

Studies on the major insect-pests of sesame (*Sesamum indicum* L.)

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By

SANJAY BHURA

Department of Entomology

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

College of Agriculture, Gwalior (M.P.)

2020

CERTIFICATE – I

*This is to certify that the thesis entitled, “**Studies on the major insect-pests of sesame (Sesamum indicum L.)**” submitted in partial fulfillment of the requirements for the Degree of **MASTER OF SCIENCE** in **Agriculture** department of **Entomology** of **Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior** is a record of the bona-fide research work carried out by **Mr. Sanjay Bhura**, 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 the investigations has been acknowledged by the scholar.

Place: Gwalior

(Dr. PRADYUMN SINGH)

Date:

Chairman of Advisory Committee

MEMBER OF STUDENT’S ADVISORY COMMITTEE

Chairman (Dr. Pradyumn Singh) :

Member (Dr. N.K.S. Bhadoria) :

Member (Dr. R.K. Pandya) :

CERTIFICATE –II

*This is to certify that thesis the entitled, “**Studies on the major insect-pests of sesame (Sesamum indicum L.)**” submitted by **Mr. Sanjay Bhura** to the **Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior** in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the Department of **Entomology** 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. PRADYUMN SINGH)

Date:

Chairman of Advisory Committee

MEMBERS OF THE ADVISORY COMMITTEE

Chairman (Dr. Pradyumn Singh) :

Member (Dr. N.K.S. Bhadoria) :

Member (Dr. R.K. Pandya) :

Head of the Department :

Dean, Collage of Agriculture, Gwalior :

Director of Instruction :

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Date :

Place : **Gwalior**

BHURA)

(SANJAY

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Chapter – I

INTRODUCTION

Sesame (*Sesamum indicum* L.) popularly known as “til” is one of the important edible oil seed crop in India and called "the queen of oilseed crops". Africa is considered to be the primary centre of origin of this crop because of the presence of its diverse wild species in that continent whereas India and Japan ranks second. India ranks first in the area and production of sesame.

Sesame (*Sesamum indicum*) belongs to the family Pedaliaceae and order Tubiflorae which contains 60 species and 16 genera. Sesame is also known as Til, Sesame, Ajonjoli, Simsim, Gingelly, and Benniseed. Sesame is an important oil crop because of great stability, resistance to drought and easiness of its extraction. Sesame seeds are small and flat, after harvesting it is difficult to dry the seed because around the seed movement of air difficult by the small seed. As the seeds dry, they must be harvested and stored at 6% moisture condition. Many commercial varieties of sesame plant are grown in India. The height of growing plant is 2 to 9 feet which depends on different varieties. The outer covering of seed may be ribbed or smooth. Because of different varieties sesame seeds may be in many colors. Most of seeds are gray, black, reddish, buff, and tan, gold and brown.

With an estimated production of 1, 24,383 MT, Madhya Pradesh had a share of 29.7% in the national production followed by Gujarat (78,959 MT) with a share of 18.9%, Rajasthan (73,548 MT) with a share of 17.6% and Uttar Pradesh (56187 MT) with a share of 13.4%. These four states collectively shared 79.7% of the national production. Among the four states surveyed, at national level the highest yield of 723 kg ha⁻¹ was estimated for Gujarat followed by 293 kg ha⁻¹ for Madhya Pradesh, 270 kg ha⁻¹ for Rajasthan and 187 kg/ha for Uttar Pradesh. Much of the area under sesame is covered by medium and short duration crop which are harvested after 86-90 days.

Madhya Pradesh ranks third in production as well as area. The average productivity of sesame in Madhya Pradesh is 319 kg ha⁻¹. Nearly 78

percent of the sesame seed produced in India is used for oil extraction, 2.5 percent for planting purposes and the rest is used in confectionaries and in religious Hindu ceremonies. Nearly 73 percent of the oil is used for edible purpose, 8.3 percent of hydrogenation, and 4.2 percent for industrial purposes in the manufacture of paints, pharmaceuticals and insecticides.

The sesame seed is a rich source of edible oilseeds and mixed with sugar and in several forms in sweet meals.

