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"Studies on pest complex of Cluster bean [*Cyamopsis tetragonoloba* (Linn.) Taubert] in Northern M.P."

THESIS

submitted to the

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

In partial fulfilment of the requirements for the Degree of

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In

AGRICULTURE

ENTOMOLOGY

by

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College of Agriculture, Gwalior (M.P.)

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CERTIFICATE – I

This is to certify that the thesis entitled, **"Studies on pest complex of Cluster bean [*Cyamopsis tetragonoloba* (Linn.) Taubert] in Northern M.P."** *submitted in partial fulfillment of the requirements for the Degree of* **MASTER OF SCIENCE** *in* **Agriculture Entomology** *of* **Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior**, *is a record of the bona-fide research work carried out by* **Mr. KAMLESH KUMAR KUMAWAT, ID: 20111906** *under my guidance and supervision. The subject of the thesis has been approved by the student's Advisory Committee and the Director of Instruction.*

No part of the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigations has been acknowledged by the scholar.

Place: Gwalior (**Dr. U.C. Singh**)
Date: Chairman of the Advisory Committee

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Member	**(Dr. V.B. Singh)**	…………………………

CERTIFICATE – II

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This is to certify that thesis the entitled **"Studies on pest complex of Cluster bean [*Cyamopsis tetragonoloba* (Linn.) Taubert] in Northern M.P."** *submitted by* **Mr. KAMLESH KUMAR KUMAWAT** *to the* **Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior** *in partial fulfilment of the requirements for the degree of* **MASTER OF SCIENCE** *in* **AGRICULTURE** *in the department of* **Entomology**, *College of Agriculture, Gwalior has been accepted after evaluation by the External Examiner and approved by the Student's Advisory Committee after an oral examination of the same.*

Place: Gwalior (**Dr. U.C. Singh**)

Date: Chairman of the Advisory Committee

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Member	(Dr. V.B. Singh)	……………………………
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Place : Gwalior
Date : / / 202 **Kamlesh Kumar Kumawat)**

Contents

List of Tables

List of Figures

List of Abbreviations and Symbols

Symbol	Abbreviation	Stand for
@		At the rate of
%		Per cent
±		Plus or minus
^oC		Degree centigrade
	CV	Coefficient of variation
	CD	Critical difference
	d.f.	Degrees of freedom
	et al.	Co- workers
	Fig.	Figure
	RH	Relative Humidity
	NS	Non-significant
	spp.	species
	viz.	For instance
	i.e.	That is
	Etc.	Et Cetera
	kg.	kilogram
	Gm	gram
	Cm	centimetre
	Mg	Milligram
	hrs.	hours
	Q	quintal
	R	Correlation coefficient
	m^2	Square meter

DEDICATED TO MY

LOVABLE PARENT

CHAPTER – I

INTRODUCTION

Cluster bean [*Cyamopsis tetragonoloba* (Linn.) Taubert] is a legume crop popularly known as guar, guvar, or gawar, and is one of the most significant commercial crops in arid and semi-arid areas. It belongs to the fabaceae family and is a popular seed and vegetable crop. *Cyamopsis tetragonoloba* is expected to be originated from the African species. Cluster beans are a sun-loving, drought-tolerant crop. It is typically cultivated during the rainy season, although it may also be produced well under irrigated circumstances throughout summer. It may grow in a number of soil types, including sandy loam and soils with a medium texture. Cluster bean is helpful to both animals and humans because of its nutritional worth, but the gelling agent contained in the seed is the most important aspect. Cluster bean seed has a protein content of 18% and a fibre content of 32%. For monogastric animals, seed coat and germ cell meal (high protein content) is an ideal diet. Gum is one of the important product, which has made the crop useful commercially and for export. The use of guar gum has increased tremendously, as it is a natural absorbent. It has diversified uses covering major industrial sectors like textile, printing, cosmetics, mining, explosive, pharmaceutical, oil and toiletry products.

Being a leguminous annual crop its primary use is in soil health enrichment through atmospheric nitrogen fixation , on average basis it has been estimated that it may fix nearly 30 kg N/ha. Furthermore, due to complete shedding of leaves up to maturity, the organic carbon may be added to the soil which would elevate organic carbon level that is the major concern under the arid areas. From the ancient time, cluster bean is being used as a source of food, fodder and feed under harsh environment. Young pods are a source of delicious vegetables from the late summer to the mid of rainy season which contain vitamin A, calcium, iron, phosphorous and ascorbic acid. Cluster bean provides very palatable and nutritious fodder and *guar* meal (feed) to the animals.

Madhya Pradesh is 5th major guar production state in India. The total guar production covering an area of 65.62 thousand hectares with an annual production of 46.98 thousand tones having a productivity of 716 kg ha^{-1}. (Anonymous, 2018)

Insect-pests are the major constrainst in the productivity of cluster bean. Among them Aphid *(Aphis craccivora* ; Koch), Jassid (*Empoasca kerri*; Pruthi), Thrips (*Megaleurothrips distalis* Karny), Mite (*Polyphagotarsonemus latus* ;Banks), White flies (*Bemisia tabaci).* Genn are important infesting cluster bean (Muralidharan *et al.,* 1999; Reddy and Rao, 2001; Arora and Kashyap, 2002; Khan *et al.,* 2002 and Singh, 2004).

Among various pests, sucking pests like whitefly, jassid and aphid cause considerable losses in the yield of cluster bean crop by sucking the sap from the ventral surface of leaves. As a result of their feeding, the affected parts become yellowish, the leaves wrinkle and curl downwards and are ultimately shed. Besides the feeding, these insects exude honey dew which favours the development of sooty mould which hinders the photosynthesis of the plant resulting in stunting growth. Not only seed yield is considerably reduced but the quality of the fodder also deteriorates, if the crop is grown for fodder purpose.

As a result of being high remunerative crop due to increasing demand by the gum producing industries, the area under the same has increased dramatically in the recent past. The availability of short duration cultivars are also responsible for tremendous increase in area under this crop, as the long duration cultivars have no promise due to erratic nature of monsoon. Since certain varieties are more preferred by a pest as compared to other or some may bear the losses caused by the pest, the study of the population of major insect pests on different varieties of cluster bean would be done with a view to find out the least susceptible varieties against cluster bean major insect pest

For the management of major insect-pests, chemical control has been recommended by some workers to combat with insect pests of cluster bean (Noor, 2002, Dodia *et. al.,* 2003, Patel, 2009 and Yadav *et.al*., 2011) but due to one or the other reasons could not become panacea in the protection of this crop. Various insecticides and botanicals have been entered into market for controlling various sucking/major insect pests, but their efficacy is needed to be checked in cluster bean crop.

Approximately 73.86 per cent yield loss due to its pest complex has been reported by Pandey *et al.* (1991). According to Sharma *et al*., 2000 every unit increase in aphid population resulted in a yield loss of (3.54-4.68 kg ha^{-1}). For increasing production or reducing yield loss management strategies against any pest is important. For this the information regarding appearance of the pests and fluctuation in their population is essential. One of the best choices for most cost-effective and safe method for this pests control is growing resistant variety. A resistant variety can provide a base for construct on integrated control system (Gallun *et al*., 1975) and may most fruitful when used in connection with other methods of control. Keeping the above facts, in view, the present study was carried out at College of Agriculture, Gwalior during *Kharif* season 2021-22 with the following objectives:

Objectives:

1. To study on the population dynamics of major insect pest of cluster bean.
2. To identify less susceptible varieties against major insect pests of cluster bean.

CHAPTER- II

REVIEW OF LITERATURE

Clusterbean crop is attacked by many of insect-pests right from germination to harvest of the crop. Among the various pests infesting the crop, Aphid *(Aphis craccivora* ; Koch), Jassid (*Empoasca kerri*;Pruthi), Thrips (*Megaleurothrips distalis* Karny), Mite (*Polyphagotarsonemus latus* ;Banks), White flies (*Bemisia tabaci*) were observed in Gwalior. The available literature related to the different aspects of present studies in India and abroad has been reviewed and presented here.

1. To study on the population dynamics of major insect pest of cluster bean.
2. To identify less susceptible varieties against major insect pests of cluster bean.

2.1 To study on the population dynamics of major insect pest of cluster bean

Saleh *et al*. (1972) studied of the population denseness of aphid on broad beans and cowpea in southern Egypt, in 1965 and 1966. In both years, maximum numbers were present on broad beans in March and the population had virtually died out, however by late April when the crop had matured.

Faleiro *et al.* (1990) observed that the aphid population had a significant negative correlation with minimum temperature on cowpea. A unit increase in the minimum daily temperature caused a decrease of 0.12 aphids/plant.

Pithava (1996) revealed that thrips appeared after fifth week of sowing and remained active throughout the crop season. The pest showed two peaks of its population, 3.80 and 8.12 thrips/flower during sixth and tenth week of sowing, respectively on mungbean. They noticed significant positive correlation with maximum temperature and sunshine hours and significant negative correlation with morning and evening relative humidity.

Ahuja (2000) reported that mite populations (28.7/leaf) were recorded during mid-September in 1994, when the maximum and minimum temperature ranged from 30.1 to 33.0ºC and 22.6 to 25.2ºC, respectively.

Abou-Elhagag and Salman (2001) reported that population of leafhoppers (*Empoasca* spp.) was observed during the 1st week of February, 2000 and the 2nd week of January, 2001, reaching its highest level between the 2nd and 3rd week of March on faba bean. At New Delhi Reddy *et al.* (2001) reported that population of *E. kerri* on pigeon pea appeared from the 15th day after sowing and remained till the harvest of crop. Reddy *et al*., (2001) reported that leafhopper, *E. kerri* population on pigeonpea appeared in the field from 15 days after sowing (DAS) and continued up to harvest at New Delhi.

Jovicich *et al.* (2004) studied infestations of mite occurring at the seedling developmental stages, the mite populations first increased exponentially as days after seeding (DAS) increased and populations developed more rapidly in older seedlings that were infested. At 38 DAS (transplanting age, with 6 leaves unfolded in uninfected seedlings), seedling damage was greater in those infested at younger developmental stages. Mite population in seedlings infested at 2 and 4 leaves were still increasing at 38 DAS.

Patel (2006) reported that the population of jassids on cowpea started from 2nd week of sowing *i.e*. 1st week of March and reached to the peak level at 5th and 8th week after sowing. There after, the population of jassids declined and reached a low level at the time of harvest. Similarly, Patel *et al.* (2009) reported that the population of leafhopper, *E. kerri* on cowpea started from the 1st week of March, increased gradually and reached to a peak (2.83 hoppers /leaf) during 4th week of March in middle Gujarat.

Yadav and Singh (2006) conducted the experiments on mungbean during summer and Kharif seasons in Uttar Pradesh, India. They found that jassid infestation appeared in third week of sowing with its high intensity from second fortnight of May to first week of June during summer season and its population was adversely affected by high humidity to a significant level but it was markedly increased by maximum and minimum temperature, whereas rainfall was found to be detrimental for its multiplication and thrips. The cumulative effect of environmental factors was more pronounced during Kharif season with marked effect of maximum temperature, whereas minimum temperature and relative humidity exhibited negative response in summer. Rainfall was slightly conducive during summer on population of thrips.

Dalwadi *et al*. (2007) noticed in their research that aphid remained active from mid-November to end of March with two distinct peaks. First peak (24.10 aphids/twig) was noticed during second week of December and second peak (123.80 aphids/twig) during last week of January.

Pandey and Ahmed (2008) reported that the incidence of aphids in cowpea started in the second week of May and reached its peak in the last week of July and stared declining thereafter. The maximum aphid population was recorded when the temperature ranged from 26.8 to 28.5°C with relative humidity ranging from 33.0 to 49.0 per cent. They found a positive correlation between populations of aphids and mean maximum temperature.

Prasad *et al.* (2008) stated that morning and evening relative humidity were significantly positive, they also stated that minimum temperature showed significant negative correlation with aphid population on groundnut.

Yadav and Kumawat (2008) at Jobner, Rajasthan noticed that the incidence of aphid on cluster bean started in first week of August and reached its peak on second week of September. Population of jassid and whitefly were first noticed in second week of August and reached its peak in first week of September. Aphid showed negative non-significant correlation with temperature and relative humidity and significant correlation with rainfall. Jassid showed positive correlation with temperature and negative significant correlation with relative humidity and rainfall. While whitefly showed negative correlation with abiotic factor.

Pachundkar (2011) conducted the experiment on clusterbean during *kharif* season in Gujarat. Incidence of thrips, whitefly and jassids was first time showed in cluster bean crop during Ist week of September during *kharif* season. The activity of whitefly,jassid and thrips was continued till 2nd week of November, 3rd week of November and 1st week of November, respectively. The peak activity of whitefly,jassid and thrips was found during 4th week of September to 4th week of October, 2nd week of October to 2nd week of November and 3rd week of September to 3rd week of October, respectively. The maximum temperature had significantly positive correlation, while the minimum temperature, morning and evening relative humidity as well as vapour pressure exhibited significantly negative relationship with *B. tabaci* population on cluster bean. The rainfall had significantly negative correlation with jassid population.

Sagar *et al.* (2012-2013) reported the pest population of whitefly, thrips and aphids in mung bean field. Highest population of whitefly, thrips and aphids were observed during 2nd week of Feb to 1st week of Mar (14.0 per 10 cm shoot tip, 1.68 per compound leaf and 4.37 per flower, respectively) during first season. Whereas, highest population of aphids, whitefly and thrips were observed during 2nd week of April with 14.18 per 10 cm shoot tip, 2.0 per compound leaf and 6.89 per flower, respectively during second season. The sucking pest viz., thrips, whitefly and aphid populations exhibited significant positive correlation with maximum temperature (r= 0.78, 0.78, 0.79, 0.78) and significant negative correlation with evening relative humidity (r= -0.51, -0.51, -0.57, -0.53) and rainfall (-0.41, - 0.41, -0.45, -0.45), respectively during first season.

Nitharwal and Kumawat (2013) observed that jassid, whiteflies and thrips, are the major insect pests of green gram, in the semi-arid region of Rajasthan. The population started from first week of August and remained active throughout the crop season. The infestation gradually reached to the peak in the first week of September during both the years.

Singh and Yadav (2013) reported the seasonal abundance of insect pests during *kharif* season on mungbean. Incidence of the jassid and whitefly were started in 31st standard week. The jassid population had significant positive correlation with sunshine and evaporation and non-significant with other factors. The population of whitefly had significant negative correlation with maximum temperature, sunshine hours and evaporation. The incidence of thrips, blister beetle, tobacco caterpillar, epilachna beetle was also observed.

Vadja (2013) observed that aphid population commenced in the 2nd week of October and attained its peak of 3.04 aphid/3 leaf during the 1st week of November and it showed negative significant correlation with minimum temperature (r = -0.622*). The incidence of jassid started in the 3rd week of October and attained its peak (4.8 jassid/3 leaf) during the 1st week of November. The jassid exhibited significant positive correlation with maximum temperature (r = 0.588*) and mean bright sunshine hours (r = 0.674*). The incidence of thrips observed in the 3rd week of October and attained its peak (3.9 thrips/3 leaf) during the 1st week of November. It showed significant negative correlation (r = -0.755**) with minimum temperature and negative significant correlation with relative humidity (r = -0.617*) and mean temperature (r = -0.614*). The incidence of whitefly started in the 3rd week of October and attained its peak during the 1st week of November i.e. 3.9 whitefly/3 leaf. Whitefly population exhibited a significant positive correlation with mean bright sunshine hours (r = 0.649*) and maximum temperature (r = 0.619*).

Parmar and Litoriya (2015)) studied on management of major insect pests of cluster bean. (*Cyamopsis tetragonaloba* (Linn.) during summer at JAU, Junagadh and revealed that incidence of jassid, aphid and thrips were started in second week of March and these insects remained active throughout the crop period. The infestation of aphid gradually increased and reach to its peak in the first week of April. Jassid and thrips infestation gradually reached to the peak in the fourth week of April. Aphid and thrips population showed significant negative correlation with temperature and non-significant correlation with other abiotic factor. Jassid showed significant positive correlation with evaporation and maximum temperature.

Sharma and Singh (2015) reported on urdbean that population of thrips, jassid and white fly were recorded with crop age and found that the population of all the three pests increased with increase the crop age up to reproductive stage 4.06 jassid/6 leaves, 6.32 thrips /6 leaves and 9.54 whitefly/6 plants, respectively at 48 days after sowing.

Yadav *et al.* (2015) observed that biotic and abiotic factors limit the productivity of black gram including insect pests like leafhopper, *Empoasca kerri*, whitefly, *Bemisia tabaci*, tobacco caterpillar, *Spodoptera litura*, semilooper, *Trichoplusia ni* and bihar hairy caterpillar, *Spilosoma obliqua*.The high population of 3.49 whiteflies/leaf was observed during 39th standard week. Whitefly and leafhopper population with sunshine hours showed non-significant negative correlation while rainfall, temperature (minimum and maximum), relative humidity (morning and evening), and wind velocity showed a non-significant positive correlation.

Yadav *et al*. (2016) studied population dynamics of major insect pest of cluster bean and their correlation with abiotic factors and resulted that population of jassid and whitefly appeared from the first week of September and increased up to the last week of September and declined gradually till the crop was matured in the last week of October. The maximum and minimum temperature showed significantly positive correlation whereas, the relative humidity revealed negative significant correlation with jassid and whitefly population, respectively. The rainfall showed significantly positive correlation with jassid population only.

Tamang *et al*. (2017) studied on pest population in mung bean field and found aphids, whitefly, thrips and their highest population were observed during 2nd weekof Feb to 1st week of March (14.0 per 10 cm shoot tip, 1.68 per compound leaf and 4.37 per flower, respectively) during first season. Whereas, highest population of aphids, whitefly and thrips were observed during 2nd week of April with 14.18 per 10 cm shoot tip, 2.0 per compound leaf and 6.89 per flower, respectively during second season.

Jat *et al*. (2017) at Udaipur (Rajasthan) recorded that pest population in blackgram field and found that aphids, jassids, whitefly, thrips and blister beetle population attained peak in the 1st week of September during 2013 and 2nd week of September during 2014; the jassids and whiteflies remained active throughout the growing stage and attained the peak in the 4th week of August and last week of August during both years; thrips infestation reached its peak in the last week of August.

