2.75	2.25	1.75	2.75
07-08	**17-Feb**	4.50	3.50	2.95	2.00	3.23
09-10	**04-Mar**	6.00	5.60	4.75	4.25	5.15
11-12	**19-Mar**	7.54	6.75	6.16	5.20	6.41
13-14	**03-Apr**	9.12	8.25	7.58	6.70	7.90
15-16	**18-Apr**	9.12	8.54	7.75	6.75	8.01
17-18	**03-May**	7.00	6.66	5.87	4.83	6.09
19-20	**18-May**	7.00	6.16	5.58	4.58	5.83
21-22	**02-June**	5.62	4.50	3.90	3.00	4.25
23-24	**17-June**	4.00	3.66	2.70	1.70	3.01
25-26	**02-July**	4.00	3.50	2.50	1.50	2.87

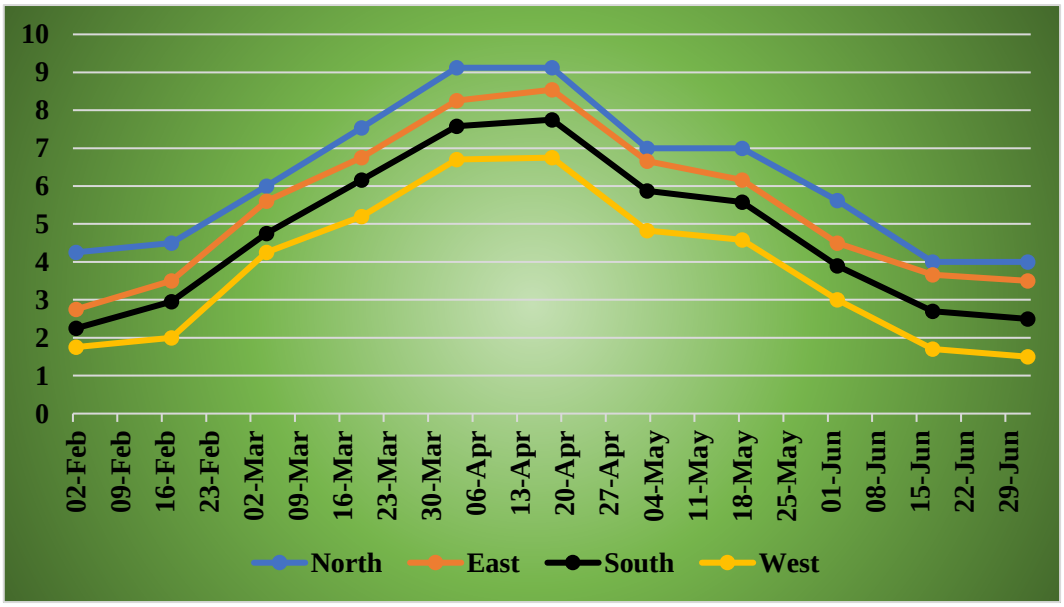


Fig-4.25: Population density of *Chrysoperla spp.* in *Kusmi* strain of lac insect during 2020-21

Table-4.13 Correlation between *Chrysoperla spp.* population and weather parameter

Weather parameters	North	East	South	West
Rainfall	-0.57	-0.48	-0.54	-0.59
Max. temp	0.93*	0.96*	0.95*	0.95*
Min. temp	0.43	0.52	0.48	0.42
Max. RH	0.39	-0.31	-0.36	-0.43
Min. RH	-0.53	-0.44	-0.50	-0.55
Wind speed	-0.32	-0.26	-0.29	-0.34

Significant at 5% Table value (.602)

4.4.3.1 Correlation of the population of *Chrysoperla* spp. in four cardinal direction with weather parameter.

The population of *Chrysoperla* spp. from North direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.93*) whereas positive non-significant correlation with minimum temperature (r= 0.43), maximum relative humidity (0.39) however, negatively non-significant with rainfall (r= -0.57), minimum relative humidity (r= -0.53), wind speed (r= -0.32).