A hundred gram of seeds provides 592 calories. Its seeds contain 50 to 54% oil of high quality and protein 18 to 20% (Deshmukh and Raghuvanshi, 2008). Sesame oil is important cooking oil in south India. It is really the poor man's substitute for ghee. It is also used as perfumed oil as it does not itself possess any strong odor, especially after it is kept for sometimes and is able to absorb the fragrant essence of sweet scented flowers. Lower grade of oil are used in soap making industries. It finds also a number of medicinal uses. The oilcake is an edible cake. It is eaten mixed with sugar by poor people. It is also used as a cattle feed especially for milch animals. It can be used as manure. Cake contains 6.0- 6.2 percent nitrogen 2.0-2.2 percent phosphorous and 1.0-1.2 percent potash (Singh *et al.*, 2007).

The national yield was estimated at 291 kg ha⁻¹ among the eight districts in Madhya Pradesh, the highest yield (475 kg ha⁻¹) was estimated for Morena and the lowest (94 kg/ ha) for Tikamgarh. The highest production was estimated for Bhind, the district which accounted for the second largest acreage in the state. In production, Bhind was closely followed by Chattarpur which accounted for the largest as well as nearly double the acreage of bhind. The total production of sesame crop in Madhya Pradesh was estimated at 1, 24,383 MT with an average yield of 293 kg⁻¹/ha (.Anonymous 2017).

Although, it is a short duration crop but is known to suffer from severe insect pests and disease infestation. Among 67 insect pests damage sesame crop leaf insect pests *viz.* leaf roller/ capsule borer, *Antigastra catalaunalis* (Duponchel). Til hawk moth, *Acherontia styx*, Jassid, *Orocious albicinctus* (Distance), Bihar hairy caterpillar *Spilosoma oblique* (Walker), Whitefly

Bemisia tabaci (Genadius) and Mirid bug *Cryptopeltis tenuis* (Reuter), are considered to be key pests of regular occurrence (Ahirwar *et al.*, 2009).

Among these, Til capsule borer (*Antigastra catalaunalis* Dup.) is the most serious pest. Larvae roll few leaves together and feed on them in the early stage of the crop. At reproductive stage, flowers and pods are damaged by them. Yield losses upto 90% were reported by Ahuja and Bakhetia (1995) while up to 43.1% was recorded by Gupta (2002).

Til hawk moth, *Acherontia styx* Westwood is a sporadic pest but voracious feeder of sesame crop at larval stage. The larvae feed voraciously on leaves and defoliate the plants and is capable of inflicting heavy damage at times. Only one larvae is enough to denude the whole plant. The most damaging insects are Hawk moth, hairy caterpillar, leaf roller, common cutworm, pod borer, stem flies, bugs and white fly those are reported to damage during vegetative, flowering and pod formation stages of the crop. Practical experiences reveal that 15-20 percent of the total sesame production is lost directly or indirectly by the attack of insect and mite pests every year (Biswas and Das 2000).

Leaf roller/ capsule borer, *Antigastra catalaunalis* Dup. is a major and serious pest of sesame crop damaging the crop from seedling to flower and capsule stages at larval stages. At initial stage it webs the upper portion of plant and feed there upon, whereas at flowering stage it feeds on the flowers and at capsule stage it bores into the capsules. Thus, 20 to 50 per cent losses in yield are caused. One to three larvae are enough to denude a fully grown plant within 24 to 48 hours.

There are two types of insects, sucking and chewing insect. Young ones of sucking insects are called nymphs. These insects suck all sap from veins of plant and always found beneath the leaves. Sucking insects are small in size. Insects of the family Miridae are commonly called Mirid bug. Common names of Mirid bug may be grass bugs, plant bugs, and leaf bugs. Mirid bug includes 10,000 described species and 1400 genera. The family of Mirid bug is Miridae (Plant Bugs), Kingdom: Animalia, Phylum: Arthropoda, Subphylum: Hexapoda, class: insecta, Order: Hemiptera, Suborder: Heteroptera [8].

Information on the pattern of insect pest complex and their succession on crop is of immense importance for evolving pest management practices which are ecologically sound and economically feasible. Besides, it is also important to understand the existing relationship between the incidence of pest population and abiotic factors of environment. These would permit an ecological manoeuvring, by bringing about changes in the cropping system having relevant impact on pest damage.

Keeping these points in view, the present investigation was conducted with the following objectives:

1. To study the seasonal incidence of major insect-pests of sesame.
2. To study the screening of sesame cultivars against major insect-pests.