Pawar *et al* (2011) observed that jassid was first to appear during 3 weeks after sowing (WAS), and whitefly 4 weeks after sowing (WAS). Thrips appeared little late at 5 WAS and disappeared from the crop from 13 WAS, while the population of leafhopper and whitefly was noted on cluster bean up to 14 and 15 WAS, respectivelyat North Gujarat conditions.

Pawar *et al*. (2017) five insect pests viz.,leafhopper (*Empoasca kerri* Pruthi); whitefly (*Acaudaleyrodes rachipora* Singh); thrips (*Megaleurothrips usitatus* Karny); black weevil (*Cyrtozemia dispar* Pascoe) and termite (*Odontotermus obesus* Rambur) were recorded on clusterbean. Among them, *E. kerri* was noted first during 3 weeks after sowing (WAS), which wasfollowed by *A. rachipora* during 4 WAS. *M. usitatus* appeared little late (5 WAS) and disappeared from the crop from 13 WAS, while the population of leafhopper and whitefly was noted on clusterbean up to 14 and 15 WAS, respectively. *Cyrtozemia dispar* appeared on the crop during 7 WAS, whereas incidence of *O. obesus* commenced during 9 WAS. Population of *C. dispar* and damage due to *O. obesus* disappeared from the crop 13 WAS and 16 WAS, respectively.

Yadav *et al.* (2017) conducted the experiment on intercropping of cluster bean with pearl millet, sesame, green gram and sorghum was laid out with the view to find out the possibility of minimum incidence of insect pests on the main crop. It was observed that in the intercrop combinations, *viz*., clusterbean + pearl millet and clusterbean + sorghum the main crop (clusterbean) harboured significantly lower population of leaf hopper, *Empoasca motti* (4.0 and 4.2/ three leaves, respectively), whitefly, *Bemisia tabaci* (3.0 and 3.7/ three leaves, respectively) and aphid, *Aphis craccivora* (2.8 and 3.1/ central shoot) as compared to the sole crop of clusterbean. The aphid population was minimum in clusterbean + pearlmillet (2.8/central shoot) followed by clusterbean + sorghum (3.1/ centralshoot) as compared to sole crop (5.2/ central shoot). The highest yield was obtained from clusterbean + pearl millet (9.2 q ha$^{-1)}$ and clusterbean + sorghum (9.1 q ha^{-1}), the two combinations being onpar with each other. The equivalent yield was minimum in the sole crop (6.8 q ha^{-1}).

Mohapatra *et al.* (2018) studied and reported that insect-pests with biotic and abiotic factors play a major role in low production and productivity of black gram in India. The insect-pests were white fly, *Bemisia tabaci* (Genn.), jassid, *Empoasca kerri* Pruthi. The high population of 18.50 whiteflies/cage/plant, 36.80 jassid/cage/plant, were observed during 39th standard week. Temperature (maximum & minimum) and rainfall showed non-significant positive correlation and relative humidity showed non- significant negative with the population of white fly and jassids.

Yadav *et al*. (2020) find out the major sucking pest's viz., jassid, *Empoasca motti* Pruthi; whitefly, *Bemisia tabaci* (Genn.) and aphid, Aphis *craccivora* Koch attacking cluster bean crop sown at different dates to determine the optimum sowing of dates. The five different sowing dates revealed that early sown crop (14th July) had the minimum infestation of major sucking pests and highest seed yield was obtained as compared to the late sowing crop (11th August).

2.2 To identify less susceptible varieties against major insect pests of cluster bean.

Singh *et al.* (1996) screened 60 genotypes of clusterbean against whitefly, *B. tabaci* and found five genotypes, CH 14-2, HG 75, HG 94, HG 258 and HGS 365 with lowest nymphal population and appeared to be least preferred to whitefly, while genotypes, RGC 1001 was observed to have highest nymphal population followed by GAUG 9005 and GAUG 9010.

Singh (2002) screened 15 normal maturing and 9 early maturing cultivars of cluster bean for resistance against whitefly, *Acaudaleyrodes rechipora* in Jodhpur, Rajasthan during *rainy* season of 1999. It was higher (5-5o %) in the normal maturity cultivar, (0-35%) in early maturity cultivar of cluster bean. The early maturity cultivar, RGC 1017 had less than 10 per pest incidence. In the normal maturity group, the promising cultivar, CZ 9820, showed no incidence of whitefly; however, RGC 1020, RGC 1023, RGM 111 and RGM 112 were also promising, recording less than 10 per cent pest incidence.

Singh *et al.* (2003) studied the incidence and damage incurred by black weevil, *Cyrtozemia cognata* on cluster bean (15 normal and 10 early maturing cultivars) in Jodhpur, Rajasthan during the *rainy* season of 2001. Pest incidence did not significantly vary among the cluster bean cultivars. Among the early maturing cultivars, pest incidence ranged from 6.67 (RGM1-13) to 86.67 per cent (HGS-- 880, HGS-885, RGC-1025, HG-365 and RGC-936), whereas, damage varied from 33.33 (RGM-114) to 66.67 per cent (GAUG-012) on 8 August. On 24 August, pest incidence varied from 46.67 (HGS-880 and HG-365) to 80.00 per cent (CAZG-50, HGS-870 and RGM-114), whereas, damage ranged from 53.33 (HGS-885) to 80.00 per cent (GAUG-011 and GAUG-012). Among the normal maturing cultivars, pest incidence ranged from 60.00 (HGS-875 and RGC-1031) to 86.67 per cent (GAUG-014), whereas, the percentage of damaged plants varied from 26.67 (HGS-875, HGS-881, HGS-884 and RGC-1031) to 40.00 per cent (GAUG-014 and CAZG-90-2) on 8 August. On 24 August, *C. cognata* incidence ranged from 53.33 (CAZG-97), HG-75 and GG-1) to 73.33 per cent (GAUG-014 and CAZG-90-2), whereas the extent of damage varied from 33.33 (HG-75) to 53.33 per cent (HGS-875, CAZG-97 and GG-1).

Verma and Henry (2003) screened fifteen normal maturity and 9 early maturity varieties of cluster bean, against the whiteflies, *Acaudaleyrodes rachipora* at CAZRI, Jodhpur. The incidence of the pest in clusterbean was more (5-50 %) in the early varieties than in normal maturity varieties (0-35 %). In the normal maturity group, CZ 9820 showed no incidence of whiteflies, whereas others showing promise (<10 % incidence) were RGC 1020, RGM 111 and RGM 112. The only promising cultivar in the early maturity group (showing <10% pest incidence) was RGC 1017.

Chaudhary*, et al.* (2007a) determine the performance of the promising guar genotypes RGC-1033 and RGC-1038. RGC-1033 and RGC-1038 have shown an increase of 23.04, 28.85, 27.15 and 9.60% and 21.98, 27.73, 26.05 and 8.65% seed yield over the controls RGC-986, HG-75, GG-1 and HGS-

365, respectively. The performance of RGC-1033 and RGC-1038 showed an increase in seed yield by 42.55, 62.11 and 26.68 and 21.19, 31.77 and 23.82% over the controls RGC-986, GG-1 and HGS-365, respectively. The genotypes RGC-1033 and RGC-1038 showed tolerance against jassid population per leaf over the controls. RGC-1033 and RGC-1038 showed an increase in seed yield of 51.52 and 57.58% compared to the local cultivar during the 2005 and 2006 *kharif* season.

Chaudhary *et al.* (2007b) reported that RGC-1031 (Guar Kranti) a cluster bean cultivar shown an increase of 28.15 and 33.48% seed yield over the controls GG-1 and HG-75 during, *kharif* 1999; and 11.81 and 16.41% seed yield over the controls RGC-986 and GG-1 during *kharif* 2000. In the State Multi-location trials during *kharif* 2004 and 2005, Guar Kranti has shown an increase of 9.49, 7.09, 16.37, 18.12 and 6.35% seed yield over the controls RGC-936, RGC-1003, RGC- 986, RGC-197 and RGC-1002, respectively. RGC-1031 was found promising in the coordinated varietal trials conducted during *kharif* 2001 by a margin of 6.20 and 9.18% over the controls GG-1 and HG-75, respectively. It has been promising in seed yield by a margin of 4.74 and 11.18% over the controls RGC-986 and GG- 1 in the coordinated trials conducted during *kharif* 2002 at the national level, respectively. This cultivar has a high degree of tolerance to major insect pests in comparison to RGC-986, HG-75 and GG-1.

Yadav and Kumawat (2008) evaluated fifteen genotype of cluster bean against jassid and whitefly. The genotype, RGC-197, RGC-1031, RGC-1017, RGC-1055 were found least susceptible to jassid; genotypes, RGC-1077, RGC- 1066 and RGC-1078 moderately susceptible and genotypes RGC-1038, RGC- 1003, RGC-1002, and RGC-936 were highly susceptible. The genotypes, RGC- 1017, HGS-365, RGC-986, RGC-197, RGC-1031 and RGC-1076 were least susceptible to whitefly; genotypes, RGC-1017, RGC-986, RGC-197, RGC-1031 and RGC-1076 were moderately susceptible; genotypes RGC-1038, RGC-1003, RGC-1002, RGC-1078, and RGC-936 were highly susceptible to whitefly.

Patel *et al.* (2009) evaluated fourteen genotypes of clusterbean against whitefly. The results revealed that whitefly population differed among all the varieties from 3.63 (GAUG-0308) to 5.00 (GAUG-0524) per leaf. Significantly minimum whitefly population was recorded in the genotype GAUG-0308(3.63/ leaf) and it was at par with that of GAUG-0013 (3.86 /leaf) and GAUG-0004 (3.88 /leaf). Variety GG-2 gave highest yield of clusterbean (454 kg/ ha).

Panwar and Patel (2011) tested 20 varieties/genotypes for their susceptibility /resistance, variety GG 2 showed the multiple resistances against leafhopper, whitefly and thrips. Similarly, the genotype GAUG 826 exhibited the multiple resistances against leafhopper and whitefly, while GRG 1007 was resistant against leafhopper and thrips. Among rest of the genotypes, HG 75 was resistant against leafhopper; GRG 1012, GRG 1014 and GRG 1010 were resistant against whitefly and GRG 1023 was resistant against thrips.

Yadav *et al*. (2011) screened fifteen genotypes of clusterbean against jassid and whitefly. The genotype RGC-197, RGC-1031, RGC-1017, RGC-1055 were found least susceptible to jassid genotypes RGC-1077, RGC-1066 and RGC- 1078 moderately susceptible and genotypes RGC-1038, RGC-1003, RGC-1002 and RGC-936 were highly susceptible. The genotypes RGC-1017, HGS-365, RGC-986, RGC- 197, RGC-1031 and RGC-1076 were least susceptible to whitefly whereas, genotypes RGC-1017, RGC-986, RGC-197, RGC-1031 and RGC-1076 were moderately susceptible. Genotypes RGC-1038, RGC-1003, RGC-1002 and RGC-936 were highly susceptible to whitefly.

CHAPTER- III

MATERIALS AND METHODS

The present Studies on pest complex of Cluster bean [*Cyamopsis tetragonoloba* (Linn.) Taubert] in Northern M.P was conducted at Farm, College of Agriculture, Gwalior (M.P.) during *Kharif* season, 2021-22. The details were carried out at the research of materials used and methodology adopted for the studies are described under following sub headings.

3.1 The population dynamics of major insect pest of cluster bean

The investigation on cluster bean was carried out under Gwalior Agro-climatic conditions at the RVSKVV, College of Agriculture, Gwalior during *Kharif* season 2021-22. The field preparation was done by standard package and practices; fertilizer dose was given before sowing the crop as recommended dose. Experimental plots were kept free from insecticidal spray throughout the crop season.

Details of experiment:

Name of crop	: Cluster bean
Date of sowing	: 23/07/2021
Plot size	: 8.1m ×12 m
Spacing (RxR and PxP)	: 45 cm x10 cm
Fertilizer dose	: 20:40:20 NPK (kg ha^{-1})
Variety	: HG 2-20

Observation:

The observations on the incidence of major insect pests were recorded from first appearance to maturity of the crop at weekly interval on 10 randomly selected plants. The population of major pests was recorded by counting on three leaves (top, middle and bottom) on 10 randomly selected plants. Weekly data on meteorological parameter, viz. maximum and minimum temperature, relative humidity, and rainfall were collected from the meteorological observatory of the College of Agriculture, Gwalior. Data was correlated with major insect pests of cluster bean.

Table 3.1: Weather data *kharif* 2021-22

WAS	SMW	Months and weeks	Temperature		Humidity (%)		Rainfall (mm)	Evaporation on (mm)
			Max.	Min.	Mor.	Eve.		
2nd	31	July	33.2	25.9	91.3	64.3	9.2	4.8
3rd	32	Aug. I	32.9	24.9	89.1	66.1	22.4	3.8
4th	33	II	31.1	24.1	91.1	84	69.8	2.8
5th	34	III	32.3	24.4	89.9	72.1	117	3.6
6th	35	IV	33.5	25.2	90.1	67.7	20.8	3.5
7th	36	Sept. I	33.4	25.1	90.9	67.6	67.4	3.6
8th	37	II	32.8	24.8	94.9	78.3	37	3
9th	38	III	30.2	23	94.1	77.1	123.8	3.1
10th	39	IV	29	22.2	95.1	80	89.8	1.1
11th	40	Oct. I	31.64	21.5	90.8	66	31.4	3.4
12th	41	II	33.2	17.98	80.2	40.4	0	5.2
13th	42	III	32.6	17.5	90.5	44.4	0	5
14th	43	IV	31.44	14.1	89.4	31.7	0	4
15th	44	V	32	16.4	89	42.3	0	4

WAS= Week after sowing, SMW= Standard Meteorological week, Mor. = Morning, Eve. = Evening, Max.= maximum, Min.= Minimum,

3.2. Identification of less susceptible varieties against major insect pests of cluster bean.

The genotypes were allowed to have natural infestation. Weekly observations on population of aphid, jassid, whitefly, mite and thrips were recorded soon after their appearance till harvesting of the crop. All the observations were recorded early in the morning. The population of aphid, jassid, whitefly, mite and thrips were recorded on ten randomly selected plants in each plot.

Details of experiment:

Experimental design : RBD (Randomized BlockDesign)

No. of genotypes : 18

1. HG 2-20	7. X 25	13. GD 580
2. RGC-1033	8. CAZG 17-16-1	14. HG 19-2-6
3. RGC 1066	9. CAZG 19-7	15. CAZG 18-4
4. GG 1806	10. DRLGG 13-28	16. CAZG 19-9
5. GG 1909	11. GG 1903	17. DRLGG 13-39
6. GD 567	12. GD 565	18. GL-01

No. of replications : 03

Plot size : 4 m x 2.7 m

Spacing (RxP) : 45 cm x10 cm

Total no. of plot : 54

Fertilizer dose : 20:40:20 NPK (kg/ha)

No. of rows per plot : 6

Statistical analysis

The data were subjected to statistical analysis after transformation. The population data were transformed to $\sqrt{x+0.5}$, while data in percentages were transformed to their angular values. The data so obtained were subjected to using the analysis of variance as given below:

Table 3.2(A) Analysis of variance (ANOVA)

Source of variation	d.f.	SS	MSS	F cal.	F. tab.
Treatment	t- 1				
Replication	r- 1				
Error	(t-1) (r-1)				
Total	(r t - 1)				

The differences between means were subjected to further testing by computing CD at 5% probability level. The following formulas were used for various estimation:

Standard error for observation mean

$$\text{SEm}\pm = \frac{\sqrt{\text{EMS}}}{r}$$

1. Critical difference (C.D.)

$$\textbf{CD} = \textbf{SEm X} \sqrt{2\text{xt}(5\%)}$$

Where,

r = Number of replications

t = ‘t’ value at 5% probability level

SEm+ = Standard error of means

CD = Critical difference

(B) Correlation studies:

Correlation of meteorological parameters with different pest population with natural enemies was worked out by using the formula as suggested by Snedecor and Cochran (1967).

$$r = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum(X - \bar{X})^2}\sqrt{\sum(Y - \bar{Y})^2}}$$

Where, $\bar{X} = \text{mean of X variable}$

$\bar{Y} = \text{mean of Y variable}$

Test of significance of correlation coefficient

$$\boldsymbol{t} = \frac{\boldsymbol{r}\sqrt{\boldsymbol{n} - \mathbf{2}}}{\sqrt{\mathbf{1} - \boldsymbol{r}^{\mathbf{2}}}}$$

Where,

'n' is the number of sets of observations and 'r' is the correlation coefficient and value of ’t’ based on (n-2) degree of freedom.

CHAPTER-IV

RESULTS

The current research assessed eighteen cluster bean genotypes in order to identify the major insect pests of the cluster bean and to identify genotypes that are less vulnerable to major insect pests of the cluster bean. The results are presented in this section.

4.1 The population dynamics of major insect pest of cluster bean

The aphid, *Aphis craccivora* (Koch), jassid, *Empoasca kerri* (Pruthi), thrips, *Megleurothrips ditalis* (Karny), mite, *Polyphagotarsonemus latus* (Banks), and whitefly, *Bemisia tabaci* are among the main major insect pests of cluster bean.

4.1.1 Aphid, *Aphis craccivora* (Koch)

The population of aphid appeared (Table 4.1) (Fig. 4.1) in the second week of August (33th SMW) and increased up to the last week of August (36th SMW) and declined gradually till the crop was matured in last week of October. The population of aphid ranged from 1.26 to 4.56. The peak activity of aphid (4.56) was recorded in the 36th standard week or last week of August.

The incidence of aphid started when maximum and minimum temperature was 33.2ºC and 25.9ºC however, relative humidity morning and evening; rainfall and evaporation were 91.3 and 64.3 per cent 9.2 and 4.8 mm, respectively. The aphid population increased to its peak (4.56 aphids) at 33.4ºC maximum, 25.10ºC minimum, relative humidity morning and evening 90.9 and 67.6 per cent and rainfall and evaporation 67.4 mm and 3.6 mm. The data presented in table 4.2 showed the incidence of aphid resulted significant positive correlation (r=+0.596), (r=+0.645) and (r=+0.634) at 5 per cent level with minimum temperature, humidity (evening) and rainfall respectively.