The population of *Chrysoperla* spp. from East direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.96*) whereas positive non-significant correlation with minimum temperature (r = 0.52) however, negatively non-significant with maximum relative humidity (r= -0.31), minimum relative humidity (r= -0.44), rainfall (r= -0.48), wind speed (r= -0.26).

The population of *Chrysoperla* spp. from South direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.95*) whereas positive non-significant correlation with minimum temperature (r= 0.48) however, negatively non-significant with maximum relative humidity (r= -0.36), minimum relative humidity (r= -0.50), rainfall (r= -0.54), wind speed (r= -0.29).

The population of *Chrysoperla* spp. from West direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.95*) whereas positive non-significant correlation with minimum temperature (r= 0.42) however, negatively non-significant with maximum relative humidity (r= -0.43), minimum relative humidity (r= -0.55), rainfall (r= -0.59), wind speed (r= -0.34).

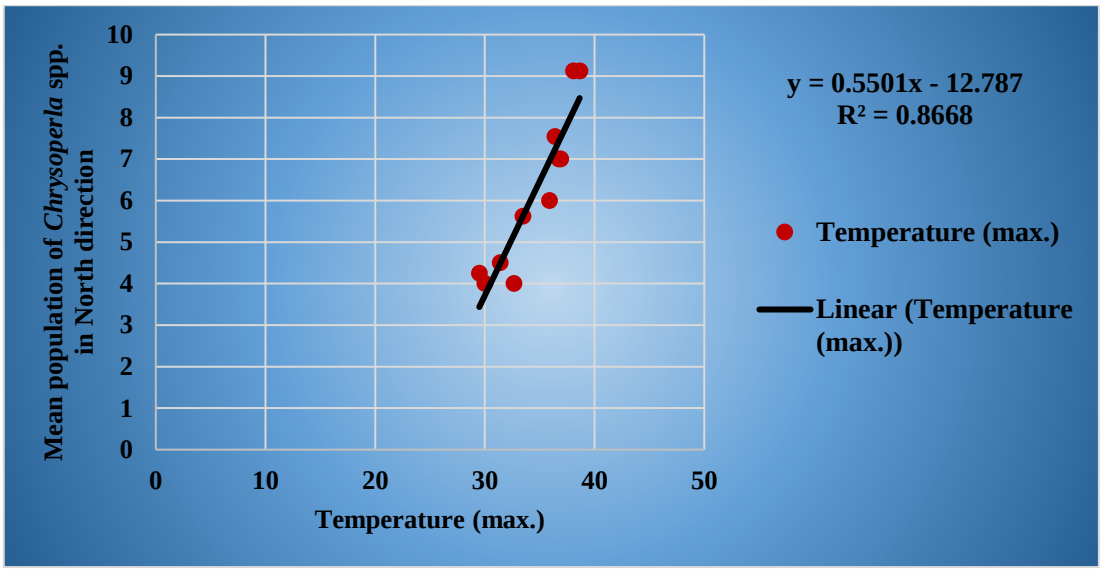


Fig- 4.26 Regression equation between mean population of *Chrysoperla* spp. in North direction and Temperature (max.)