Chapter – II

REVIEW OF LITERATURE

The literature according to the objectives of present study is reviewed and presented in the chapter.

Baskaran *et al.*, (1994) screened 20 entries of *S. indicum* (including five local varieties) and the wild species, *S. alatum* against sesame leaf roller/pod borer, *A. catalaunalis* under artificial and natural infestation conditions. Leaf damage per cent was recorded at 45 DAS and capsule damage after 70 DAS. Only seven entries were identified as moderately resistant under artificial conditions while 12 entries were moderately resistant under natural conditions. The wild species and two entries, ES-22 and SI-250 were highly resistant under both conditions.

Angood Ba *et al.* (2000) reported that the occurrence of whitefly on two local cultivars of sesame crop under eight different dates of sowing. The result of August and September sown crop showed high number of pests compared to February and October sown crop. The population of whitefly showed a significant positive correlation with maximum temperature and evaporation. While non-significant positive correlation was observed between minimum temperature, sunshine hours, morning and evening vapour pressure, number of rainy days. Non-significant negative correlation was observed between rainfall, wind speed, morning and evening relative humidity, further, they also reported that the occurrence of jassid on sesame crop was higher in August and September sown crop as compared to February and October sown crop. The population of jassid showed significant positive correlation with maximum temperature and evaporation while non-significant positive correlation was observed between minimum temperature, sunshine hours, wind speed, morning and evening relative humidity, morning and evening vapour pressure. Non-significant correlation was observed between rainfall and number of rainy days.

Bhadoria *et al.* (2000) recorded 25 species of insect pests on sesame in Gwalior, Madhya Pradesh, India during the *Kharif* seasons of (1994-97), from germination to harvest, which included 11 homopterous, 7 lepidopterous,

2 each of orthopterous, coleopterous and dipterous pest. Out of these pests 12 insect species were observed as regular and other 13 were sporadic pest.

Selvanarayanan and Baskaran (2000) reported that the duration of the life stages of *A. catalaunalis* was influenced by environmental factors. It was concluded that the spinning process was influenced by the area of the leaves, irrespective of the larval size.

Ahuja and Kalyan (2001) screened germplasm of sesame (*Sesamum indicum*) against leaf webber/ capsule borer *A. catalaunalis* and *Asphondylia sesami*. Seven lines, viz., ES-12, ES-22, SI-3315111, *S. alatum*, SI-250, IS-210-1 and Zodge-3 were resistant to *A. catalaunalis* whereas resistance to *A. catalaunalis* and *A. sesami* was observed in *S. alatum*.

Gupta *et al.* (2001) reported that the peak incidence of all three sucking pests jassid (0.39/ plant), whitefly (0.59/ plant) and mirid bug (0.52/ plant) during 34th, 34th and 35th SMW respectively.

The incidence and abundance of insects associated with sesame varieties S-17, PR-19/9, PR 28/88 and PR-37/88 were tested. Insects' viz., whitefly, thrips, leaf roller/ capsule borer attacked sesame. The varieties PR-1919 and S-17 showed relative resistance against these insects while PR-29/88 was relatively susceptible for these insect pest complexes (Muzaffar *et al.* 2002).

Shrivastava *et al.* (2002) screened 782 germplasm lines of sesame (*Sesamum indicum* L.) against leaf roller/ capsule borer (*Antigastra catalaunalis* Dup.), and revealed seven germplasm lines viz., SI-1729, SI-3239, IC-132246, IC-204137, IC-205071, IC-2050S2 and IC-205304 least susceptible.

Thirteen genotypes of sesame (*Sesamum indicum* L.) were evaluated under greenhouse conditions to find out their reaction to *Antigastra catalaunalis* Duponchel. The preference for oviposition was nil on the genotype ES-22 and very low on SI-250, IS-23-1, KIS-305 and ES-12. The overall development of *A. catalaunalis* was also very low on these genotypes whereas a good growth was noticed on remaining cultivated varieties of

sesame. The above genotypes were less preferred for egg laying as well as development and thus considered as being resistant to this pest (Singh 2002).

Sridhar and Gopalan (2002) reported that the overall development of *A. catalaunalis* was highly reduced in the resistant genotypes ES-22 and lower in SI-250 and good growth when the larvae fed with the susceptible check TC-25. The genotypes exhibited resistant reaction to *A. catalaunalis*.