4.1.2 Jassid, *Empoasca kerri* (Pruthi)

The population of jassid appeared (Table 4.1) (Fig. 4.1) in the first week of August (32th SMW) and increased up to the first week of September

(37th SMW) and declined gradually till the crop was matured in last week of October. The population of jassid ranged from 1.71 to 5.63. The peak activity of jassid (5.63) was recorded in the 37th standard week or first week of September.

The incidence of jassid started when maximum and minimum temperature was 32.9ºC and 24.9ºC however, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The jassid population increased to its peak (5.63 jassid) at 32.8ºC maximum, 24.8 ºC minimum, relative humidity morning and evening 94.9 and 78.3 per cent and rainfall and evaporation 37.0 mm and 3.0 mm. The data presented in table 4.2 showed the incidence of jassid resulted significant positive correlation (r=+0.599) and (r=+0.566) at 5 per cent level with humidity (evening) and rainfall respectively.

4.1.3 Thrips, ***Megleurothrips ditalis*** (Karny)

The population of thrips appeared in (Table 4.1) (Fig. 4.1) the first week of August (32th SMW) and increased up to the second week of September (38th SMW) and declined gradually till the crop was matured in last week of October. The population of thrips ranged from 0.77 to 4.74. The peak activity of thrips (4.74) was recorded in the 38th standard week, or second week of September.

The incidence of thrips started when maximum and minimum temperature was 32.9ºC and 24.9ºC however, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The thrips population increased to its peak (4.74 thrips) at 30.2 ºC maximum, 23.0 ºC minimum, relative humidity morning and evening 94.1 and 77.1 per cent and rainfall and evaporation 123.8 mm and 3.1 mm. The data presented in table 4.2 showed the incidence of thrips resulted significant positive (r=+0.610) and negative correlation (r=-0.579) at 5 per cent level with humidity (evening) and evaporation respectively. The incidence of thrips resulted significant positive (r=+0.758) at 1 per cent level with rainfall respectively.

4.1.4 Mites, ***Polyphagotarsonemus latus*** (Banks)

The population of mites appeared in(Table 4.1) (Fig. 4.1) the first week of august (32th SMW) and increased up to the first week of September (38th SMW) and declined gradually till the crop was matured in last week of October. The population of mites ranged from 0.12 to 5.83. The peak activity of mites (5.83) was recorded in the 37th standard week or first week of September.

The incidence of mites started when maximum and minimum temperature was 32.9ºC and 24.9ºC however, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The mites population increased to its peak (5.83 mites) at 32.8 ºC maximum, 24.8 ºC minimum, relative humidity morning and evening 94.9 and 78.3 per cent and rainfall and evaporation 37.0 mm and 3.0 mm. The data presented in table 4.2 showed the incidence of mites resulted non-significant with all-weather parameters, respectively.

4.1.5 White flies, ***Bemisia tabaci (Genn.)***

The population of whiteflies appeared in (Table 4.1) (Fig. 4.1) the first week of August (32th SMW) and increased up to the first week of September (37th SMW) and declined gradually till the crop was matured in last week of October. The population of whiteflies ranged from 1.75 to 5.68. The peak activity of whiteflies (5.68) was recorded in the 37th standard week, or first week of September.

The incidence of whiteflies started when maximum and minimum temperature was 32.9ºC and 24.9ºC however, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The whiteflies population increased to its peak (5.68 whiteflies) at 32.8ºC maximum, 24.8 ºC minimum, relative humidity morning and evening 94.9 and 78.3 per cent and rainfall and evaporation 37.0 mm and 3.0 mm. The data presented in table 4.2 showed the incidence of whiteflies resulted significant positive correlation (r=+0.606) and (r=+0.570) at 5 per cent level with humidity (evening) and rainfall respectively.

Table 4.1: Periodic major pests population on Cluster bean during *kharif* season 2021-22

Major insect pests population on cluster bean during *Kharif* 2021-22								Temperature (^{o}C)		Humidity (%)		Rainfall (mm)	Evaporation (mm)
WAS	SMW	Months and Weeks	Population of major insect pests/leaf										
			Aphid	Jassid	Thrips	Mites	Whitefly	Maximum	Minimum	Morning	Evening		
2	31	July IV	0	0	0	0	0	33.2	25.9	91.3	64.3	9.2	4.8
3	32	August I	0	2.91	0.82	0.12	2.93	32.9	24.9	89.1	66.1	22.4	3.8
4	33	II	1.43	3.62	0.92	1.37	3.76	31.1	24.1	91.1	84	69.8	2.8
5	34	III	2.66	4.23	1.72	2.36	4.28	32.3	24.4	89.9	72.1	117	3.6
6	35	IV	3.35	4.83	2.07	3.77	4.88	33.5	25.2	90.1	67.7	20.8	3.5
7	36	V	4.56	5.24	3.14	4.49	5.29	33.4	25.1	90.9	67.6	67.4	3.6
8	37	September I	3.47	5.63	2.13	5.83	5.68	32.8	24.8	94.9	78.3	37	3
9	38	II	2.78	4.44	4.74	4.64	4.44	30.2	23	94.1	77.1	123.8	3.1
10	39	III	2.14	4.11	3.18	4.31	4.15	29	22.2	95.1	80	89.8	1.1
11	40	IV	1.26	3.74	2.09	3.95	3.7	31.64	21.5	90.8	66	31.4	3.4
12	41	October I	0	3.14	1.07	3.32	3.12	33.2	17.98	80.2	40.4	0	5.2
13	42	II	0	2.73	0.77	2.83	2.71	32.6	17.5	90.5	44.4	0	5
14	43	III	0	1.71	0	1.05	1.75	31.44	14.1	89.4	31.7	0	4
15	44	IV	0	0	0	0.15	0	32	16.4	89	42.3	0	4

WAS= Week after sowing, SMW= Standard Meteorological week

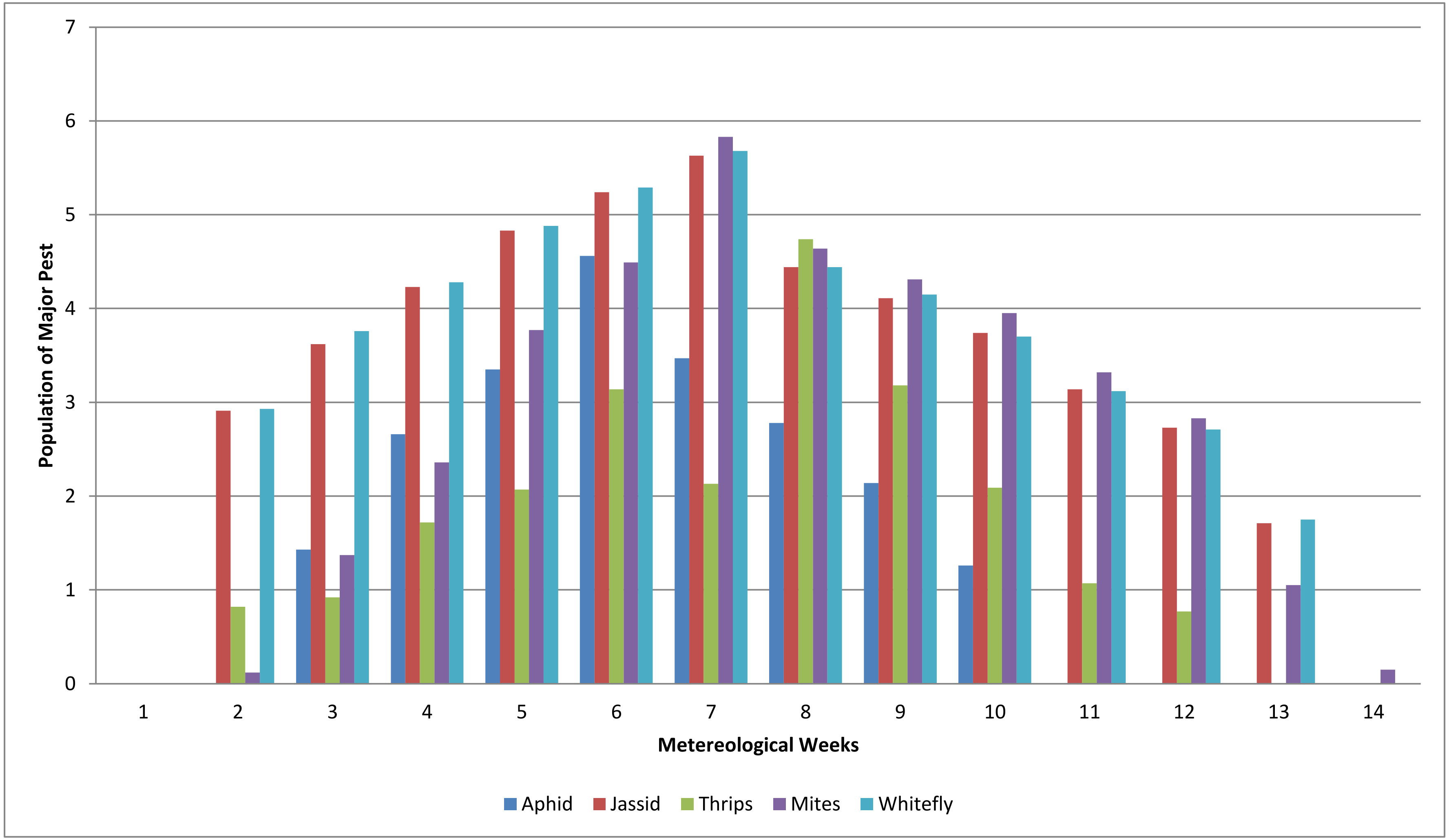

Fig 4.1: Periodic major pests population on Cluster bean during *kharif* season 2021-22

Table 4.2 Correlation between major pest population and weather parameters during *kharif* 2021-22.

Sr. No.	Pests	Temperature (^{0}C)		Relative Humidity %		Rainfall (mm)	Evaporation on (mm)
		Maximum	Minimum	Morning	Evening		
1	Aphid	-0.006^{NS}	0.596*	0.483^{NS}	0.645*	0.634*	-0.525^{NS}
2	Jassid	-0.059^{NS}	0.478^{NS}	0.299^{NS}	0.599*	0.566*	-0.494^{NS}
3	Thrips	-0.401^{NS}	0.413^{NS}	0.470^{NS}	0.610*	0.758**	-0.579*
4	Mites	-0.151^{NS}	0.230^{NS}	0.325^{NS}	0.401^{NS}	0.413^{NS}	-0.407^{NS}
5.	White flies	-0.062^{NS}	0.483^{NS}	0.304^{NS}	0.606*	0.570*	-0.502^{NS}

***** significant at 5%, ****** significant at 1%

4.2 Identification of less susceptible varieties against major insect pests of cluster bean

Eighteen genotypes of cluster bean were screened for relative susceptibility to aphid, jassid, thrips, mites, and whitefly during *Kharif,* 2021-22. The observation on aphid, Jassid, thrips, mites, and whitefly population was recorded at weekly interval just after their appearance till disappearance of the pest. The data of comparative resistance are being presented below.

4.2.1 Aphid, *Aphis craccivora* (Koch)

The data presented in table 4.3 and fig 4.2 revealed that none of the genotypes was found completely free from attack of aphid during the crop season *kharif* 2021-22. The infestation of aphid started 4 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, aphid population ranged from 1.24 to 4.67. During this stage the minimum aphid was observed on CAZG 17-16-1 (1.24 aphid) followed by GL-01 (1.58 aphid) which were found significantly superior over rest of the genotype. The maximum aphid population was observed on HG 2-20 (4.67 aphid) followed by RGC 1066 (3.94 aphid) and DRLGG 13-28 (3.78 aphid), however, these genotype were statically at par. The aphid population was 1.87, 2.06, 2.28, 2.61, 2.63, 2.73, 2.78, 2.84, 3.01, 3.32, 3.49, 3.54 and 3.74, on HG 19-2-6, GD 565, DRLGG 13-39, CAZG 19-7,

CAZG 19-9, GG 1806, GD 580, GG 1903, GD 567, X-25, RGC-1033, CAZG 18-4, and GG 1909, respectively, and all this genotype were statistically at par to each other.

The infestation of aphid increased gradually and reached to its peak in the last week of August (29th August, 2021). At this stage the mean aphid population ranged from 3.61 to 7.54. The minimum aphid population was observed on, genotype, X-25 (3.61 aphid) followed by RGC-1033 (4.44 aphid) however, and both varieties were statistically at par with each other. The maximum aphid population was observed on GD 565 (7.54 aphid) followed by, HG 19-2-6 (7.46 aphid) and was found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* GL-01 (4.57 aphid), CAZG 19-9 (4.76 aphid), GG 1903 (4.82 aphid), CAZG 18-4 (4.89 aphid), GG 1806 (4.93 aphid), CAZG 17-16-1 (5.25 aphid), GD 580 (5.51 aphid), HG 2-20 (5.57 aphid), CAZG 19-7 (5.62 aphid), RGC 1066 (5.72 aphid), DRLGG 13-39 (5.73 aphid), GG 1909 (5.89 aphid), GD 567 (6.95 aphid) and DRLGG 13-28 (7.35 aphid) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of aphid declined and persisted up to third week of September.

The mean aphid population at all the intervals (7 observations) ranged from 2.01 to 3.85. The minimum infestation was observed on GL-01 (2.01 aphid) followed by RGC-1033 (2.12 aphid) and were found statistically at par with each other. The maximum aphid population was observed on DRLGG 13-28 (3.85 aphid) followed by GD 567 (3.57 aphid) and were statistically at par. Rest of genotypes *viz.,* CAZG 19-7 (2.14 aphid), X-25 (2.24 aphid), GG 1903 (2.25 aphid), GG 1806 (2.31 aphid), CAZG 18-4 (2.41 aphid), CAZG 19-9 (2.45 aphid), GD 580 (2.50 aphid), CAZG 17-16-1 (2.59 aphid), DRLGG 13-39 (2.66 aphid), GG 1909 (2.71 aphid), HG 2-20 (2.74 aphid) HG 19-2-6 (3.16 aphid), RGC 1066 (3.28 aphid) and GD 567 (3.39 aphid) were ranked in middle order of infestation and were statistically at par to each other.

Table-4.3: Population of aphid on different genotypes of Cluster bean

Genotypes	Different dates of observation of aphid population (*kharif* 2021)							Average
	08-08-21	15-08-21	22-08-2021	29-08-2021	05-09-21	12-09-21	19-09-21	
HG 2-20	4.67 (12.42)	2.24 (8.57)	1.29 (6.49)	5.57 (13.59)	1.42 (6.81)	2.54 (9.13)	1.45 (6.89)	2.74 (9.49)
RGC-1033	3.49 (10.72)	1.31 (6.54)	1.71 (7.48)	4.44 (12.11)	1.56 (7.14)	1.11 (6.02)	1.22 (6.31)	2.12 (8.34)
RGC 1066	3.94 (11.40)	3.25 (10.34)	3.64 (10.95)	5.72 (13.78)	3.28 (10.39)	1.42 (6.81)	1.71 (7.48)	3.28 (10.39)
GG 1806	2.73 (9.47)	1.82 (7.72)	1.26 (6.42)	4.93 (12.77)	2.37 (8.82)	1.63 (7.30)	1.43 (6.84)	2.31 (8.70)
GG 1909	3.74 (11.10)	1.91 (7.91)	1.45 (6.89)	5.89 (13.99)	2.48 (9.02)	2.21 (8.51)	1.29 (6.49)	2.71 (9.43)
GD 567	3.01 (9.95)	3.69 (11.03)	3.05 (10.01)	6.95 (15.22)	2.45 (8.97)	2.58 (9.20)	2.00 (8.10)	3.39 (10.56)
X-25	3.32 (10.45)	1.96 (8.01)	2.39 (8.86)	3.61 (10.91)	1.27 (6.44)	1.41 (6.79)	1.72 (7.50)	2.24 (8.57)
CAZG 17-16-1	1.24 (6.36)	3.05 (10.01)	2.95 (9.85)	5.25 (13.19)	2.26 (8.61)	2.03 (8.16)	1.35 (6.64)	2.59 (9.22)
CAZG 19-7	2.61 (9.25)	1.04 (5.83)	1.65 (7.35)	5.62 (13.66)	1.23 (6.34)	1.37 (6.69)	1.46 (6.91)	2.14 (8.38)
DRLGG 13-28	3.78 (11.16)	3.68 (11.01)	3.38 (10.55)	7.35 (15.67)	3.75 (11.12)	2.59 (9.22)	2.42 (8.91)	3.85 (11.27)
GG 1903	2.84 (9.66)	1.98 (8.05)	1.47 (6.93)	4.82 (12.63)	0.94 (5.54)	2.37 (8.82)	1.33 (6.59)	2.25 (8.59)
GD 565	2.06 (21.00)	4.65 (12.40)	3.42 (10.61)	7.54 (15.87)	3.28 (10.39)	2.30 (8.69)	1.74 (7.55)	3.57 (10.84)
GD 580	2.78 (9.55)	2.27 (8.63)	1.83 (7.74)	5.51 (13.52)	2.24 (8.57)	1.76 (7.59)	1.11 (6.02)	2.50 (9.06)
HG 19-2-6	1.87 (7.82)	3.38 (10.55)	2.96 (9.86)	7.46 (15.79)	2.54 (9.13)	1.98 (8.05)	1.93 (7.95)	3.16 (10.20)
CAZG 18-4	3.54 (10.80)	2.05 (8.19)	1.54 (7.10)	4.89 (12.72)	1.01 (5.74)	2.44 (8.95)	1.40 (6.77)	2.41 (8.89)
CAZG 19-9	2.63 (9.29)	2.32 (8.72)	2.08 (8.26)	4.76 (12.55)	2.04 (8.18)	1.97 (8.03)	1.35 (6.64)	2.45 (8.97)
DRLGG 13-39	2.28 (8.65)	3.45 (10.66)	1.29 (6.49)	5.73 (13.79)	1.74 (7.55)	2.59 (9.22)	1.54 (7.10)	2.66 (9.35)
GL-01	1.58 (7.19)	2.13 (8.35)	2.14 (8.38)	4.57 (12.29)	1.36 (6.67)	1.07 (5.91)	1.22 (6.31)	2.01 (8.12)
S.Em^{+}	0.11	0.12	0.11	0.10	0.11	0.08	0.05	0.06
CD	0.32	0.35	0.31	0.28	0.32	0.22	0.14	0.18