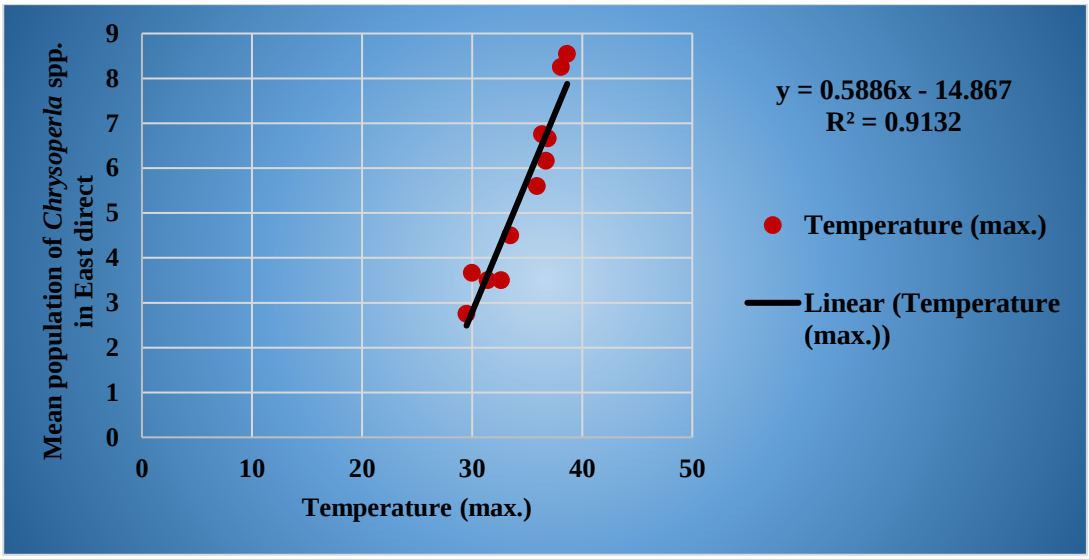


Fig- 4.27 Regression equation between mean population of *Chrysoperla* spp. in East direction and Temperature (max.)

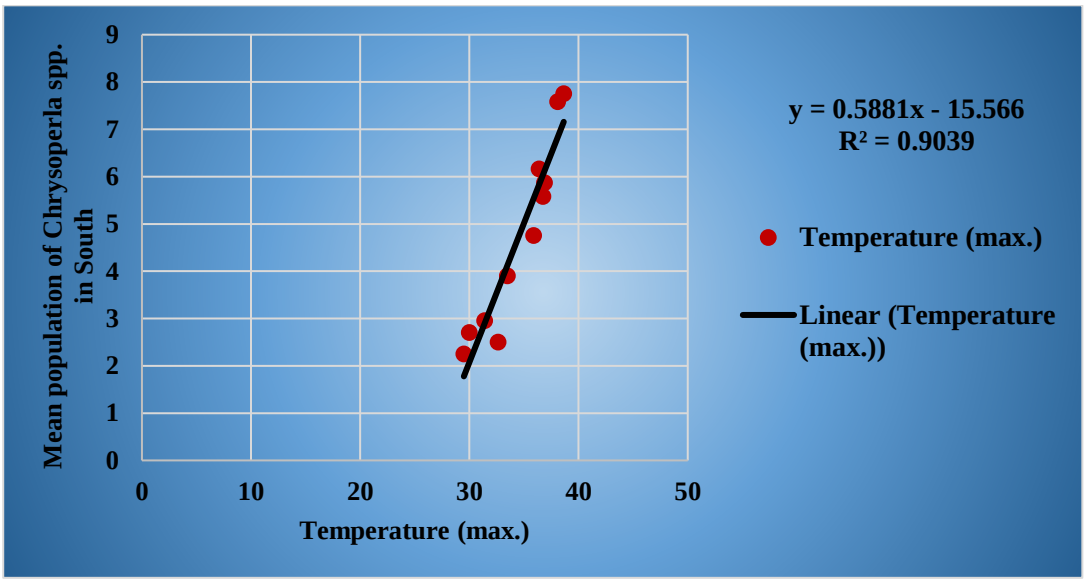


Fig- 4.28 Regression equation between mean population of *Chrysoperla* spp. in South direction and Temperature (max.)