Talpur *et al.* (2002) studied the incidence and abundance of insect pests associated with sesame crop, recorded whitefly, aphids, thrips, plant bugs and leaf roller/ capsule borer. In Australia and Pakistan, the sesame leaf webber and green vegetable bug have been recorded associated with sesame.

Laurentin *et al.* (2003) and Berlinger *et al.* (1983) reported cases of insect incidence on sesame has been suspected to be correlated with varying plant metabolites from different cultivars of which foliar acidity was said to be the determining factor in whiteflies.

Kalaiyarasan and Palanisamy (2004) reported that the correlation analysis of minimum temperature and relative humidity were highly and positively correlated with the *E. sordidus* incidence. The regression analysis indicated that the maximum temperature had negative influence on its incidence. In addition, the minimum temperature had a positive regression coefficient which predicted that for every one degree of minimum temperature, increased the pest population to the tune of 1.704 insects.

Suliman *et al.* (2004). Sesame is attacked by different insect pests during its different growing stages, but sesame web worm, (*A. catalaunalis*) is the most important pest. It was reported to attack the crop in all growth stage, after about two weeks of emergence.

Egonyu *et al.* (2005) reported that the *A. catalaunalis* as the important pest in northern Uganda with percent occurrence of 62.00 and relative incidence of 0.63.

Thakur and Ghorpade (2006) reported that *Antigastra catalaunalis* as one of the key pest of sesame in India and caused economic loss in the yield.

The pest is active in the sesame field from seedling stage till harvest of the crop.

Twenty four sesamum entries against *A. catalaunalis* viz., MT-7-06, OSC-906, RT-354, Nirmala, PKDS-62, TKG-357, CST-2001 and ASS-9 to be resistant to *A. catalaunalis* (Anonymous 2008a).

Screened 150 germplasm accessions against leaf roller/ capsule borer at reported, nine entries viz., KMR-30, KMR-41, KMR-55, KMR-5-358, KMR-5-370, SI-1930, SI-3282, KMR-8 and G-44 were found to be resistant to *Antigastra catalaunalis* (Anonymous 2008b).

Kumar *et al.* (2009) studied pest succession on sesame. Among the pests Whitefly, Leaf hopper and Stink bug, remained active from vegetative stage of crop and their population were recorded while Sesame gallfly, Bihar hairy caterpillars were active from flowering to capsule stage of crop. Til leaf roller/ Capsule borer was active from seedling to harvesting stages and til hawk moth was active from capsule formation to capsule maturity stage of crop.

Kumar *et al.* (2009) recorded a total of 14 insect pests on sesame cultivars Type-4, Type-12, Type-13, Type-78 and Shekhar in a field trial conducted in Faizabad, Uttar Pradesh, India, during *Kharif* 2006 and 2007. Among the pests, the whitefly, *Bemisia tabaci*, sesame leafhopper, *Orosius albicinctus* [*O. orientalis*], stink bug, *Nezara viridula*, cotton aphid, *Aphis gossypii* and Sesame fly, *Gitonides persicae* remained active from the vegetative stage of the crop and the peaked population was recorded in the 36th standard week. The sesame gall fly, *Asphondylia sesami*, flower beetle, *Oxycetonia dispar*, sesame butterfly, *Dasyneura sesami* and blister beetle were active from flowering to capsule formation stage with a peak infestation was in the 37th standard week during both years. The surface grasshopper *Chrotogonus trachypterus* and til leaf webber/ capsule borer, *Antigastra catalaunalis* were recorded from sowing to harvesting stages of the crop and the peak infestation was recorded during the 35th standard week. The lygeid bug *Aphanus sordidus* [*Elasmolomus sordidus*] and til hawk

moth *Acherotia styx* was found at capsule formation to capsule maturity stage of crop growth with a peak in the 40th standard week during both years.

Shrivastava *et al.* (2009) screened 150 germplasm lines against *A. catalaunalis* and reported that 12 germplasm lines *viz.*, KMR-5, KMR-13, KMR-37, KMR-75, KMR-77, KMR-71, G-19, G-9, KMR-80, KMR-67, G-22 and ST-3279-1 most promising to *A. catalaunalis*.