Figures in the parentheses are transformed ($\sqrt{x+0.5}$) values

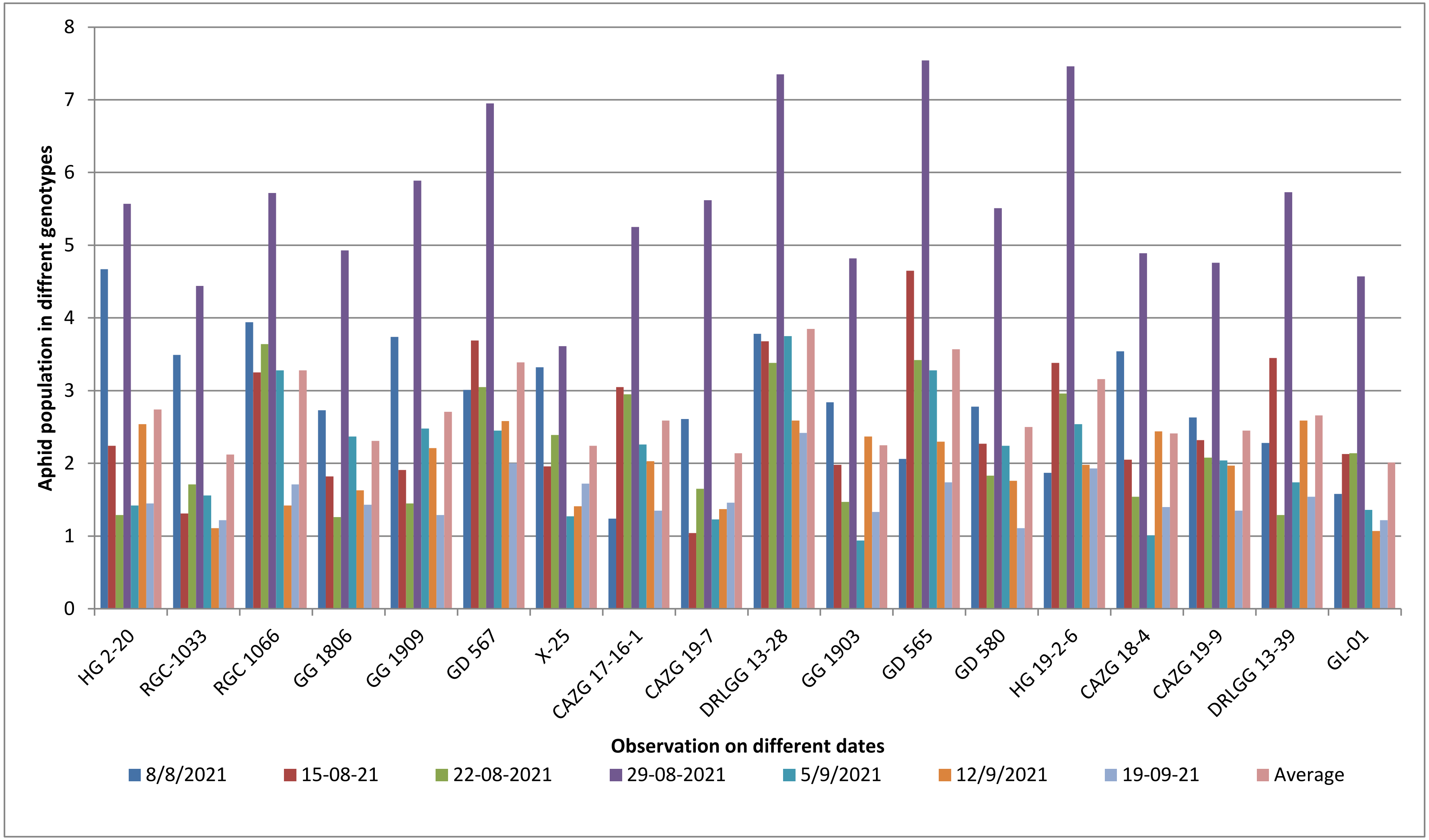

Fig 4.2: Population of aphids on different genotypes of Cluster bean

For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak aphid population recorded on 29th August, 2021 using the formula:-

X ± σ

Where,

X = Mean of peak population

σ = Standard deviation

***X* = 05.59**

σ = 1.11

So the categories were made as 5.59 ± 1.11

Mean aphid population	**Categories**
Below 4.48	less susceptible
4.48 to 6.70	Moderate susceptible
Above 6.70	High susceptible

Taking the above criterion into consideration, the genotypes, X-25, and RGC-1033 were considered as less susceptible and GL-01, CAZG 19-9, GG 1903, CAZG 18-4, GG 1806, CAZG 17-16-1, GD 580, HG 2-20, CAZG 19-7, RGC 1066, DRLGG 13-39, and GG 1909 as moderate susceptible, Whereas, GD 567, DRLGG 13-28, HG 19-2-6 and GD 565 as highly susceptible against aphid.

4.2.2 Jassid, *E.kerri*

The data presented in table 4.4 and fig 4.3 revealed that none of the genotypes was found completely free from attack of jassid during the crop season *kharif* 2021-22. The infestation of jassid started 3 weeks after sowing in all the gynotypes screened. The mean data indicated that on initial stage of crop, jassid population ranged from 1.35 to 3.37. During this stage the minimum jassid was observed on GD 565 (1.35 jassids) followed by CAZG 1-7 (1.44 jassids) which were found significantly superior over rest of the genotype. The maximum jassid population was observed on GL-01 (3.37 jassid) followed by GG 1806 (2.96 jassids) and CAZG 19-9 (2.68 jassids), however, these genotype were statically at par. The jassid population was 1.54, 1.55, 1.58, 2.03, 2.04, 2.05, 2.06, 2.30, 2.33, 2.35, 2.36, 2.38, 2.40, and 2.68 on CAZG 18-4, GD 580, HG 2-20, RGC-1033, DRLGG 13-39, X-25, CAZG 17-16-1, DRLGG 13-28, GD 567, GG 1903, GG 1909, RGC 1066, HG 19-2-6 and CAZG 19-9, respectively, and all this genotype were statistically at par to each other.

Table-4.4: Population of jassid on different genotypes of Cluster bean

Genotypes	Different dates of observation of jassid population (*kharif* 2021)							Average
	08-08-21	15-08-21	22-08-2021	29-08-2021	05-09-21	12-09-21	19-09-21	
HG 2-20	1.58 (7.18)	2.39 (8.84)	1.70 (7.45)	1.04 (5.82)	1.61 (7.25)	1.48 (6.95)	1.33 (6.58)	1.59 (7.20)
RGC-1033	2.03 (8.14)	1.28 (6.46)	2.42 (8.90)	1.31 (6.53)	2.28 (8.63)	1.71 (7.47)	1.08 (5.93)	1.73 (7.51)
RGC 1066	2.38 (8.82)	2.41 (8.88)	1.02 (5.76)	1.62 (7.27)	2.16 (8.40)	1.22 (6.30)	1.44 (6.85)	1.75 (7.56)
GG 1806	2.96 (9.85)	1.67 (7.38)	2.14 (8.36)	2.04 (8.16)	1.53 (7.06)	2.02 (8.12)	1.22 (6.30)	1.94 (7.96)
GG 1909	2.36 (8.79)	2.25 (8.58)	1.41 (6.78)	1.72 (7.49)	1.28 (6.46)	1.64 (7.32)	0.05 (1.27)	1.53 (7.06)
GD 567	2.33 (8.73)	1.52 (7.04)	1.67 (7.38)	2.00 (8.08)	2.04 (8.16)	2.00 (8.08)	1.67 (7.38)	1.89 (7.86)
X-25	2.05 (8.18)	1.82 (7.71)	3.04 (9.98)	2.63 (9.28)	3.54 (10.78)	2.88 (9.71)	1.68 (7.40)	2.52 (9.08)
CAZG 17-16-1	2.06 (8.20)	1.24 (6.36)	1.56 (7.13)	1.42 (6.80)	1.00 (5.71)	1.08 (5.93)	2.00 (8.08)	1.48 (6.95)
CAZG 19-7	1.44 (6.85)	1.65 (7.34)	3.43 (10.61)	2.22 (8.52)	2.34 (8.75)	3.03 (9.97)	1.36 (6.66)	2.21 (8.50)
DRLGG 13-28	2.30 (8.67)	1.49 (6.97)	1.64 (7.32)	1.97 (8.02)	2.01 (8.10)	1.97 (8.02)	1.64 (7.32)	1.86 (7.79)
GG 1903	2.35 (8.77)	1.65 (7.34)	2.43 (8.92)	2.06 (8.20)	1.66 (7.36)	1.33 (6.58)	1.26 (6.41)	1.82 (7.71)
GD 565	1.35 (6.63)	1.31 (6.53)	1.00 (5.71)	1.98 (8.04)	1.36 (6.66)	1.28 (6.46)	1.24 (6.36)	1.36 (6.66)
GD 580	1.55 (7.11)	2.88 (9.71)	2.45 (8.95)	1.56 (7.13)	2.78 (9.54)	2.40 (8.86)	2.20 (8.48)	2.26 (8.60)
HG 19-2-6	2.40 (8.86)	3.55 (10.80)	3.45 (10.64)	2.26 (8.60)	2.99 (9.90)	3.71 (11.04)	2.29 (8.65)	2.95 (9.83)
CAZG 18-4	1.54 (7.09)	1.96 (8.00)	1.48 (6.95)	2.02 (8.12)	1.63 (7.29)	1.46 (6.90)	1.32 (6.56)	1.63 (7.29)
CAZG 19-9	2.68 (9.37)	2.60 (9.23)	3.39 (10.55)	3.62 (10.91)	3.36 (10.50)	2.00 (8.08)	1.32 (6.56)	2.71 (9.42)
DRLGG 13-39	2.04 (8.16)	1.78 (7.62)	2.02 (8.12)	1.30 (6.51)	2.27 (8.62)	1.36 (6.66)	2.39 (8.84)	1.88 (7.84)
GL-01	3.37 (10.52)	2.68 (9.37)	1.33 (6.58)	1.63 (7.29)	3.36 (10.50)	3.06 (10.02)	1.02 (5.76)	2.35 (8.77)
S.Em^{+}	0.08	0.10	0.13	0.09	0.12	0.12	0.13	0.07
CD	0.24	0.28	0.36	0.26	0.34	0.33	0.37	0.20

Figures in the parentheses are transformed ($\sqrt{x+0.5}$) values

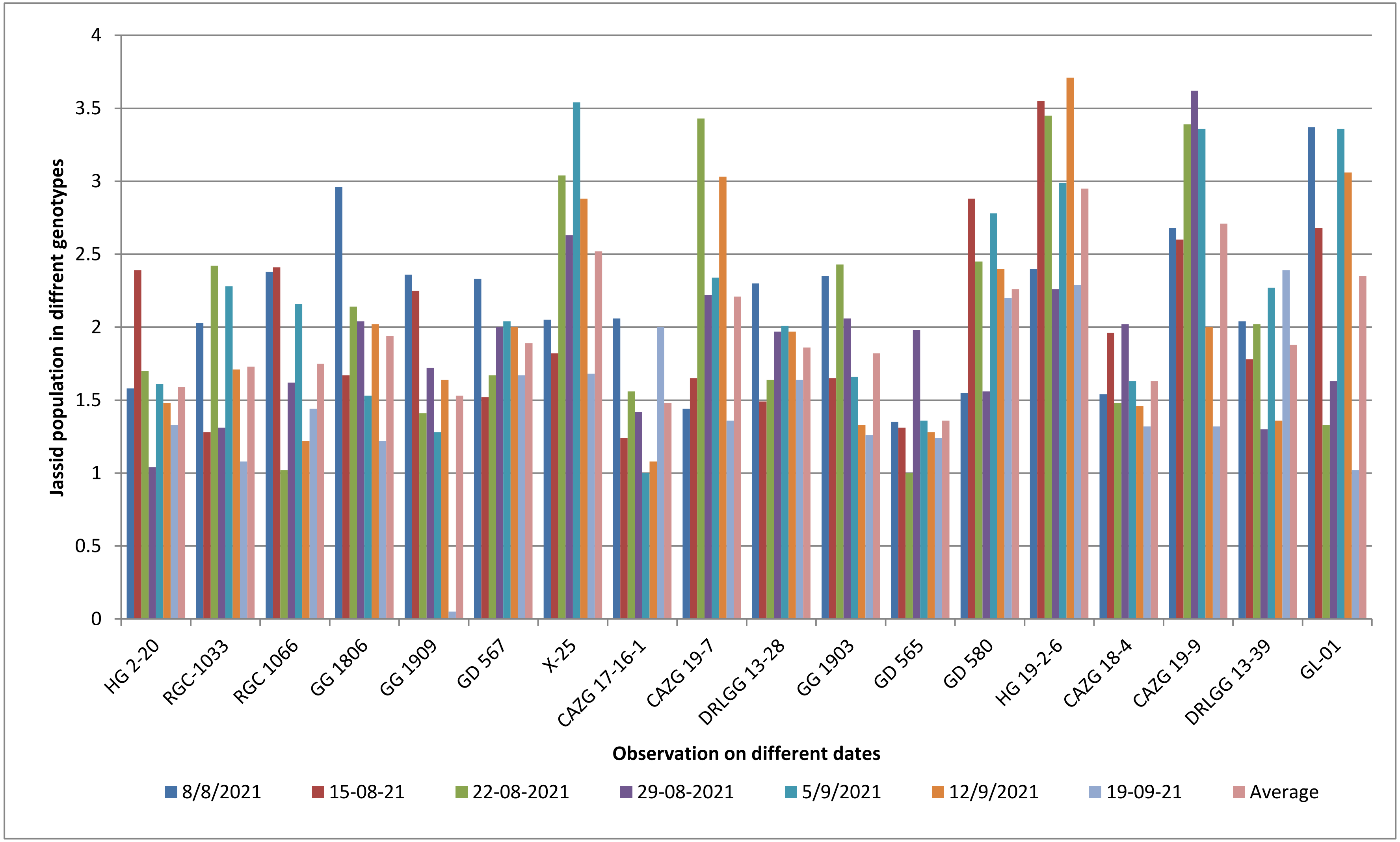

Fig 4.3: Population of jassid on different genotypes of Cluster bean

The infestation of jassid increased gradually and reached to its peak in the first week of September (05th September, 2021). At this stage the mean jassid population ranged from 1.00 to 3.54. The minimum jassid population were observed on, genotype, CAZG 17-16-1 (1.00 jassids) followed by GG 1909 (1.28 jassids) however, both varieties were statistically at par with each other. The maximum jassid population was observed on, X-25 (3.54 jassids) followed by, CAZG 19-9 (3.36 jassids) and was found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* GD 565 (1.36 jassids), GG 1806 (1.53 jassids), HG 2-20 (1.61 jassids), CAZG 18-4 (1.63 jassids), GG 1903 (1.66 jassids), DRLGG 13-28 (2.01 jassids), GD 567 (2.04 jassids), RGC 1066 (2.16 jassids), DRLGG 13-39 (2.27 jassids), RGC-1033 (2.28 jassids), CAZG 19-7 (2.34 jassids), GD 580 (2.78 jassids), HG 19-2-6 (2.99 jassids) and GL-01 (3.36 jassids) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of jassid declined and persisted up to third week of September.

The mean jassid population at all the intervals (7 observations) ranged from 1.36 to 2.95. The minimum infestation was observed on GD 565 (1.36 jassids) followed by CAZG 17-16-1 (1.48 jassids) and were found statistically at par with each other. The maximum jassid population was observed on HG 19-2-6 (2.95 jassids) followed by CAZG 19-9 (2.71 jassids) and were statistically at par. Rest of varieties *viz.,* GG 1909 (1.53 jassids), HG 2-20 (1.59 jassids), CAZG 18-4 (1.63 jassids), RGC 1033 (1.73 jassids), RGC 1066 (1.75 jassids), GG 1903 (1.82 jassids), DRLGG 13-28 (1.86 jassids), DRLGG 13-39 (1.88 jassids), GD 567 (1.89 jassids), GG 1806 (1.94 jassids), CAZG 19-7 (2.21 jassids) GD 580 (2.26 jassids), GL-01 (2.35 jassids) and X-25 (2.52 jassids) were ranked in middle order of infestation and were statistically at par to each other.

For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak jassid population recorded on 05th September, 2021 using the formula:-

$$\mathbf{X \pm \sigma}$$

Where,

X = Mean of peak population

σ = Standard deviation

***X* = 02.18**

σ = 0.76

So the categories were made as 2.18 ± 0.76

Mean jassid population	**Categories**
Below 1.42	less susceptible
1.42 to 2.94	Moderate susceptible
Above 2.94	High susceptible

Taking the above criterion into consideration, the genotypes, CAZG 17-16-1, GG 1909 and GD 565 were considered as less susceptible and GD 580, GG 1806, HG 2-20, CAZG 18-4, GG 1903, DRLGG 13-28, GD 567, RGC 1066, DRLGG 13-39, RGC-1033, CAZG 19-7, GD 580, as moderate susceptible, Whereas, HG 19-2-6, GL-01, CAZG 19-9 and X-25 as highly susceptible against jassid.

4.2.3 Thrips, *Megleurothrips ditalis* (Karny)

The data presented in table 4.5 and fig 4.4 revealed that none of the genotypes was found completely free from attack of thrips during the crop season *kharif* 2021-22. The infestation of thrips started 4 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, thrips population ranged from 1.15 to 3.84. During this stage the minimum thrips was observed on GD 565 (1.15 thrips) followed by GL-01(1.30 thrips) which were found significantly superior over rest of the genotype. The maximum thrips population was observed on X-25 (3.84 thrips) followed by CAZG 17-16-1 (2.82 thrips) and GG 1909 (2.81 thrips), however, these genotype were statically at par. The thrips population was 1.80, 1.87, 2.02, 2.03, 2.13, 2.14, 2.42, 2.53, 2.55, 2.56, 2.57, 2.61 and 2.62, on CAZG 18-4, HG 2-20, DRLGG 13-39, DRLGG 13-28, RGC-1033, CAZG 19-7, CAZG 19-9, GD 580, GG 1806, RGC 1066, GD 567, HG 19-2-6, and GG 1903, respectively, and all genotype were statistically at par to each other.