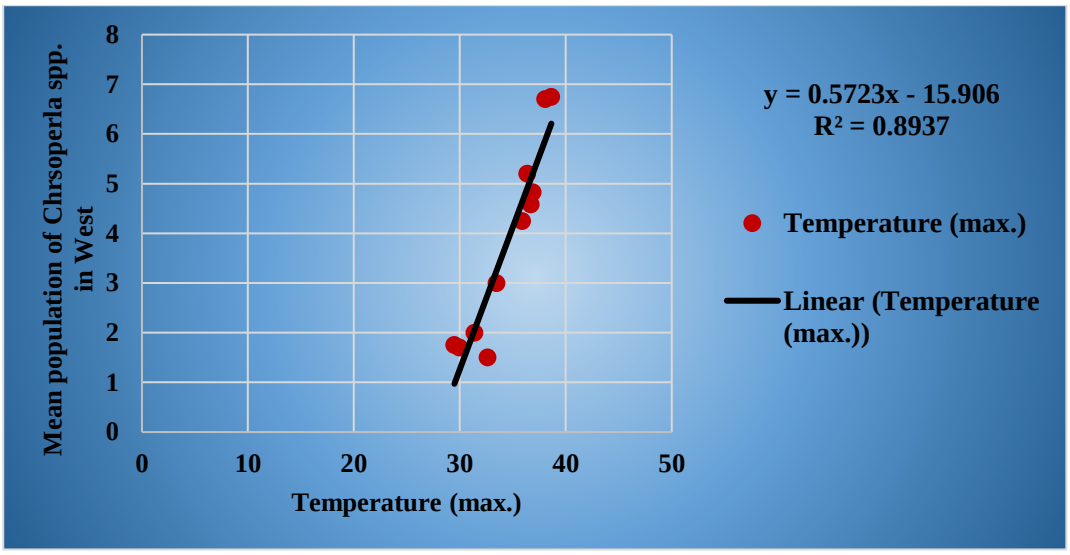
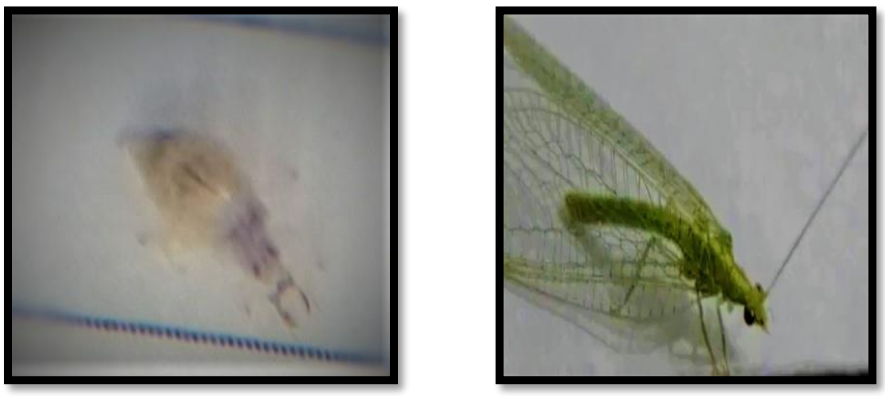


Fig- 4.29 Regression equation between mean population of *Chrysoperla* spp. in West direction and Temperature (max)

3.7

A. Larva, pupae and adult of *Eublemma amabilis*

B. Larvae, pupa and Adult of *Pseudohypatopa pulverea*



C. Nymph and adult of *Chrysoperla* spp.

Plate-07: Photographs of predators of lac insect, *K. lacca* Kerr

CHAPTER – V
SUMMARY AND CONCLUTSIONS

The present investigation entitled studies on the survival, potential yield and major predators of lac insect *Kerria lacca* Kerr. on Kusum (*Schleicera oleosa*) was carried out in Kanker district of Chhattisgarh.

5.1 Nutrient management

Nutrient management in plant are very important for its growth and production and plant nutrient have an impact on the growth and reproduction of phloem feeders. Nitrogen is the most important element for plant growth, yield and quality of products. Phosphorus is the second most important macronutrient next to the nitrogen is required for plant growth. Potassium is essential for growth and various physiological processes.

Insect-plant relationship is affected by the application of micro or macro nutrients to crop plants. Nutrient deficient plants remain weak and vulnerable to incidence of plant disease and insect pest attack.