The bioecology of til hawk moth, *Acherontia styx* Westwood was studied on *Sesamum indicum* (Linn.) variety TKG-22 under field and laboratory conditions during 2004-06. The eggs were globular in shape, yellow in colour with 0.70-0.95 mm in size. The incubation period of the eggs was 2-4 days with the neonate period of 10-15 minutes. There were five larval instars and length of the completely developed larva was 68-79 mm with larval period of 20-21 days. The maximum larvae were obtained during late August to September. The pre-pupal and pupal periods were 3-4 and 14-23 days respectively, with pupae conical in shape. The mating was always at morning (0.07-0.10 minutes) followed by oviposition (24 to 36 hours) with fecundity of 5-8. Life span of the adult was 3-5 days, total life cycle was completed in 39-52 days. Mean adult emergence (%), sex ratio and growth index were 95 to 100%, 1:1 and 2.64 to 2.27, respectively. There are only three generations in a year. The plants were infested to the extent of 31.6% by this insect. Maximum damage is caused during September-October. (Ahirwar and Gupta 2010)

Ahirwar *et al.* (2010) studied the bio-ecology of leaf roller / capsule borer *Antigastra catalaunalis* Duponchel on *Sesamum indicum* (L.) variety TKG-22 under field and laboratory conditions during 2004-06. The eggs were conical in shape, white in colour with length and width varying from 0.35-0.43 mm and 0.18-0.24 mm, respectively. The incubation period took 2-3 days and the neonate period was 17 min. There were five larval instars and length of the completely developed larva was 16 mm and larval period was 10-15 days. The larvae were observed maximum during last August to September. The pre-pupal and pupal periods were 2-8 and 4-12 days, respectively. The pupae were slender in shape. The mating was always at morning within 0.0148 min. The oviposition period was 3-4 days and fecundity 30-90. Life span of the

adult was 4-12 days. Total life span was completed in 22-39 days. Mean adult emergence (per cent), sex ratio and growth index were 87 to 100%, 1:1 and 7.22 to 3.15, respectively. There was nearly 12-14 generations in a year. The leaves, flowers and capsules were infested to the extent of 23.4%, 7.94% and 3.12%. Maximum damage was caused during last of August and September.

Kumar *et al.* (2010a) studied the seasonal incidence of sap feeders of sesame and reported that the peak population of whitefly, *B. tabaci*, *O. albicinctus* and stink bug, *Nazara viridula* was observed in 36th SMW and found that the population of *B. tabaci*, *O. albicinctus*, *N. viridula* and aphid, *Aphis gossypii* were negatively correlated with minimum temperature, relative humidity and rainfall and positively correlated with maximum temperature.

Kumar *et al.* (2010b) reported that the population of *A. sesame* and *D. sesame* were positively correlated with the minimum, maximum temperatures and relative humidity and negatively correlated with rainfall. The population of *A. sesame* and *D. sesame* on sesame were recorded from 4th week of August and continued till 1st week of October a peak in 37th SMW. The peak population of *A. styx* was recorded in 40th SMW (Kumar *et al.*, 2010c).

Monim *et al.* (2010) observed the highest hawk moth population 4 per plant in the last week of April in 2008, 2009. Among the treatments Dursban 20 EC reduced the highest Hawk moth (98.89%) with the highest BCR (5.03) followed by Neem kernel extract + Biskatali dust extract (31.11%), Neem kernel extract+ Zet powder (28.337%) and Neem oil + Zet powder (26.67%) recorded at 15 days after spray over the pre-treatment count. Neem kernel extract +Zet powder gave the second highest BCR (4.41) followed by Neem kernel extract (4.17), Neem oil + Zet powder (3.85) and Zet powder (3.67).

The gall midges (*Asphondylia sesame*), additively caused extensive galling of the capsule (Sintim *et al.*, 2010).

Forty three sesame genotypes were listed against the sesame leaf roller/ capsule borer, *Antigastra catalaunalis* (Dup), using 0–9 scale scoring technique. The differential response of the genotypes was noticed at the various crop growth stages. The genotypes, SI 250, ES 22 and UMA showed resistance at all the three stages, *i.e.* vegetative, flowering and pod maturity.