The infestation of thrips increased gradually and reached to its peak in the first week of September (5th September, 2021). At this stage the mean thrips population ranged from 1.06 to 4.38. The minimum thrips population was observed on, genotype, GD 565 (1.06 thrips) followed by GD 567 (1.37 thrips) however, and both genotypes were statistically at par with each other.

Table 4.5: Population of thrips on different genotypes of Cluster bean

Genotypes	Different dates of observation of thrips population (*kharif* 2021)							Average
	08-08-21	15-08-21	22-08-2021	29-08-2021	05-09-21	12-09-21	19-09-21	
HG 2-20	1.87 (7.84)	3.36 (10.54)	3.90 (11.36)	3.77 (11.17)	3.69 (11.05)	2.13 (8.37)	1.86 (7.82)	2.94 (9.85)
RGC-1033	2.13 (8.37)	1.64 (7.34)	2.44 (8.96)	2.31 (8.72)	2.46 (9.00)	2.02 (8.15)	1.84 (7.78)	2.12 (8.35)
RGC 1066	2.56 (9.18)	2.97 (9.90)	2.93 (9.83)	2.07 (8.25)	4.38 (12.05)	2.47 (9.02)	1.31 (6.56)	2.67 (9.38)
GG 1806	2.55 (9.16)	1.22 (6.32)	2.02 (8.15)	2.65 (9.34)	2.28 (8.66)	2.15 (8.41)	2.46 (9.00)	2.19 (8.49)
GG 1909	2.81 (9.62)	4.34 (11.99)	2.35 (8.79)	1.74 (7.56)	3.55 (10.83)	2.84 (9.68)	1.13 (6.09)	2.68 (9.40)
GD 567	2.57 (9.20)	1.27 (6.45)	1.33 (6.60)	1.63 (7.32)	1.37 (6.70)	1.48 (6.97)	1.20 (6.27)	1.55 (7.13)
X-25	3.84 (11.27)	2.97 (9.90)	3.87 (11.32)	2.13 (8.37)	4.04 (11.57)	2.16 (8.43)	1.92 (7.94)	2.99 (9.93)
CAZG 17-16-1	2.82 (9.64)	2.45 (8.98)	1.38 (6.73)	1.52 (7.06)	2.52 (9.11)	1.28 (6.48)	1.05 (5.87)	1.86 (7.82)
CAZG 19-7	2.14 (8.39)	1.75 (7.58)	2.04 (8.19)	2.96 (9.88)	2.87 (9.73)	2.56 (9.18)	1.64 (7.34)	2.28 (8.66)
DRLGG 13-28	2.03 (8.17)	1.40 (6.78)	2.29 (8.68)	1.32 (6.58)	1.66 (7.38)	1.96 (8.03)	1.24 (6.38)	1.70 (7.47)
GG 1903	2.62 (9.29)	2.03 (8.17)	2.00 (8.11)	2.33 (8.76)	2.68 (9.40)	1.31 (6.55)	1.66 (7.38)	2.09 (8.29)
GD 565	1.15 (6.14)	1.59 (7.23)	2.12 (8.35)	1.22 (6.32)	1.06 (5.89)	1.85 (7.80)	1.72 (7.52)	1.53 (7.09)
GD 580	2.53 (9.13)	3.57 (10.86)	1.55 (7.13)	2.09 (8.29)	3.07 (10.07)	1.83 (7.75)	2.65 (9.34)	2.47 (9.02)
HG 19-2-6	2.61 (9.27)	1.31 (6.56)	1.37 (6.70)	1.67 (7.40)	1.41 (6.80)	1.52 (7.06)	1.24 (6.38)	1.59 (7.23)
CAZG 18-4	1.80 (7.69)	3.04 (10.02)	1.58 (7.20)	2.01 (8.13)	1.74 (7.56)	2.18 (8.47)	1.65 (7.36)	2.00 (8.11)
CAZG 19-9	2.42 (8.93)	2.22 (8.55)	1.02 (5.78)	1.88 (7.86)	2.08 (8.27)	2.05 (8.21)	2.54 (9.15)	2.03 (8.17)
DRLGG 13-39	2.02 (8.15)	2.29 (8.68)	1.96 (8.03)	2.48 (9.04)	2.74 (9.50)	1.95 (8.01)	2.24 (8.59)	2.24 (8.59)
GL-01	1.30 (6.53)	1.44 (6.87)	2.14 (8.39)	1.26 (6.43)	1.86 (7.82)	1.64 (7.34)	1.42 (6.83)	1.58 (7.20)
S.Em^{+}	0.06	0.09	0.08	0.07	0.09	0.05	0.06	0.05
CD	0.18	0.26	0.23	0.19	0.27	0.13	0.16	0.14

Figures in the parentheses are transformed (√x+0.5) values

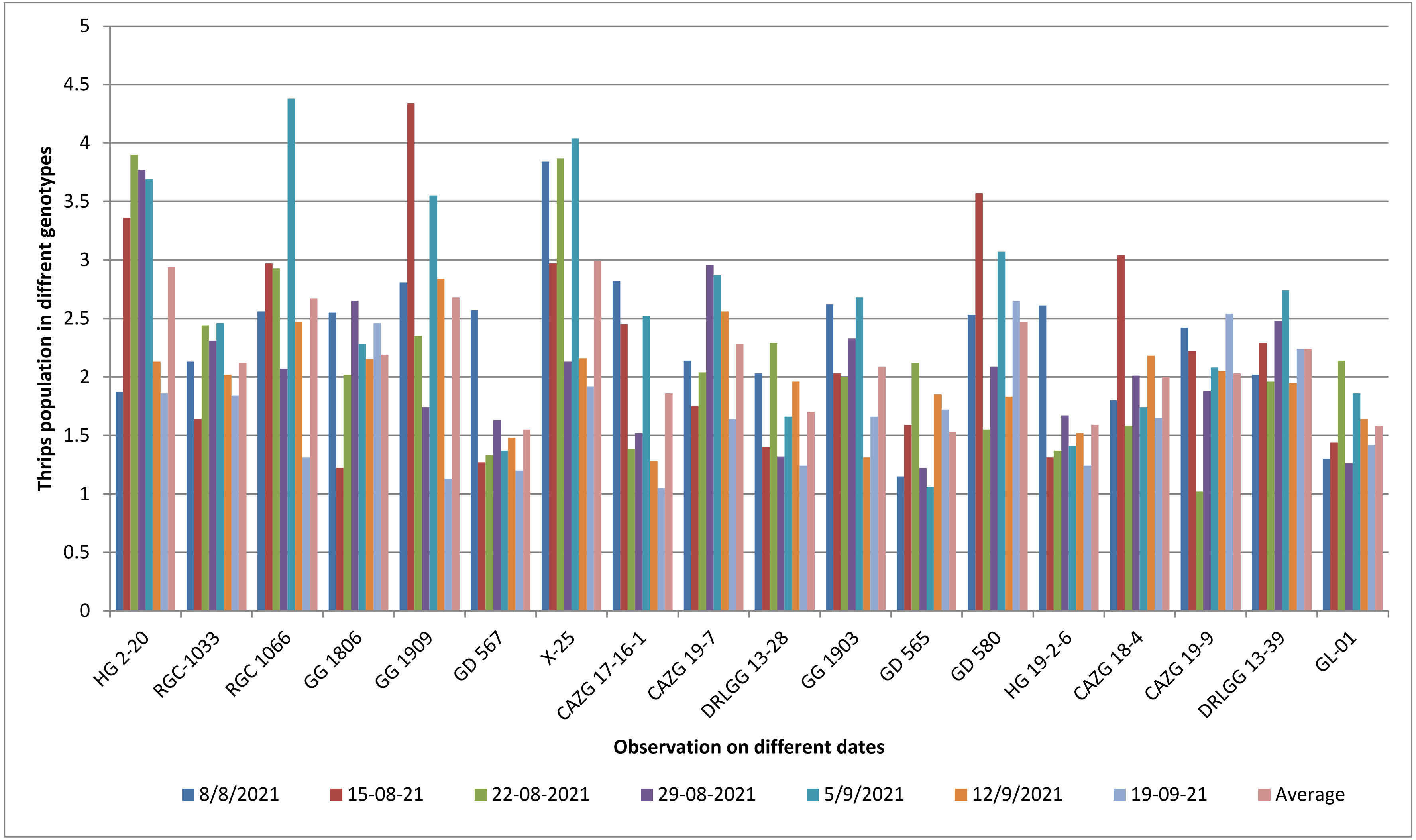

Fig 4.4: Population of thrips on different genotypes of Cluster bean

The maximum thrips population was observed on RGC 1066 (4.38 thrips) followed by, X-25 (4.04 thrips) and was found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* HG 19-2-6 (1.41 thrips), DRLGG 13-28 (1.66 thrips), CAZG 18-4 (1.74 thrips), GL-01 (1.86 thrips), CAZG 19-9 (2.08 thrips), GG 1806 (2.28 thrips), RGC-1033 (2.46 thrips), CAZG 17-16-1 (2.52 thrips), GG 1903 (2.68 thrips), DRLGG 13-39 (2.74 thrips), CAZG 19-7 (2.87 thrips), GD 580 (3.07 thrips), GG 1909 (3.55 thrips) and HG 2-20 (3.69 thrips) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of thrips declined and persisted up to third week of September.

The mean thrips population at all the intervals (7 observations) ranged from 1.53 to 2.99. The minimum infestation was observed on GD 565 (1.53 thrips) followed by GD 567 (1.55 thrips) and were found statistically at par with each other. The maximum thrips population was observed on X-25 (2.99 thrips) followed by HG 2-20 (2.94 thrips) and were statistically at par. Rest of genotypes *viz.,* GL-01 (1.58 thrips), HG 19-2-6 (1.59 thrips), DRLGG 13-28 (1.70 thrips), CAZG 17-16-1(1.86 thrips), CAZG 18-4 (2.00 thrips), CAZG 19-9 (2.03 thrips), GG 1903 (2.09 thrips), RGC-1033 (2.12 aphid), GG 1806 (2.19 thrips), DRLGG 13-39 (2.24 thrips), CAZG 19-7 (2.28 thrips) GD 580 (2.47 thrips), RGC 1066 (2.67 thrips) and GG 1909 (2.68 thrips) were ranked in middle order of infestation and were statistically at par to each other.

For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak thrips population recorded on 05th September, 2021 using the formula:-

$$\mathbf{X \pm \sigma}$$

Where,

X = Mean of peak population

σ = Standard deviation

***X* = 02.53**

σ = 0.95

So the categories were made as 2.53 $\pm$ 0.95

Mean thrips population	**Categories**
Below 1.57	less susceptible
1.57 to 3.48	Moderate susceptible
Above 3.48	High susceptible

Taking the above criterion into consideration, the genotypes, GD 1903, GD 567 and HG 19-2-6 were considered as less susceptible and DRLGG 13-28, CAZG 18-4, GL-01, CAZG 19-9, GG 1806, RGC-1033, CAZG 17-16-1, GG 1903, DRLGG 13-39, CAZG 19-7, GD 580 as moderate susceptible, Where as, GG 1909, HG 2-20, X-25 and RGC 1066 as highly susceptible against thrips.

4.2.4 Mite, *Polyphagotarsonemus latus* (Banks)

The data presented in table 4.6 and fig 4.5 revealed that none of the genotypes was found completely free from attack of mites during the crop season *kharif* 2021-22. The infestation of mites started 4 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, mites population ranged from 3.88 to 8.26. During this stage the minimum mites was observed on GD 565 (3.88 mites) followed by GL-01(4.19 mites) which were found significantly superior over rest of the genotype. The maximum mites population was observed on X-25 (8.26 mites) followed by GG 1806 (8.25 mites) and GG 1909 (7.91 mites), however, these genotypes were statically at par. The mites population was 4.28, 4.35, 4.58, 5.91, 6.58, 6.79, 6.91, and 7.25, on DRLGG 13-28, HG 19-2-6, CAZG 17-16-1, CAZG 19-9, HG 2-20, GG 1903, CAZG 18-4, CAZG 19-7, GD 567, RGC 1066, RGC-1033, GD 580, and DRLGG 13-39, respectively, and all this genotype were statistically at par to each other.

The infestation of mites increased gradually and reached to its peak in the third week of August (22th August, 2021). At this stage the mean mites population ranged from 5.14 to 9.37. The minimum mites population was observed on, genotype, GD 565 (5.14 mites) followed by DRLGG 13-28 (5.15 mites) however, and both genotypes were statistically at par with each other. The maximum mites population was observed on X-25 (9.37 mites) followed by, GG 1806 (9.26 mites) and was found statistically at par with each other and significantly superior to rest of the genotype.

The genotype *viz.,* CAZG 17-16-1 (5.25 mites), GL-01 (5.76 mites), HG 19-2-6 (5.78 mites), CAZG 18-4 (6.75 mites), CAZG 19-7 (7.14 mites), HG 2-20 (7.15 mites), RGC-1033 (7.16 mites), CAZG 19-9 (7.25 mites), GG 1903 (7.45 mites), RGC 1066 (7.49 mites), GD 567 (7.73 mites), DRLGG 13-39 (7.77 mites), GD 580 (8.74 mites) and GG 1909 (9.11 mites) were statistically at par and ranked in middle order of infestation.

Table-4.6: Population of mites on different genotypes of Cluster bean

Genotypes	Different dates of observation of mites population (*kharif* 2021)							Average
	08-08-21	15-08-21	22-08-2021	29-08-2021	05-09-21	12-09-21	19-09-21	
HG 2-20	6.58 (14.76)	7.15 (15.40)	7.15 (15.40)	5.92 (13.30)	5.35 (13.30)	3.74 (11.09)	2.40 (8.86)	5.47 (13.46)
RGC-1033	7.25 (15.51)	6.76 (14.97)	7.16 (15.42)	5.95 (14.49)	6.33 (14.49)	13.38 (21.35)	2.73 (9.46)	7.08 (15.35)
RGC 1066	7.25 (15.51)	6.56 (14.74)	7.49 (15.78)	6.29 (14.49)	6.33 (14.49)	4.05 (11.55)	3.26 (10.35)	5.89 (13.97)
GG 1806	8.25 (16.58)	8.76 (17.10)	9.26 (17.60)	7.95 (15.62)	7.33 (15.62)	4.72 (12.48)	4.06 (11.56)	7.19 (15.47)
GG 1909	7.91 (16.22)	8.10 (16.42)	9.11 (17.45)	6.82 (14.87)	6.66 (14.87)	4.05 (11.55)	3.13 (10.14)	6.54 (14.74)
GD 567	6.91 (15.14)	7.10 (15.35)	7.73 (16.03)	6.95 (14.49)	6.33 (14.49)	3.61 (10.90)	2.53 (9.10)	5.88 (13.96)
X-25	8.26 (16.59)	8.71 (17.05)	9.37 (17.71)	7.39 (15.13)	6.89 (15.13)	4.38 (12.02)	3.44 (10.63)	6.92 (15.17)
CAZG 17-16-1	4.58 (12.27)	4.01 (11.47)	5.25 (13.15)	3.85 (10.45)	3.33 (10.45)	2.48 (9.01)	2.05 (8.18)	3.65 (10.95)
CAZG 19-7	6.79 (15.00)	7.19 (15.45)	7.14 (15.39)	6.62 (14.88)	6.67 (14.88)	4.38 (12.01)	3.42 (10.59)	6.03 (14.13)
DRLGG 13-28	4.28 (11.86)	4.43 (12.07)	5.15 (13.03)	4.59 (10.96)	3.66 (10.96)	2.77 (9.52)	2.42 (8.90)	3.90 (11.32)
GG 1903	6.58 (14.76)	6.76 (14.97)	7.45 (15.73)	6.29 (15.19)	6.94 (15.19)	3.73 (11.07)	2.43 (8.91)	5.74 (13.78)
GD 565	3.88 (11.28)	4.43 (12.07)	5.14 (13.01)	3.62 (10.93)	3.64 (10.93)	1.75 (7.56)	1.83 (7.73)	3.47 (10.67)
GD 580	7.25 (15.51)	7.76 (16.07)	8.74 (17.08)	6.95 (14.87)	6.66 (14.87)	3.72 (11.05)	3.16 (10.18)	6.32 (14.48)
HG 19-2-6	4.35 (11.95)	4.65 (12.37)	5.78 (13.82)	3.55 (11.11)	3.76 (11.11)	2.28 (8.63)	2.16 (8.40)	3.79 (11.16)
CAZG 18-4	6.58 (14.76)	6.43 (14.59)	6.75 (14.96)	6.62 (14.08)	5.99 (14.08)	4.05 (11.54)	3.06 (10.01)	5.64 (13.66)
CAZG 19-9	5.91 (13.97)	6.17 (14.28)	7.25 (15.51)	6.29 (14.73)	6.54 (14.73)	4.33 (11.94)	3.55 (10.80)	5.72 (13.76)
DRLGG 13-39	7.25 (15.51)	7.11 (15.36)	7.77 (16.08)	6.81 (14.56)	6.39 (14.56)	3.68 (10.99)	2.50 (9.04)	5.93 (14.01)
GL-01	4.19 (11.73)	4.70 (12.43)	5.76 (13.79)	3.89 (10.87)	3.60 (10.87)	2.32 (8.71)	2.07 (8.22)	3.79 (11.16)
S.Em^{+}	0.16	0.16	0.14	0.15	0.15	0.22	0.08	0.11
CD	0.46	0.46	0.41	0.42	43	0.64	0.23	0.33