Phloem sap is an extreme food source used as the dominant or sole diet of insects in the order Hemiptera. Essential amino acids in the plant sap are essential for growth and reproduction of sucking insect. The plants provide nutrients to herbivorous insects. Any increase in the nutrient content of the plant is likely to increase its acceptability to pest populations.

Increased nitrogen fertilizer application is positive associated with increase in the population of the sucking insect. Nitrogen is one of the most important factors in development of herbivore populations. The application of nitrogen fertilizer in plants can normally increase herbivore feeding preference, food consumption, survival, growth, reproduction, and population density.

Dry matter accumulation takes place due to phosphorus thus increases in total dry matter, the survival of *K. lacca* affected. Potassium has been considered a key component of plant nutrition that significantly influences crop growth and some pest infestation. The assimilation of potassium in plants reach maximum by 110 days after its application. Once absorbed/ assimilated, potassium increases sugar % in phloem, activates a wide range of enzyme, increases uptake of water, enhance phloem loading of sucrose and also amino acids, voluminous flow of photosynthate from source to sink. Reduction in dry matter of the plant and increases in succulence due to potassium.

5.2 Survival of lac insect

The mean brood lac inoculation per *S. oleosa* plant ranged from 6000g to 7000g. As the twigs of lac host trees are cylindrical and narrow, it is practically difficult to mark one square inch area followed by counting of larvae of *K. lacca* which are usually 0.5 mm in size. In the present study 2.5 sq. cm was the area to study the lac insect count. It provides comfortable space for accurate Lac insect counting. The mean lac larval settlement per 2.5 sq. cm from 30 days after BLI to the harvest of the lac crop showed a significant difference among the six treatments. The mean number of lac larvae per 2.5 sq. cm was in T1 (109.25), T2 (106.83), T3 (103.50), T4 (104.61), T5 (101.17), T6 (94.89) at 30 days after BLI. There was more in comparison to lac grower practice (control T6). 172 days after BLI the mean lac cell count at harvest or maturity the live lac cell count was highest in T1 (18.43) followed byT3 (20.08), T2 (18.50), T4 (18.08), T5 (15.17), T6 (12.83) which is significantly difference due to the nutrient application. Nitrogen is one of the most important factors in development of herbivore populations. The second highest larval settlement of lac insect at maturity was on *S. oleosa* treated with potassium because assimilation of potassium in plants reach maximum by 110 days after its application. Once absorbed/ assimilated, potassium increases sugar % activates a wide range of enzymes, increases uptake of water, enhance phloem loading of sucrose and also amino acids, voluminous flow of photosynthate from source to sink. Reduction of dry matter of the plant and increase in succulence due to potassium might have favoured *K. lacca* with more nutrients for its growth, development. Dry matter accumulation takes place due to phosphorous; this might be the reason for comparatively lesser number of lac insect in T2, T4, T5.

In present study, the lac insect survived at the time of harvest are T3 (19.40) followed by T1 (18.76), T2 (17.31), T4 (17.28), T5 (14.99) and T6 (13.52). There was a significant difference in the survival percentage of lac insect at harvest due to nutrient application. It was highest in T1 and lowest in T6.