However, TKG 309 and CST 2001-3 showed resistances only at the vegetative stage; KMR 14 and VRI 1 exhibited resistance only at the pod maturity stage. Based on the overall grading, SI 250 and UMA genotypes were found resistant, and ES 22 was highly resistant. (Karuppaiah and Nadarajan 2011)

Kumar *et al.* (2012) sesame (*Sesamum indicum* L.), commonly known as Til, is one of the most important edible oilseed crop cultivated in India, present study on incidence of capsule borer (*Antigastra catalaunalis*) in different variety of sesame during *Kharif* season was under taken. The results show that the incidence of *A. catalaunali* was recorded in the first week of August and continued till fourth week of October at vegetative to pod maturity stage of the crop, and the population of *A. catalaunalis* was found significant and negatively correlated with maximum temperature and relative humidity in all varieties of sesame tested.

Nayer *et al.* (2013) conducted the experiments during 2009-11 seasons in Gedarif Research Station laboratory, Agricultural Research Corporation, to study biology and webbing (spinning) behaviour of sesame webworm, *A. catalaunalis* Dup. under laboratory conditions during the period of September to November 2006. Eggs incubation period was 2.45 days, while larval period lasted for 10.2 ± 1.05 days, completing five larval instars. The pupation occurred both inside the webbed leaves and the in the soil, and the average pupal period was 4.9 ± 0.21 days. The average adults longevity was 6.18 ± 0.2 days. The webbing behaviour revealed that the area of the leaves greatly influenced the webbing process. The larger area of the leaves, the greater number of stitches made and the longer time taken for complete the webbing. The larva changed the position while webbing, if the leaf area was large. Smaller leaves were webbed quickly, even if the length of the larvae was short.

Choudhary *et al.* (2015) reported that the peak population of *O. albicinctus* appeared during 35th SMW with maximum, minimum temperature and relative humidity of 32.3°C , 23.2°C and 65 per cent, respectively.

Gebregergis *et al.* (2016) sesame (*Sesamum indicum* L.), Sesame webworm, *Antigastra catalaunalis* is a major pest in western Tigray. To assess the incidence and severity of *A. catalaunalis*, a survey was conducted in western zone of Tigray (KaftaHumera, Tsegede and Welkait) in FAOSTAT,2015 cropping season starting from seedling up to capsule development stages. A total of 48 farm plots were assessed for prevalence, incidence and severity. All surveyed farm plots were infested at all stages of the crop. In the study area incidence of the pest was 66% and 15% capsule damage/ severity. Capsule developmental stage of the crop was the most infested crop growth stage in the surveyed area and 100% incidence was also observed in late sown sesame (end of July). An increasing infestation trend of the pest was also observed as altitude is decreased. Therefore, *A. catalaunalis* is an economic pest in western zone of Tigray.

Sesame webworm, *Antigastra catalaunalis* Duponchel (Lepidoptera: Crambidae) feeds on tender foliage at the early stages of the crop by webbing the top leaves, and bores into flower buds and pods at maturity. Its infestation from seedling to maturity stage of the crop causes heavy yield loss. Sesame, being a seasonal crop, survival and development of *A. catalaunalis* on alternate hosts play a significant role in its perpetual predominance. Hence, a survey was conducted at Annamalai Nagar, Cuddalore district, Tamil Nadu state, Southern India during June to September 2014 and December 2014 to March 2015 to catalogue the alternate hosts of *A. catalaunalis*. During the survey, the weed plant, *Pedaliium murex* Linn, commonly called large caltrops, was recorded for the first time as alternate host of *A. catalaunalis*. On *P. murex*, shoot damage to the tune of 13.66% was recorded where as the capsules were undamaged. Further, to evaluate the role of *P. murex* on the pest, the biology of *A. catalaunalis* was studied using pot cultured plants of this novel host in comparison with the prime host, sesame. Larval tenure and adult longevity were found extended on *P. murex* than sesame. This indicates that *A. catalaunalis* survives successfully on *P. murex*. (Saravanaraman *et al.* 2016)

Wazire and Patel (2016) conducted a field trial at Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University,

Sardarkrushinagar (Gujarat) during *Kharif* 2012 and 2013 on Gujarat Til2 variety. The correlation coefficient between the larval population and yield was found highly significant and relationship was found negative during both the years. The regression equation showed that the yield of sesame seeds was reduced by 0.5730 and 0.4383 q/ ha⁻¹ for every increase of one larva/ quadrat during *Kharif* 2012 and 2013. The economic injury level at 40 days after germination *i.e.*, at pod initiation stage was found 0.26 and 0.23 larvae/ quadrat for sesame during *Kharif* 2012 and 2013, respectively.