Figures in the parentheses are transformed (√x+0.5) values

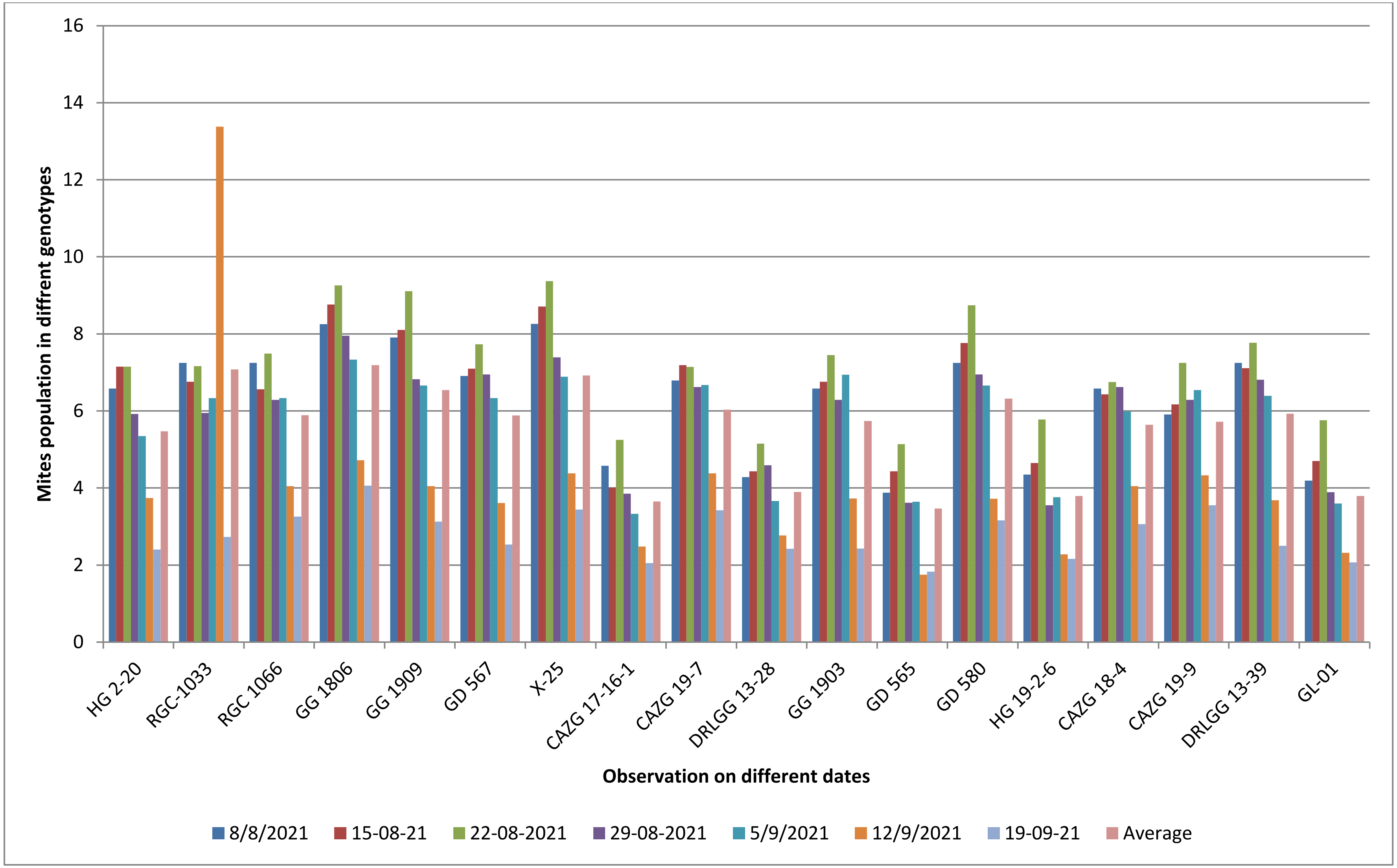

Fig 4.5: Population of mites on different genotypes of Cluster bean

After reach peak, the population of mites declined and persisted up to third week of September. The mean mites population at all the intervals (7 observations) ranged from 3.47 to 7.19. The minimum infestation was observed on GD 565 (3.47 mites) followed by CAZG 17-16-1 (3.65 mites) and were found statistically at par with each other. The maximum mites population was observed on GG 1806 (7.19 mites) followed by RGC-1033 (7.08 mites) and were statistically at par. Rest of genotypes *viz.,* HG 19-2-6 (3.79 mites), GL-01 (3.79 mites), DRLGG 13-28 (3.90 mites), HG 2-20 (5.47 mites), CAZG 18- (5.64 mites), CAZG 19-9 (5.72 mites), GG 1903 (5.74 mites), GD 567 (5.88 aphid), RGC 1066 (5.89 mites), DRLGG 13-39 (5.93 mites), CAZG 19-7 (6.03 mites) GD 580 (6.32 mites), GG 1909 (6.54 mites) and X-25 (6.92 mites) were ranked in middle order of infestation and were statistically at par to each other.

For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak mites population recorded on 22th August, 2021 using the formula:-

X $\underline{+}$ σ

Where,

X = Mean of peak population

σ = Standard deviation

***X* = 07.19**

σ = 1.38

So the categories were made as 7.19 $\underline{+}$ 1.38

Mean mites population	**Categories**
Below 5.81	less susceptible
5.81 to 8.57	Moderate susceptible
Above 8.57	High susceptible

Taking the above criterion into consideration, the genotypes, GD 565, DRLGG 13-28, CAZG 17-16-1, GL-01 and HG 19-2-6 were considered as less susceptible and CAZG 18-4, CAZG 19-7, HG 2-20, RGC-1033, CAZG 19-9, GG 1903, RGC

1066, GD 567, DRLGG 13-39, and GG 1909 as moderate susceptible, Whereas, GD 580, GG 1909, GG 1806 and X-25 as highly susceptible against mites.

4.2.5 White flies, *Bemisia tabaci*

The data presented in table 4.7 and fig 4.6 revealed that none of the genotypes was found completely free from attack of white flies during the crop season *kharif* 2021-22. The infestation of white flies started 3 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, white flies population ranged from 4.42 to 8.68. During this stage the minimum white flies was observed on GD 565 (4.42 white flies) followed by GL-01 (4.52 white flies) which were found significantly superior over rest of the genotype. The maximum white flies population was observed on DRLGG 13-28 (8.68 white flies) followed by CAZG 17-16-1 (8.65 white flies) and RGC 1066 (8.38 white flies), however, these genotypes were statically at par. The white flies population was 4.56, 4.61, 5.00, 6.48, 7.00, 7.07, 7.13, 7.34, 7.35, 7.58, 7.63, 7.68 and 7.72 on GD 567, HG 19-2-6, GG 1806, X-25, CAZG 19-7, GG 1903, CAZG 18-4, RGC-1033, GD 580, DRLGG 13-39, HG 2-20, GG 1909 and CAZG 19-9, respectively, and all this genotype were statistically at par to each other.

The infestation of white flies increased gradually and reached to its peak in the third week of August (22th August, 2021). At this stage the mean white flies population ranged from 5.65 to 9. 69. The minimum white flies population was observed on genotype, GG 1806 (5.65 white flies) followed by GD 565 and GD 567 (5.66 white flies) however, and both genotypes were statistically at par with each other. The maximum white flies population was observed on DRLGG 13-28 (9.96 white flies) followed by CAZG 17-16-1 (9.69 white flies) and were found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* GL-01 (6.23 white flies), HG 19-2-6 (6.37 white flies), CAZG 18-4 (7.36 white flies), CAZG 19-9 (7.62 white flies), X-25, GD 580 (7.63 white flies), CAZG 19-7 (7.67 white flies), GG 1903 (7.93 white flies), DRLGG 13-39 (8.05 white flies), RGC-1033 (8.29 white flies), GG 1909 (8.32 white flies), HG 2-20 (9.34 white flies) and RGC 1066 (9.63 white flies) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of white flies declined and persisted up to third week of September.

Table-4.7: Population of white flies on different genotypes of Cluster bean

Genotypes	Different dates of observation white flies population (*kharif* 2021)							Average
	08-08-21	**15-08-21**	**22-08-2021**	**29-08-2021**	**05-09-21**	**12-09-21**	**19-09-21**	
HG 2-20	7.63 (15.95)	8.34 (16.70)	9.34 (17.71)	7.22 (15.51)	7.00 (15.26)	2.78 (9.55)	2.35 (8.77)	6.38 (14.56)
RGC-1033	7.34 (15.64)	7.65 (15.97)	8.29 (16.65)	7.28 (15.57)	6.67 (14.89)	2.63 (9.28)	1.72 (7.50)	5.94 (14.03)
RGC 1066	8.38 (16.74)	8.68 (17.05)	9.63 (17.99)	7.15 (15.43)	7.14 (15.42)	3.05 (10.00)	2.38 (8.83)	6.61 (14.82)
GG 1806	5.00 (12.85)	4.69 (12.44)	5.65 (13.68)	4.34 (11.96)	3.67 (10.99)	1.33 (6.59)	1.36 (6.66)	3.72 (11.06)
GG 1909	7.68 (16.01)	7.58 (15.90)	8.32 (16.68)	7.37 (15.67)	6.67 (14.89)	2.67 (9.35)	1.64 (7.32)	5.99 (14.09)
GD 567	4.56 (12.27)	5.02 (12.88)	5.66 (13.69)	5.00 (12.85)	3.98 (11.45)	1.67 (7.39)	1.69 (7.43)	3.94 (11.39)
X-25	6.48 (14.67)	6.85 (15.09)	7.63 (15.95)	6.58 (14.79)	6.95 (15.21)	3.33 (10.46)	2.57 (9.18)	5.77 (13.83)
CAZG 17-16-1	8.65 (17.01)	9.33 (17.68)	9.69 (18.03)	8.43 (16.78)	7.67 (15.99)	3.77 (11.13)	3.35 (10.48)	7.27 (15.55)
CAZG 19-7	7.00 (15.25)	7.69 (16.01)	7.67 (15.99)	6.38 (14.55)	5.67 (13.69)	2.65 (9.31)	1.65 (7.34)	5.53 (13.52)
DRLGG 13-28	8.68 (17.04)	9.30 (17.66)	9.96 (18.29)	7.72 (16.04)	7.33 (15.62)	3.28 (10.37)	2.66 (9.33)	6.99 (15.24)
GG 1903	7.07 (15.33)	7.31 (15.60)	7.93 (16.26)	6.85 (15.08)	7.31 (15.60)	2.58 (9.19)	1.69 (7.42)	5.81 (13.87)
GD 565	4.42 (12.06)	5.00 (12.84)	5.66 (13.68)	3.96 (11.41)	4.02 (11.50)	0.67 (4.67)	0.98 (5.65)	3.53 (10.76)
GD 580	7.35 (15.64)	7.64 (15.95)	7.63 (15.94)	6.98 (15.23)	7.08 (15.34)	3.34 (10.47)	2.75 (9.49)	6.11 (14.23)
HG 19-2-6	4.61 (12.30)	5.43 (13.37)	6.37 (14.51)	4.29 (11.86)	4.10 (11.59)	1.32 (6.55)	1.25 (6.37)	3.91 (11.32)
CAZG 18-4	7.13 (15.37)	7.04 (15.27)	7.36 (15.62)	6.92 (15.14)	6.33 (14.46)	3.15 (10.14)	2.18 (8.42)	5.73 (13.74)
CAZG 19-9	7.72 (16.01)	7.53 (15.81)	7.62 (15.90)	6.30 (14.43)	6.67 (14.85)	2.33 (8.71)	2.15 (8.37)	5.76 (13.78)
DRLGG 13-39	7.58 (15.89)	7.40 (15.69)	8.05 (16.39)	6.70 (14.91)	6.67 (14.88)	2.94 (9.81)	2.45 (8.95)	5.97 (14.06)
GL-01	4.52 (12.20)	5.37 (13.32)	6.23 (14.37)	4.28 (11.87)	3.94 (11.38)	1.27 (6.43)	1.27 (6.43)	3.84 (11.23)
S.Em^{+}	0.17	0.16	0.14	0.15	0.16	0.15	0.11	0.14
CD	0.48	0.45	0.41	0.43	0.47	0.42	0.32	0.40

Figures in the parentheses are transformed ($\sqrt{x+0.5}$) values

The mean white flies population at all the intervals (7 observations) ranged from 3.53 to 7.27. The minimum infestation was observed on GD 565 (3.53 white flies) followed by CG-1806 (3.72 white flies) and were found statistically at par with each other. The maximum white flies population was observed on CAZG 17-16-1

(7.27 white flies) followed by DRLGG 13-28 (6.99 white flies) and were statistically at par. Rest of genotypes *viz.,* GL-01 (3.84 white flies), HG 19-2-6 (3.91 white flies), GD 567 (3.94 white flies), CAZG 19-7 (5.53 white flies), CAZG 18-4 (5.73 white flies), CAZG 19-9(5.76 white flies), X-25 (5.77 white flies), GG 1903 (5.81 white flies), RGC-1033 (5.94 white flies), DRLGG 13-39 (5.97 white flies), GG 1909 (5.99 white flies), GD 580 (6.11 white flies), CAZG 18-4 (2.18 white flies), HG 2-20 (6.38 white flies) and RGC 1066 (6.61 white flies), were ranked in middle order of infestation and were statistically at par to each other.

For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak white flies population recorded on 22th August, 2021 using the formula:-

X ± σ

Where,

X = Mean of peak population

σ = Standard deviation

***X* = 07.71**

σ = 1.39

So the categories were made as 7.71 ± 1.39

Mean white flies population	Categories
Below 6.31	less susceptible
6.31 to 9.10	Moderate susceptible
Above 9.10	High susceptible

Taking the above criterion into consideration, the genotypes, GG 1806, GD 565, GD 567 and GL-01, were considered as less susceptible and HG 19-2-6, CAZG 18-4, CAZG 19-9, X-25, GD 580, CAZG 19-7, GG 1903, DRLGG 13-39, RGC-1033, GG 1909, as moderate susceptible, Where as, HG 2-20, RGC 1066, DRLGG 13-28 and CAZG 17-16-1 as highly susceptible against white flies.

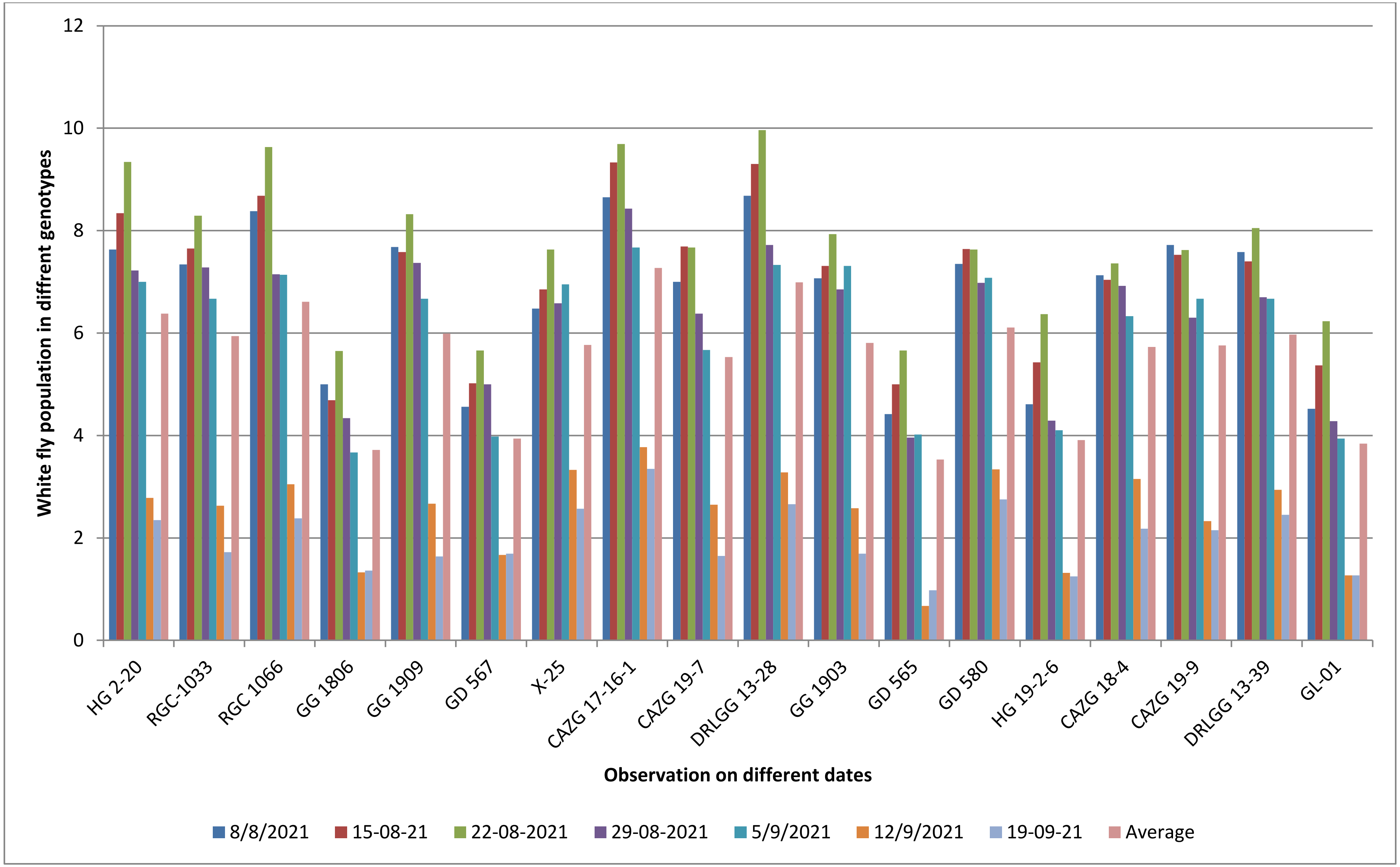

Fig 4.6: Population of white fly on different genotypes of Cluster bean

Chapter-V

DISCUSSION

The investigations carried out during *kharif*, 2021-22 and results obtained are present in the chapter 4 are discussed under the following headings:

1. To study on the population dynamics of major insect pest of cluster bean.
2. To identify less susceptible varieties against major insect pests of cluster bean.

The management of major insect pests of cluster bean was carried out by application of safe and economic insecticide/botanicals to reduce its population and resurgence of pest. It's only possible with the long persistence of pesticides.In Gird region of Madhya Pradesh cluster bean is one of the major crop which is sown as rainfed as well as irrigated. The increasing infestation of aphid, jassid, thirps, mites, and whitefly causes menaces to this crop. A part from pest management by insecticide/botanicals to reduce its infestation, other methods were also tested i.e. studies on population dynamics as well as less susceptible genotype of cluster bean varieties to know any resistance against aphid, jassid, thirps, mites and whitefly.