5.3 Yield potential

The mean number of stick lac was highestT3 (249.25) followed by T2 (247.00)), T4 (244.75), T5 (240.50), T1 (236.25) and T6 (233.75). There was a significant difference in the number of stick lac among different treatments. Mean length of stick lac varied from 52.58- 56.62 cm per plant in different treatments. The maximum mean length of stick lac was recorded on T3 (56.62) followed by T2 (55.75), T4 (54.25), T5 (53.37), T1 (53.31) and T6 (52.58). The mean fresh weight of 30 cm stick lac highest in T3 (43.00) followed by T2 (40.37), T4 (36.50), T5 (35.75), T1 (33.25) and T6 (32.12). The mean weight of scrap lac from 30 cm stick lac (g) highest in T3 (22.06) followed by T2 (21.00), T4 (20.62), T5 (19.87), T1 (19.18) and T6 (18.25).The mean fresh weight of 100 lac cell (g) was highest in T3 (8.50) followed by T2 (8.37), T4 (7.75), T5 (6.87), T1 (6.57) and T6 (5.62). The meandry weight of 100 lac cell (g) was highest in T3 (7.62) followed by T2 (6.50), T4 (5.75), T5 (5.50), T1 (4.56) and T6 (3.81). Mean yield of stick lac per plant was varied from 34.25 to 52.75 kg in different treatments. The maximum mean yield of stick lac was recorded on T3 (NPK). The quality of food dependent upon the nutrient available on host plant. Thus, settlement of *K. lacca* depends on many reasons other than availability of succulent shoots. Higher density of the lac insect means higher competition for food.

5.4 Sex ratio

Sex ratio was recorded on the different treatments. The number of male lac insect *Kerria lacca* (Kerr.) maximum mean population density were observed inT1 (13.14) followed by T2 (13.00), T4 (12.54), T3 (12.50), T5 (12.06) and T6 (10.31). There was significant difference among the directions. Maximum female population density was observed inT1 (39.44) followed by T2 (37.63), T4 (36.13), T3 (34.13), T5 (31.11) and T6 (27.61). The maximum sex ratios were observed in T1 (3.00) which differed significantly from the T5 (2.57).

5.5 Net profit

The net profit was highest in case in T3 (Rs 13441.05/tree), T2 (Rs 12599.45/tree), T4 (Rs 11692.43/tree), T5 (Rs 10498.3/tree), T1 (Rs 9575.63/tree) and it was lowest in case of T6 (Rs 8243.1/tree).The Cost-Benefit ratio was highest (1:4.72) in case of T3 followed by T2 (1:4.52), T4 (1:4.31), T5 (1:4.00), T1 (1.:3.74) and lowest (1:3.35) in case of T6.

5.6 Predators

Incidence of various major predators with lac insect in *kusmi* strain of *Jethwi*(summer) crop were recorded at fortnightly interval. *E. amabilis,* its first appearance was recorded during 1stfortnight of March with the mean population of 4.01 insect per 30cm lac stick which suddenly increased and reached its peak in the 1stfortnight of June with the mean population 10.96 insect /30 stick lac, after that gradually decreased the population till harvest. Maximum mean population density of *E.amabilis* observed in north direction of the host plant. *P.pulverea* mean population were recorded in 1stfortnight of February with the mean population 4.88 /30cm stick lac which increased in 1st fortnight of May andits peak were recorded with mean 11.46 insects/30cm stick lac, after that gradually decreased the population till harvesting. Maximum mean number of *P. pulverea* observed in north direction. *Chrysoperla* spp. first appeared in 1stfortnight of February with peak population of 2.75 insect per 30 cm stick lac, the population increases gradually withdensity of 8.01 during first fortnight of April.

5.7 Correlation between major predators and weather parameters

The population of *Eublemma amabilis* from North direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.62*), maximum relative humidity (r= 0.64*), wind speed (r= 0.61*), minimum temperature (r=0.84*) whereas non-significant positive correlation was noticed with maximum temperature (r=0.30) and rainfall (r=0.57) were observed. From East direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.66*), maximum relative humidity (r=0.69*), wind speed (r=0.65*), minimum temperature (r=0.84*), rainfall (r=0.62*) whereas non-significant correlation was noticed with maximum temperature (r=0.25*) were observed. From South direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.68*), maximum relative humidity (r=0.72*), wind speed (r=0.68*), minimum temperature (r=0.85*), rainfall (r=0.63*) whereas non-significant correlation was noticed with maximum temperature (r=0.24*) were observed. From West direction inoculated tree showed significant positive correlation with minimum relative humidity (r= 0.63*), maximum relative humidity (r= 0.68*), wind speed (r= 0.67*), minimum temperature (r=0.85*) whereas non-significant positive correlation was noticed with maximum temperature (r=0.26) and rainfall (r=0.57) were observed.