Choudhary *et al.* (2017) recorded *A. catalaunalis* as major insect pests of sesame study. Total eleven treatments including untreated control were tested against *A. catalaunalis* for their efficacy. The integrated pest management modules *viz.* T2 (Hand picking+destruction of larvae/ infested plant part+spinosad 45SC+NSKE), T4 (Hand picking+destruction of larvae/ infested plant part+indoxacarb 14.5 SC+NSKE), T1 (Hand picking+destruction of larvae/ infested plant part+acephate 75 SP+NSKE) and standard check (carbaryl) were found effective in the management of *A. catalaunalis*. The highest seed yield of 8.21 qha⁻¹ was recorded in the plots treated with T2 (picking+destruction of larvae/ infested plant part+spinosad45 SC SC+NSKE) followed by T4 (Hand picking+destruction of larvae/ infested plant part+indoxacarb14.5 SC+NSKE), (8.18 q ha⁻¹) and T1 (Hand picking+destruction of larvae/infested plant part+acephate75 SP+NSKE) (8.16q ha⁻¹). The highest B:C ratio was recorded in T9 (Greengram+HPDL/DIPP+NSKE+ *Chrysoperlazastrowi arabica* (two releases) (8.69), followed by T8 (Greengram+HPDL/DIPP+NSKE+ *Trichogramma chilonis* (two releases) (6.31).

The whitefly *Bemisia tabaci* (Genn.), (Hemiptera: Aleyrodidae) is a polyphagous insect pest and infested/ harbored on many crops/ trees/ fruits/ vegetables and cause economic damage. The studies were conducted during 2014, 2015 and 2016 using 123 plant species belonging to twenty four families including 43 crops, sixteen fruits plants, 21 vegetables, eight flowers, eleven weeds, eighteen trees, two spices and one each from ornamental, aromatic, medicinal and creeper at the College of Agriculture, Ganjbasoda (MP). The research revealed that maximum (35%) host plants were damaged

from crops followed by vegetables (17.1%), tree (14.6%) fruit plant (13%), weeds (7.3%), flower (6.5%), and rest of the plant categories *i.e.* Spices, ornamental, aromatic plants, medicinal and creeper were the least preferred by white fly for infestation and multiplication. Maximum (34) host plants were found damaged in fabaceae family followed by Cucurbitaceae (14), Malvaceae (8), Solanaceae (8), Moraceae and Euphorbeaceae (6) and Asteraceae and Brassicaceae (5). The rest of the families were found least preferred. The higher per cent of damaged crops was observed in the Fabaceae family (27.6%) followed by Cucurbitaceae (11.4%), Poaceae (8.1%), Malvaceae and Solanaceae (6.5%), Asteraceae and Moraceae (4.9%). Infestation was found less than five percentage in rest of the families. The average maximum population intensity *i.e.* 39 individual/ leaf was observed in Malvaceae family followed by Solanaceae (35.7 individual/ leaf), Amaranthaceae (28.5 individual / leaf), Solanaceae (35.7 individual/leaf), Caricaceae (28.4 individual/ leaf), Cucurbitaceae (23.4 individual/ leaf) and Bracicaceae (21.4 individual/ leaf), Compositae (19 individual/ leaf), Chenopodiaceae (14.5 individual/ leaf), Euphorbiaceae (12.1 individual/ leaf), Lamiaceae (11.4 individual/ leaf) and Poaceae (10.5 individual/ leaf). The rest of families noted less than ten individual per leaf. (Garg *et al.* 2017)

Simoglou *et al.* (2017) recorded in August 2016, severe infestations of sesame crops by the sesame leaf webber/ capsule borer, *Antigastra catalaunalis* (Duponchel) (Lepidoptera: Crambidae), in rural areas of the Regional Unit of Drama, Northern Greece. Larval feeding-damage symptoms were observed on leaves and capsules. Infestations were recorded in all of the inspected sesame fields. The infestation levels were considerable high resulting in significant economic loss.