5.1 To study on the population dynamics of major insect pest of cluster bean.

5.1.1 Aphid, *Aphis craccivora* (Koch) (Table: 4.1, Fig.4.1)

The population of aphid appeared in the second week of August (33th SMW) and increased up to the last week of August (36th SMW) and declined gradually till the crop was matured in last week of October. The population of aphid ranged from 1.26 to 4.56. The peak activity of aphid (4.56) was recorded in the 36th standard week or last week of August. The present findings were with that of Saleh *et al*. (1972), Faleiro *et al.* (1990) and Dalwadi *et al*. (2007).

The incidence of aphid started when maximum and minimum temperature was 33.2ºC and 25.9ºC however, relative humidity morning and evening; rainfall and evaporation were 91.3 and 64.3 per cent 9.2 and 4.8 mm, respectively. The aphid population increased to its peak (4.56aphids) at 33.4ºC maximum, 25.10ºC minimum, relative humidity morning and evening 90.9 and 67.6 per cent and rainfall and evaporation 67.6 mm and 3.6 mm. The data presented in table 4.2 showed the incidence of aphid resulted significant positive correlation (r=+0.596), (r=+0.645) and (r=+0.634) at 5 per cent level with minimum temperature, humidity (evening) and rainfall respectively.

5.1.2 Jassid, *Empoasca kerri* (Pruthi) (Table: 4.1, Fig.4.1)

The population of jassid appeared in the first week of August (32th SMW) and increased up to the first week of September (37th SMW) and declined gradually till the crop was matured in last week of October. The population of jassid ranged from 1.71 to 5.63. The peak activity of jassid (5.63) was recorded in the 37th standard week or firstweek of September. The incidence of jassid started when maximum and minimum temperature was 32.9ºC and 24.9ºC however, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The jassid population increased to its peak (5.63 jassid) at 32.8ºC maximum, 24.8 ºC minimum, relative humidity morning and evening 94.9 and 78.3 per cent and rainfall and evaporation 37.0 mm and 3.0 mm. The data presented in table 4.2 showed the incidence of jassid resulted significant positive correlation (r=+0.599) and (r=+0.566) at 5 per cent level with humidity (evening) and rainfall respectively. The present findings were with that of Chaudhary*, et al.* (2007a), Yadav and Kumawat (2008), Yadav *et al*. (2011) and Yadav *et al*. (2016).

5.1.3 Thrips, *Megleurothrips ditalis* (Karny) (Table: 4.1, Fig.4.1)

The population of thrips appeared in the first week of August (32th SMW) and increased up to the second week of September (38th SMW) and declined gradually till the crop was matured in last week of October. The population of thrips ranged from 0.77 to 4.74. The peak activity of thrips (4.74) was recorded in the 38th standard week, or second week of September. The incidence of thrips started when maximum and minimum temperature was 32.9ºC and 24.9ºC however, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The thrips population increased to its peak (4.74 thrips) at 30.2 ºC maximum, 23.0 ºC minimum, relative humidity morning and evening 94.1 and 77.1 per cent and rainfall and evaporation 123.8 mm and 3.1 mm. The data presented in table 4.2 showed the incidence of thrips resulted significant positive (r=+0.610) and negative correlation (r=-0.579) at 5 per cent level with humidity (evening) and evaporation respectively. The incidence of thrips resulted significant positive(r=+0.758) at 1 per cent level with rainfall respectively. The incidence of thrips resulted significant positive (r=+0.758) at 1 per cent level with rainfall respectively. The present findings were with that of Pithava (1996), Panwar and Patel (2011).

5.1.4 Mites, ***Polyphagotarsonemus latus*** (Banks) (Table: 4.1, Fig.4.1)

The population of mites appeared in the first week of august (32^{th} SMW) and increased up to the first week of September (38^{th} SMW) and declined gradually till the crop was matured in last week of October. The population of mites ranged from 0.12 to 5.83. The peak activity of mites (5.83) was recorded in the 37^{th} standard week or first week of September. The incidence of mites started when maximum and minimum temperature was 32.9ºC and 24.9ºC ho+wever, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The mites population increased to its peak (5.83mites) at 32.8 ºC maximum, 24.8 ºC minimum, relative humidity morning and evening 94.9 and 78.3 per cent and rainfall and evaporation 37.0 mm and 3.0 mm. The data presented in table 4.2 showed the incidence of mites resulted non-significant with all weather parameters, respectively. The present findings were with that of Ahuja (2000) Jovicich *et al.* (2004).

5.1.5 White flies, ***Bamisia tabaci*** (Table: 4.1, Fig.4.1)

The population of white flies appeared in the first week of August (32th SMW) and increased up to the first week of September (37^{th} SMW) and declined gradually till the crop was matured in last week of October. The population of white flies ranged from 1.75 to 5.68. The peak activity of white flies(5.68) was recorded in the 37^{th} standard week, or first week of September. The incidence of white flies started when maximum and minimum temperature was 32.9ºC and 24.9ºC however, relative humidity morning and evening; rainfall and evaporation were 89.1 and 66.1 per cent 22.4 and 3.8 mm, respectively. The white flies population increased to its peak (5.68whiteflies) at 32.8ºC maximum, 24.8 ºC minimum, relative humidity morning and evening 94.9 and 78.3 per cent and rainfall and evaporation 37.0 mm and 3.0

mm. The data presented in table 4.2 showed the incidence of white flies resulted significant positive correlation (r=+0.606) and (r=+0.570) at 5 per cent level with humidity (evening) and rainfall respectively. The present findings were with that of Singh *et al.,* (1996), Singh (2002), Verma and Henry (2003) and Patel *et al.* (2009) and Yadav *et al*. (2016).

5.2 Identification of less susceptible varieties against major insect pests of cluster bean

Eighteen genotypes of cluster bean were screened for relative susceptibility to aphid, jassid, thrips, mites, and whitefly during *Kharif,* 2021-22. The observation on aphid, Jassid, thrips, mites, and whitefly population was recorded at weekly interval just after their appearance till disappearance of the pest. The data of comparative resistance are being presented below.

5.2.1 Aphid, *Aphis craccivora* (Koch) (Table: 4.3, Fig.4.2)

The infestation of aphid started 4 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, aphid population ranged from 1.24 to 4.67. During this stage the minimum aphid was observed on CAZG 17-16-1 (1.24 aphid) followed by GL-01 (1.58 aphid) which were found significantly superior over rest of the genotype. The maximum aphid population was observed on HG 2-20 (4.67aphid) followed by RGC 1066 (3.94 aphid) and DRLGG 13-28 (3.78 aphid), however, these genotype were statically at par. The aphid population was 1.87, 2.06, 2.28, 2.61, 2.63, 2.73, 2.78, 2.84, 3.01, 3.32, 3.49, 3.54 and 3.74, on HG 19-2-6, GD 565, DRLGG 13-39, CAZG 19-7, CAZG 19-9, GG 1806, GD 580, GG 1903, GD 567, X-25, RGC-1033, CAZG 18-4, and GG 1909, respectively, and all this genotype were statistically at par to each other. The infestation of aphid increased gradually and reached to its peak in the last week of August (29thAugust, 2021). At this stage the mean aphid population ranged from 3.61 to 7.54. The minimum aphid population was observed on, genotype, X-25 (3.61 aphid) followed by RGC-1033 (4.44 aphid) however, and both varieties were statistically at par with each other. The maximum aphid population was observed on GD 565 (7.54 aphid) followed by, HG 19-2-6 (7.46 aphid) and was found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* GL-01 (4.57 aphid), CAZG 19-9 (4.76 aphid), GG 1903 (4.82 aphid), CAZG 18-4 (4.89 aphid), GG 1806 (4.93 aphid), CAZG 17-16-1 (5.25 aphid), GD 580 (5.51 aphid), HG 2-20 (5.57 aphid), CAZG 19-7 (5.62 aphid), RGC 1066 (5.72 aphid), DRLGG 13-39 (5.73 aphid), GG 1909 (5.89 aphid), GD 567 (6.95 aphid) and DRLGG 13-28 (7.35 aphid) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of aphid declined and persisted up to third week of September. For the sake of convenience in expression, the cluster bean genotypes were categorized on the basis of peak aphid population recorded on 29th August, 2021. Taking the above criterion into consideration, the genotypes, X-25, and RGC-1033 were considered as less susceptible and GL-01, CAZG 19-9, GG 1903, CAZG 18-4, GG 1806, CAZG 17-16-1, GD 580, HG 2-20, CAZG 19-7, RGC 1066, DRLGG 13-39, and GG 1909as moderate susceptible, Whereas, GD 567, DRLGG 13-28, HG 19-2-6 and GD 565 as highly susceptible against aphid. The similar findings were with that of Saleh *et al*. (1972), Faleiro *et al.* (1990) and Dalwadi *et al*. (2007).

5.2.2 Jassid, *E. kerri* (Table: 4.4, Fig.4.3)

The infestation of jassid started 4 weeks after sowing in all the gynotypes screened. The mean data indicated that on initial stage of crop, jassid population ranged from 1.35 to 3.37. During this stage the minimum jassid was observed on GD 565 (1.35jassids) followed by CAZG 1-7(1.44jassids) which were found significantly superior over rest of the genotype. The maximum jassid population was observed on GL-01 (3.37jassid) followed by GG 1806(2.96jassids) and CAZG 19-9(2.68jassids), however, these genotype were statically at par. The jassid population was 1.54, 1.55, 1.58, 2.03, 2.04, 2.05, 2.06, 2.30, 2.33, 2.35, 2.36, 2.38, 2.40, and 2.68 on CAZG 18-4, GD 580, HG 2-20, RGC-1033, DRLGG 13-39, X-25, CAZG 17-16-1, DRLGG 13-28, GD 567, GG 1903, GG 1909, RGC 1066, HG 19-2-6and CAZG 19-9, respectively, and all this genotype were statistically at par to each other. The infestation of jassid increased gradually and reached to its peak in the first week of September (05th September, 2021). At this stage the mean jassid population ranged from 1.00 to 3.54. The minimum jassid population were observed on, genotype, CAZG 17-16-1 (1.00 jassids) followed by GG 1909 (1.28 jassids) however, both varieties were statistically at par with each other. The maximum jassid population was observed on, X-25 (3.54 jassids)followed by, CAZG 19-9 (3.36 jassids) and was found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* GD 565 (1.36 jassids), GG 1806 (1.53 jassids), HG 2-20 (1.61 jassids), CAZG 18-4 (1.63 jassids), GG 1903 (1.66 jassids), DRLGG 13-28 (2.01 jassids), GD 567 (2.04 jassids), RGC 1066 (2.16 jassids), DRLGG 13-39 (2.27 jassids), RGC-1033 (2.28 jassids), CAZG 19-7 (2.34 jassids), GD 580 (2.78 jassids), HG 19-2-6 (2.99 jassids) and GL-01 (3.36 jassids) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of jassid declined and persisted up to third week of September. For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak jassid population recorded on 05th September, 2021. Taking the above criterion into consideration, the genotypes, CAZG 17-16-1, GG 1909 andGD 565were considered as less susceptible and GD 580, GG 1806, HG 2-20, CAZG 18-4, GG 1903, DRLGG 13-28, GD 567, RGC 1066, DRLGG 13-39, RGC-1033, CAZG 19-7, GD 580, as moderate susceptible, Whereas, HG 19-2-6, GL-01, CAZG 19-9 and X-25as highly susceptible against jassid. The present findings were with that of Chaudhary*, et al.* (2007a), Yadav and Kumawat (2008), Yadav *et al*. (2011).

5.2.3 Thrips, *Megleurothrips ditalis* (Karny) (Table: 4.5, Fig.4.4)

The infestation of thrips started 4 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, thrips population ranged from 1.15 to 3.84. During this stage the minimum thrips was observed on GD 565 (1.15thrips) followed by GL-01(1.30thrips) which were found significantly superior over rest of the genotype. The maximum thrips population was observed on X-25 (3.84thrips) followed by CAZG 17-16-1(2.82thrips) and GG 1909 (2.81thrips), however, these genotype were statically at par. The thrips population was 1.80, 1.87, 2.02, 2.03, 2.13, 2.14, 2.42, 2.53, 2.55, 2.56, 2.57, 2.61 and 2.62, on CAZG 18-4, HG 2-20, DRLGG 13-39, DRLGG 13-28, RGC-1033, CAZG 19-7, CAZG 19-9, GD 580, GG 1806, RGC 1066, GD 567, HG 19-2-6, and GG 1903, respectively, and all this genotype were statistically at par to each other. The infestation of thrips increased gradually and reached to its peak in the first week of September(5thSeptember, 2021). At this stage the mean thrips population ranged from 1.06 to 4.38. The minimum thrips population was observed on, genotype, GD

565 (1.06thrips) followed by GD 567 (1.37thrips) however, and both genotypes were statistically at par with each other. The maximum thrips population was observed on RGC 1066 (4.38thrips) followed by, X-25 (4.04thrips) and was found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* HG 19-2-6 (1.41thrips), DRLGG 13-28 (1.66thrips), CAZG 18-4 (1.74thrips), GL-01 (1.86thrips), CAZG 19-9 (2.08thrips), GG 1806 (2.28thrips), RGC-1033 (2.46thrips), CAZG 17-16-1(2.52thrips), GG 1903 (2.68thrips), DRLGG 13-39 (2.74thrips), CAZG 19-7 (2.87thrips), GD 580 (3.07thrips), GG 1909 (3.55thrips) and HG 2-20 (3.69thrips) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of thrips declined and persisted up to third week of September. For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak thrips population recorded on 05th September, 2021. Taking the above criterion into consideration, the genotypes, GD 1903, GD 567and HG 19-2-6 were considered as less susceptible and DRLGG 13-28, CAZG 18-4, GL-01, CAZG 19-9, GG 1806, RGC-1033, CAZG 17-16-1, GG 1903, DRLGG 13-39, CAZG 19-7, GD 580as moderate susceptible, Whereas, GG 1909,HG 2-20, X-25 and RGC 1066 as highly susceptible against thrips. Yadav and Kumawat (2008) found genotypes RGC-1066, HG 2-20, RGC-1033, RGr-18-1(AVT-I), RGr-19-5-8, and RGr-19-7 to be theleast susceptible to thrips, CAZG-17-16, RG19-10, CAZG-16-21, RGr- 19-2, and FAUG-1507 to be moderately susceptible, and RGC-936 to be highly susceptible. The present findings were with that of Pithava (1996), Panwar and Patel (2011).

5.2.4 Mite, *Polyphagotarsonemus latus* (Banks) (Table: 4.6, Fig.4.5)

The infestation of mites started 4 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, mites population ranged from 3.88 to 8.26. During this stage the minimum mites was observed on GD 565 (3.88mites) followed by GL-01(4.19mites) which were found significantly superior over rest of the genotype. The maximum mites population was observed on X-25 (8.26mites) followed by GG 1806 (8.25mites) and GG 1909 (7.91 mites), however, these genotypes were statically at par. The mites population was 4.28, 4.35, 4.58, 5.91, 6.58, 6.79, 6.91, and 7.25, on DRLGG 13-28, HG 19-2-6, CAZG 17-16-1, CAZG 19-9, HG 2-20, GG 1903, CAZG 18-4, CAZG 19-7, GD 567, RGC 1066, RGC-1033, GD 580, and DRLGG 13-39, respectively, and all this genotype were statistically at par to each other. The infestation of mites increased gradually and reached to its peak in the third week of August (5thAugust, 2021). At this stage the mean mites population ranged from 5.14 to 9.37. The minimum mites population was observed on, genotype, GD 565 (5.14mites) followed by DRLGG 13-28 (5.15mites) however, and both genotypes were statistically at par with each other. The maximum mites population was observed on X-25 (9.37mites) followed by, GG 1806 (9.26mites) and was found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* CAZG 17-16-1(5.25mites), GL-01 (5.76mites), HG 19-2-6 (5.78mites), CAZG 18-4 (6.75mites), CAZG 19-7 (7.14mites), HG 2-20 (7.15mites), RGC-1033 (7.16mites), CAZG 19-9 (7.25mites), GG 1903 (7.45mites), RGC 1066 (7.49mites), GD 567 (7.73mites), DRLGG 13-39 (7.77mites), GD 580 (8.74mites) and GG 1909 (9.11mites) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of mites declined and persisted up to third week of September. For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak mites population recorded on 22th August, 2021. Taking the above criterion into consideration, the genotypes, GD 565, DRLGG 13-28,CAZG 17-16-1, GL-01and HG 19-2-6 were considered as less susceptible and CAZG 18-4, CAZG 19-7, HG 2-20,RGC-1033, CAZG 19-9, GG 1903,RGC 1066,GD 567, DRLGG 13-39, and GG 1909as moderate susceptible, Whereas, GD 580, GG 1909, GG 1806 and X-25 as highly susceptible against mites. The present findings were with that of Ahuja (2000) Jovicich *et al.* (2004).