The population of *Pseudohypatopa pulverea* from North direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.50), maximum relative humidity (r= -0.29), minimum relative humidity (r= -0.46) where as positive non-significant correlation with maximum temperature (r= 0.57), minimum temperature (r= 0.30), wind speed (r= 0.14). From East direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.52), maximum relative humidity (r= -0.30), minimum relative humidity (r= -0.48) where as positive non-significant correlation with maximum temperature (r= 0.57), minimum temperature (r= 0.29), wind speed (r= 0.12).

From South direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.54), maximum relative humidity (r= -0.32), minimum relative humidity (r= -0.50) where as positive non-significant correlation with maxim um temperature (r= 0.55), minimum temperature (r= 0.26), wind speed (r= 0.11). From West direction of inoculated tree showed negatively non-significant correlation with rainfall (r= -0.50), maximum relative humidity (r= -0.28), minimum relative humidity (r= -0.45) where as positive non-significant correlation with maximum temperature (r= 0.54), minimum temperature (r= 0.29), wind speed (r= 0.16).

The population of *Chrysoperla* spp. from North direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.93*) whereas positive non-significant correlation with minimum temperature (r= 0.43), maximum relative humidity (0.39) however, negatively non-significant with rainfall (r= -0.57), minimum relative humidity (r= -0.53), wind speed (r= -0.32). From East direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.96*) whereas positive non-significant correlation with minimum temperature (r = 0.52) however, negatively non-significant with maximum relative humidity (r= -0.31), minimum relative humidity (r= -0.44), rainfall (r= -0.48), wind speed (r= -0.26). From East direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.95*) whereas positive non-significant correlation with minimum temperature (r= 0.48) however, negatively non-significant with maximum relative humidity (r= -0.36), minimum relative humidity (r= -0.50), rainfall (r= -0.54), wind speed (r= -0.29). From East direction of inoculated tree showed significant positively correlation with maximum temperature (r= 0.95*) whereas positive non-significant correlation with minimum temperature (r= 0.42) however, negatively non-significant with maximum relative humidity (r= -0.43), minimum relative humidity (r= -0.55), rainfall (r= -0.59), wind speed (r= -0.34).

SUGGESTION FOR FUTURE RESEARCH WORK:

1. Study about the lac parasitoids in nutrient managed Kusum in Summer (*Jethwi*) crop.
2. Application of amino acid on host *Schleicera oleosa* for lac production may be studied.
3. Yield of Lac under different foliar application of micronutrients and humic acid.

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APPENDIX – A: Weekly meteorological data of Kanker during *Jethwi* (summer) crop 2020-21

SMW	Date	Rainfall (mm)	Temperature (°C)		Humidity (%)		Wind speed (kmph)
			Maximum	Minimum	Maximum	Minimum	
05-06	Feb 01- Feb 15	0.00	29.49	12.47	31.53	11.20	6.80
07-08	Feb 16- Mar 02	0.00	31.40	16.61	47.27	19.00	6.40
09-10	Mar 03- Mar 17	0.00	35.89	19.25	29.40	10.73	7.47
11-12	Mar 18- Apr 01	0.00	36.37	20.71	30.67	11.60	8.07
13-14	Apr 02- Apr 16	0.94	38.07	21.99	40.60	11.27	9.07
15-16	Apr 07-May 01	0.53	38.64	24.75	55.13	24.27	5.40
17-18	May 02May 16	0.86	36.89	23.41	59.53	20.81	10.07
19-20	May 17-May31	0.17	36.72	25.07	53.33	19.27	12.07
21-22	June01-June 15	9.59	33.47	23.60	73.60	40.87	11.93
23-24	June 16- June 30	21.69	29.98	22.45	84.33	56.07	12.53
25-26	July 01- July 15	25.43	32.64	23.93	90.64	64.43	12.50

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