5.2.5 White fly *Bemisia tabaci* (Table: 4.7, Fig.4.6)

The infestation of white flies started 4 weeks after sowing in all the genotypes screened. The mean data indicated that on initial stage of crop, white flies population ranged from 4.42 to 8.68. During this stage the minimum white flies was observed on GD 565 (4.42 white flies) followed by GL-01 (4.52 white flies) which were found significantly superior over rest of the genotype. The maximum white flies population was observed on DRLGG 13-28 (8.68 white flies) followed by CAZG 17-16-1(8.65 white flies) and RGC 1066 (8.38 white flies), however, these genotypes were statically at par. The white flies population was 4.56, 4.61, 5.00, 6.48, 7.00, 7.07, 7.13, 7.34, 7.35, 7.58, 7.63,7.68 and 7.72 on GD 567, HG 19-2-6, GG 1806, X-25, CAZG 19-7, GG 1903, CAZG 18-4, RGC-1033, GD 580, DRLGG 13-39, HG 2-20, GG 1909 and CAZG 19-9, respectively, and all this genotype were statistically at par to each other. The infestation of white flies increased gradually and reached to its peak in the third week of August (22th August, 2021). At this stage the mean whiteflies population ranged from 5.65 to 9.96. The minimum white flies population was observed on genotype, GG 1806 (5.65 white flies) followed by GD 565 and GD 567 (5.66 white flies) however, and both genotypes were statistically at par with each other. The maximum white flies population was observed on DRLGG 13-28 (9.96 white flies) followed by CAZG 17-16-1(9.69 white flies) and were found statistically at par with each other and significantly superior to rest of the genotype. The genotype *viz.,* GL-01 (6.23 white flies), HG 19-2-6 (6.37 white flies), CAZG 18-4 (7.36 white flies), CAZG 19-9 (7.62 white flies), X-25, GD 580 (7.63 white flies), CAZG 19-7 (7.67 white flies), GG 1903 (7.93 white flies), DRLGG 13-39 (8.05 white flies), RGC-1033 (8.29 white flies), GG 1909 (8.32 white flies), HG 2-20 (9.34 white flies)and RGC 1066 (9.63 white flies) were statistically at par and ranked in middle order of infestation. After reaching peak, the population of white flies declined and persisted up to third week of September. For the sake of convenience in expression, the cluster bean genotype were categorized on the basis of peak white flies population recorded on 22th August, 2021. Taking the above criterion into consideration, the genotypes, GG 1806, GD 565,GD 567and GL-01, were considered as less susceptible and HG 19-2-6, CAZG 18-4, CAZG 19-9, X-25,GD 580, CAZG 19-7, GG 1903, DRLGG 13-39, RGC-1033, GG 1909, as moderate susceptible, Whereas, HG 2-20, RGC 1066, DRLGG 13-28andCAZG 17-16-1as highly susceptible against white flies. The present findings were with that of Singh *et al.,* (1996), Singh (2002), Verma and Henry (2003) and Patel *et al.* (2009).

Chapter – VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

6.1Summary

6.1.1 The population dynamics of major insect pest of cluster bean

The current study was carried out in *Kharif* 2021-22 at the research farm, College of Agriculture, RVSKVV, Gwalior (MP), Identification of the population dynamics of major pests of the cluster bean and Identification of less susceptible genotypes against major insect pest. The findings of the research are presented in the table below.

Aphid, *Aphis craccivora* (Koch)

The incidence of aphid began in the third weeks after sowing (WAS) i.e. the second week of August (33^{th} SMW) with 1.43 aphid /leaf and peaked at 4.56 aphid /leaf during the 7th WAS i.e. the last week of august (36th SMW); thereafter, its population gradually declined from the 11th WAS i.e. the last week of September (40th SMW) and finally disappeared. The value of the simple correlation coefficient of meteorological parameters with different pest populations was computed and displayed in table 4.2. Among meteorological parameters minimum temperature, humidity (evening) and rainfall showed a strong positive and significant relationship with aphid population.

Jassid, *Empoasca kerri* (Pruthi)

The jassid population 2.91 jassid/leaf began on the 3nd WAS, corresponding with the first week of August (32nd SMW), and continuously increased up to the 8th WAS. Next that, its population began to drop in the second week of September, coinciding with the first week of September (37th SMW) and peaked at 5.63/leaf the following week. Only weekly rainfall and relative humidity at evening showed a significant positive correlation with jassid population, none other factor showed anysignificant correlation between climatic condition and jassid population.

Thrips, *Megleurothrips ditalis* (Karny)

The incidence of thrips began in the second week after sowing (WAS) i.e. the first week of August (32nd SMW) with 0.82 thrips and peaked at 4.74 thrips during the 9th WAS i.e. the second week of September (38th SMW); thereafter, its population gradually declined from the 10th WAS i.e. the third week of September (39th SMW) and finally disappeared. The value of the simple correlation coefficient of meteorological parameters with different pest populations was computed and displayed in table 4.2. Among meteorological parameters weekly rainfall and relative humidity at evening showed a strong positive and evaporation negative significant relationship with thrips population.

Mite, *Polyphagotarsonemus latus* (Banks)

The mite population 0.12 mite/leaf began on the 2nd WAS, corresponding with the first week of August (32nd SMW), and continuously increased up to the 8th WAS. Next that, its population began to drop in the third week of September, coinciding with the second week of September (38th SMW) and peaked at 5.83/leaf the following week. All factor none showed any significant correlation between climatic condition and mite population.

White fly, *Bemisia tabaci*

The white fly population 2.93 white fly /leaf began on the 3nd WAS, corresponding with the first week of August (32nd SMW), and continuously increased up to the 8th WAS. Next that, its population began to drop in the second week of September, coinciding with the first week of September (37th SMW) and peaked at 5.68/leaf the following week. Only weekly rainfall and relative humidity at evening showed a significant positive correlation with white fly population, none other factor showed any significant correlation between climatic condition and white fly population.

6.1.2 To identify less susceptible varieties against major insect pests of cluster bean

Aphid, *Aphis craccivora* (Koch)

Based on an convenience in expression, the cluster bean genotype were categorized on the basis of peak aphid population recorded on 29th August, 2021, the genotypes, X-25, and RGC-1033 were considered as less susceptible and GL-01, CAZG 19-9, GG 1903, CAZG 18-4, GG 1806, CAZG 17-16-1, GD 580, HG 2-20, CAZG 19-7, RGC 1066, DRLGG 13-39, and GG 1909as moderate susceptible, Whereas, GD 567, DRLGG 13-28, HG 19-2-6 and GD 565 as highly susceptible against aphid.

Jassid, *Empoasca kerri* (Pruthi)

Based on an convenience in expression, the cluster bean genotype were categorized on the basis of peak jassid population recorded on 05th September, 2021, the genotypes CAZG 17-16-1, GG 1909 and GD 565were considered as less susceptible and GD 580, GG 1806, HG 2-20, CAZG 18-4, GG 1903, DRLGG 13-28, GD 567, RGC 1066, DRLGG 13-39, RGC-1033, CAZG 19-7, GD 580, as moderate susceptible, Whereas, HG 19-2-6, GL-01, CAZG 19-9 and X-25as highly susceptible against jassid.

Thrips, *Megleurothrips ditalis* (Karny)

Based on an convenience in expression, the cluster bean genotype were categorized on the basis of peak thrips population recorded on 05th September, 2021, the genotypes, GD 1903, GD 567and HG 19-2-6 were considered as less susceptible and DRLGG 13-28, CAZG 18-4, GL-01, CAZG 19-9, GG 1806, RGC-1033, CAZG 17-16-1, GG 1903, DRLGG 13-39, CAZG 19-7, GD 580as moderate susceptible, Whereas, GG 1909,HG 2-20, X-25 and RGC 1066 as highly susceptible against thrips.

Mite, *Polyphagotarsonemus latus* (Banks)

Based on an convenience in expression, the cluster bean genotype were categorized on the basis of peak mites population recorded on 22th August, 2021, the genotypes GD 565, DRLGG 13-28,CAZG 17-16-1, GL-01and HG 19-2-6 were considered as less susceptible and CAZG 18-4, CAZG 19-7, HG 2-20,RGC-1033, CAZG 19-9, GG 1903,RGC 1066,GD 567, DRLGG 13-39, and GG 1909as moderate susceptible, Whereas, GD 580, GG 1909, GG 1806 and X-25 as highly susceptible against mites.

White fly, *Bemisia tabaci*

Based on an convenience in expression, the cluster bean genotype were categorized on the basis of peak white flies population recorded on 22th August, 2021, the genotypes, GG 1806, GD 565,GD 567and GL-01, were considered as less susceptible and HG 19-2-6, CAZG 18-4, CAZG 19-9, X-25,GD 580, CAZG 19-7, GG 1903, DRLGG 13-39, RGC-1033, GG 1909, as moderate susceptible, Whereas, HG 2-20, RGC 1066, DRLGG 13-28andCAZG 17-16-1as highly susceptible against white flies.

6.2 Conclusion

- Aphid, jassid, thrips, mite, and whitefly were the major insect pests that infested cluster bean crops in 2021-22.
- Studies on the seasonal prevalence of insect pests on *Kharif* cluster bean revealed that thrips and jassid first appeared in a 12-day- old crop (32nd SMW) and were present until crop maturity. During the month of August, thrips, mites and white fly populations peaked, where as aphid populations peaked during the 33th SMW.
- The minimum temperature, relative humidity in the evening and rainfall had a significant positive correlation and evaporation had a significant negative correlation with all major pests.
- The less susceptible and minimum number of aphids population were found in X-25, followed by RGC-1033. In GD 565, however, found to be the most susceptible to aphids.
- The less susceptible and minimum number of jassid population were found in CAZG 17-16-1followed by GG 1909. However, the most susceptible to jassid was found to be X-25.
- The less susceptible and minimum number of thrips population were found in GD 1903 followed by GD 567and HG 19-2-6. In RGC 1066, however, was found to be the most susceptible to thrips.
- The less susceptible and minimum number of mites population were found in

GD 565 followed by DRLGG 13-28 and CAZG 17-16-1. However, the most susceptible to mite was found to be GD 580.

- The less susceptible and minimum number of white flies population were found in genotype GG 1806 followed by GD 567 and GL-01. However, the most susceptible to white fly was found to be HG 2-20.

- **6.3 Suggestions for further work**

1) The experiment may be repeated over several years and in several locations to confirm the present findings.
2) Multi-seasonal trials must be conducted in order to discover new genotypes that are appropriate for the area.
3) A greater variety of cluster bean genotypes must be assessed in the climatic conditions of the belt area of Madhya Pradesh in order to create less sensitive genotypes.
4) It is important to evaluate genotypes for antibiosis physiologically and chemically mechanisms against cluster bean pests.

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M.Sc. (Ag.)	2022	77.60	RVSKVV, Gwalior	Agriculture Entomology
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Intermediate (12^{th})	2015	76.80	RBSE, Rajasthan	Agriculture
Matriculation (10^{th})	2013	68.17	RBSE, Rajasthan	All Subject

(Kamlesh Kumar Kumawat)

Population of aphid on different genotypes
1st observation at 08-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	41.86	20.93		
TREATMENT	17.00	149.75	8.81	**202.78**	**1.93**
ERROR	34.00	1.48	0.04		
TOTAL	53.00	193.09			

2nd observation at 15-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	33.71	16.86		
TREATMENT	17.00	128.30	7.55	**216.04**	**1.93**
ERROR	34.00	1.19	0.03		
TOTAL	53.00	163.20			

3rd observation at 22-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	91.21	45.60		
TREATMENT	17.00	95.64	5.63	**200.36**	**1.93**
ERROR	34.00	0.95	0.03		
TOTAL	53.00	187.81			

4th observation at 29-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	31.57	15.79		
TREATMENT	17.00	138.40	8.14	**216.91**	**1.93**
ERROR	34.00	1.28	0.04		
TOTAL	53.00	171.25			

5^{th} observation at 05-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	30.53	15.27		
TREATMENT	17.00	64.51	3.79	**218.22**	**1.93**
ERROR	34.00	0.59	0.02		
TOTAL	53.00	95.63			

6^{th} observation at 12-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	23.97	11.98		
TREATMENT	17.00	27.51	1.62	**218.91**	**1.93**
ERROR	34.00	0.25	0.01		
TOTAL	53.00	51.73			

All mean observation

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	42.47	21.24		
TREATMENT	17.00	44.31	2.61	**213.49**	**1.93**
ERROR	34.00	0.42	0.01		
TOTAL	53.00	87.20			

Population of Jassid on different genotypes
1^{st} observation at 08-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	44.64	22.32		
TREATMENT	17.00	113.39	6.67	**162.26**	**1.93**
ERROR	34.00	1.40	0.04		
TOTAL	53.00	159.42			

2^{nd} observation at 15-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	41.34	20.67		
TREATMENT	17.00	79.96	4.70	**162.43**	**1.93**
ERROR	34.00	0.98	0.03		
TOTAL	53.00	122.28			

3^{rd} observation at 22-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	42.50	21.25		
TREATMENT	17.00	130.44	7.67	**162.43**	**1.93**
ERROR	34.00	1.61	0.05		
TOTAL	53.00	174.55			

4^{th} observation at 29-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	39.40	19.70		
TREATMENT	17.00	68.49	4.03	**162.56**	**1.93**
ERROR	34.00	0.84	0.02		
TOTAL	53.00	108.73			

5^{th} observation at 05-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	44.76	22.38		
TREATMENT	17.00	56.68	3.33	**162.38**	**1.93**
ERROR	34.00	0.70	0.02		
TOTAL	53.00	102.13			

6th observation at 12-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	40.39	20.19		
TREATMENT	17.00	111.55	6.56	**162.36**	**1.93**
ERROR	34.00	1.37	0.04		
TOTAL	53.00	153.31			

7th observation at 19-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	29.21	14.61		
TREATMENT	17.00	138.44	8.14	**166.62**	**1.93**
ERROR	34.00	1.66	0.05		

All mean observation

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	40.99	20.49		
TREATMENT	17.00	39.80	2.34	**162.71**	**1.93**
ERROR	34.00	0.49	0.01		
TOTAL	53.00	81.27			

Population of thrips on different genotypes
1st observation at 08-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	23.46	11.73		
TREATMENT	17.00	155.93	9.17	**357.64**	**1.93**
ERROR	34.00	0.87	0.03		
TOTAL	53.00	180.26			

2^{nd} observation at 15-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	20.97	10.48		
TREATMENT	17.00	151.91	8.94	**358.44**	**1.93**
ERROR	34.00	0.85	0.02		
TOTAL	53.00	173.72			

3^{rd} observation at 22-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	20.55	10.28		
TREATMENT	17.00	115.56	6.80	**345.01**	**1.93**
ERROR	34.00	0.67	0.02		
TOTAL	53.00	136.78			

4^{th} observation at 29-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	20.03	10.01		
TREATMENT	17.00	80.10	4.71	**345.92**	**1.93**
ERROR	34.00	0.46	0.01		
TOTAL	53.00	100.60			

5^{th} observation at 05-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	22.75	11.38		
TREATMENT	17.00	71.27	4.19	**345.80**	**1.93**
ERROR	34.00	0.41	0.01		
TOTAL	53.00	94.44			

6th observation at 12-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	19.31	9.66		
TREATMENT	17.00	38.71	2.28	**348.03**	**1.93**
ERROR	34.00	0.22	0.01		
TOTAL	53.00	58.24			

7th observation at 19-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	15.96	7.98		
TREATMENT	17.00	59.73	3.51	**363.40**	**1.93**
ERROR	34.00	0.33	0.01		
TOTAL	53.00	76.02			

All mean observation

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	20.23	10.12		
TREATMENT	17.00	42.98	2.53	**360.36**	**1.93**
ERROR	34.00	0.24	0.01		
TOTAL	53.00	63.46			

Population of mite on different genotypes
1st observation at 08-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	195.87	97.94		
TREATMENT	17.00	119.91	7.05	**117.96**	**1.93**
ERROR	34.00	2.03	0.06		
TOTAL	53.00	317.82			

2^{nd} observation at 15-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	174.63	87.32		
TREATMENT	17.00	158.75	9.34	**120.45**	**1.93**
ERROR	34.00	2.64	0.08		
TOTAL	53.00	336.02			

3^{rd} observation at 22-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	170.18	85.09		
TREATMENT	17.00	159.48	9.38	**121.24**	**1.93**
ERROR	34.00	2.63	0.08		
TOTAL	53.00	332.29			

4^{th} observation at 29-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	134.36	67.18		
TREATMENT	17.00	157.17	9.25	**144.17**	**1.93**
ERROR	34.00	2.18	0.06		
TOTAL	53.00	293.71			

5^{th} observation at 05-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	128.85	64.42		
TREATMENT	17.00	168.77	9.93	**145.08**	**1.93**
ERROR	34.00	2.33	0.07		
TOTAL	53.00	299.95			

6th observation at 12-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	83.02	41.51		
TREATMENT	17.00	422.24	24.84	**169.36**	**1.93**
ERROR	34.00	4.99	0.15		
TOTAL	53.00	510.24			

7th observation at 19-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	58.45	29.22		
TREATMENT	17.00	58.38	3.43	**183.35**	**1.93**
ERROR	34.00	0.64	0.02		
TOTAL	53.00	117.46			

All mean observation

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	118.41	59.21		
TREATMENT	17.00	131.76	7.75	**195.40**	**1.93**
ERROR	34.00	1.35	0.04		
TOTAL	53.00	251.52			

Population of white fly on different genotypes
1st observation at 08-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	179.75	89.87		
TREATMENT	17.00	115.40	6.79	**110.89**	**1.93**
ERROR	34.00	2.08	0.06		
TOTAL	53.00	297.24			

2nd observation at 15-08-21

ANOVA					
SV	DF	SS	MSS	F(CAL)	F(TAB)
REPLICATION	2.00	164.38	82.19		
TREATMENT	17.00	138.68	8.16	108.82	1.93
ERROR	34.00	2.55	0.07		
TOTAL	53.00	305.61			

3rd observation at 22-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	155.75	77.87		
TREATMENT	17.00	155.44	9.14	**110.16**	**1.93**
ERROR	34.00	2.82	0.08		
TOTAL	53.00	314.01			

4th observation at 29-08-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	144.56	72.28		
TREATMENT	17.00	137.72	8.10	**120.58**	**1.93**
ERROR	34.00	2.28	0.07		
TOTAL	53.00	284.57			

5th observation at 05-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	137.76	68.88		
TREATMENT	17.00	161.50	9.50	**119.31**	**1.93**
ERROR	34.00	2.71	0.08		
TOTAL	53.00	301.96			

6th observation at 12-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	53.18	26.59		
TREATMENT	17.00	161.57	9.50	**144.97**	**1.93**
ERROR	34.00	2.23	0.07		
TOTAL	53.00	216.98			

7th observation at 19-09-21

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	43.23	21.62		
TREATMENT	17.00	84.90	4.99	**135.79**	**1.93**
ERROR	34.00	1.25	0.04		
TOTAL	53.00	129.39			

All mean observation

ANOVA					
SV	**DF**	**SS**	**MSS**	**F(CAL)**	**F(TAB)**
REPLICATION	2.00	124.48	62.24		
TREATMENT	17.00	118.65	6.98	**117.35**	**1.93**
ERROR	34.00	2.02	0.06		
TOTAL	53.00	245.15			