Investigations on “Host Plant Resistance in sesame genotypes to *Antigastra catalaunalis* Dup.” were conducted at Agronomy farm and Department of Entomology, S.K.N. College of Agriculture, Jobner during *Kharif*, 2015 and 2016. *A. catalaunalis* were recorded as major insect pests of sesame during both the years of study. The infestation of *A. catalaunalis* commenced in the third week of August and reached its peak in the last week of August during 2015 and 2016, respectively. Out of 15 varieties of sesame

screened against *A. catalaunalis* none was found immune. The varieties, RT-358 (4.63), RT-370 (4.38) and RT-371 (4.18) were ranked as least susceptible, while LT-8(7.93), TC-25 (6.78) and RT-46 (7.88) as highly susceptible. The morphological characters of these varieties viz., no. of leaves, no. of branches, no. of capsules and trichome density had negative correlation with the population of *A. catalaunalis*. (Choudhary *et al.* 2018)

Vijaykumar *et al.* (2018) evaluated 60 sesame genotypes including 7 local cultivars during 2016 for resistance against sesame leaf webber/ capsule borer, *A. catalaunalis* (Dup.) at ZARS, V. C. Farm, Mandya. Among the 60 genotypes evaluated AVT-8, IVT-15, IVT 5-1, IVT-9 and Kanakapura local were reacted as highly resistant (HR) with mean pod damage of 1.15, 1.84, 1.86, 1.94 and 4.47%, respectively, along with cumulative leaf, flower and pod damage score of 1.00 while, four genotypes viz., AVT-3, AVT-1, IVT-23 and IVT-27 in which, the leaf, flower and pod damage were varied between 9.76 to 14.20%, 3.58 to 5.88%, and 1.42 to 1.65%, respectively and were rated as resistant (R) with a cumulative score of 1.66. Whereas, seven genotypes viz., IVT-5, IVT- 7, IVT -11, IVT-13, IVT-21, AVT-10, AVT 4-2, Shivalli local were reacted as susceptible (S) with leaf, flower and pod damage varied between 30 to 40%, 15 to 20%, and 6 to 8%, respectively. Out of 60 genotypes evaluated under high pest pressure, 43 genotypes were designated as highly susceptible (HS) with the mean leaf, flower and pod damage of more than 40.00, 20.00 and 8.00%, respectively.

Chapter – III

MATERIAL AND METHODS

The present Investigations, “**Studies on major insect-pests of sesame (*Sesamum indicum* L.)**”, were conducted during the *Kharif* season 2018 in the experimental field of Department of Entomology, College of Agriculture, Gwalior. The experimental area is having uniform topography, gentle slope and adequate drainage.

Location and climate:

Gwalior is situated in Gird zone at the latitude of 26°13' North and longitude 76°14' east with an altitude of 211.52 meters from mean sea level, in Madhya Pradesh. This Region comes under semi-arid sub-tropical climate with extreme weather condition having hot and dry summer and cold winter. Generally monsoon sets in during the last week of June.

Annual rainfall ranges from 700 to 800 mm, most of which falls during last June to the middle of September. In this area winter rains are occasional and uncertain. The maximum temperature goes up to 45°C during summer and minimum as low as 5°C during winter.

Meteorological data recorded during the period of experimentation are given in table 3.1 and depicted in fig 3.1.

Table 3.1: Meteorological data during the crop season of 2018

Standard Week no.	Week	Temperature °C		Relative Humidity (%)		Rainfall (mm)
		Max	Min	Morning	Evening	
32	Aug. 6-12	33.5	26.5	87.1	62.3	013.0
33	Aug. 13-19	33.8	26.3	91.0	65.4	064.8
34	Aug. 20-26	31.6	25.7	90.7	78.6	082.0
35	Aug.-Sep. 27-2	30.5	25.0	92.9	73.7	084.4
36	Sep. 3-9	28.9	23.8	91.4	81.4	050.0
37	Sep. 10-16	31.8	24.6	79.9	67.4	000.0
38	Sep. 17-23	33.3	23.8	83.0	66.8	032.0
39	Sep. 24-30	33.8	27.7	80.1	56.8	000.0
40	Oct. 1-7	36.7	18.5	63.6	44.1	000.0
41	Oct. 8-14	35.4	18.7	81.5	38.5	000.0
42	Oct. 15-21	36.5	17.4	76.8	27.5	000.0
43	Oct. 22-28	34.5	14.9	80.7	28.7	000.0
44	Oct.-Nov.29-4	33.3	14.4	82.1	28.2	000.0
45	Nov. 5-11	29.6	10.6	83.6	33.6	000.0
Average		33.1	21.3	83.2	53.8	23.3

Source: Meteorological observatory, College of Agriculture, Gwalior (M.P.)

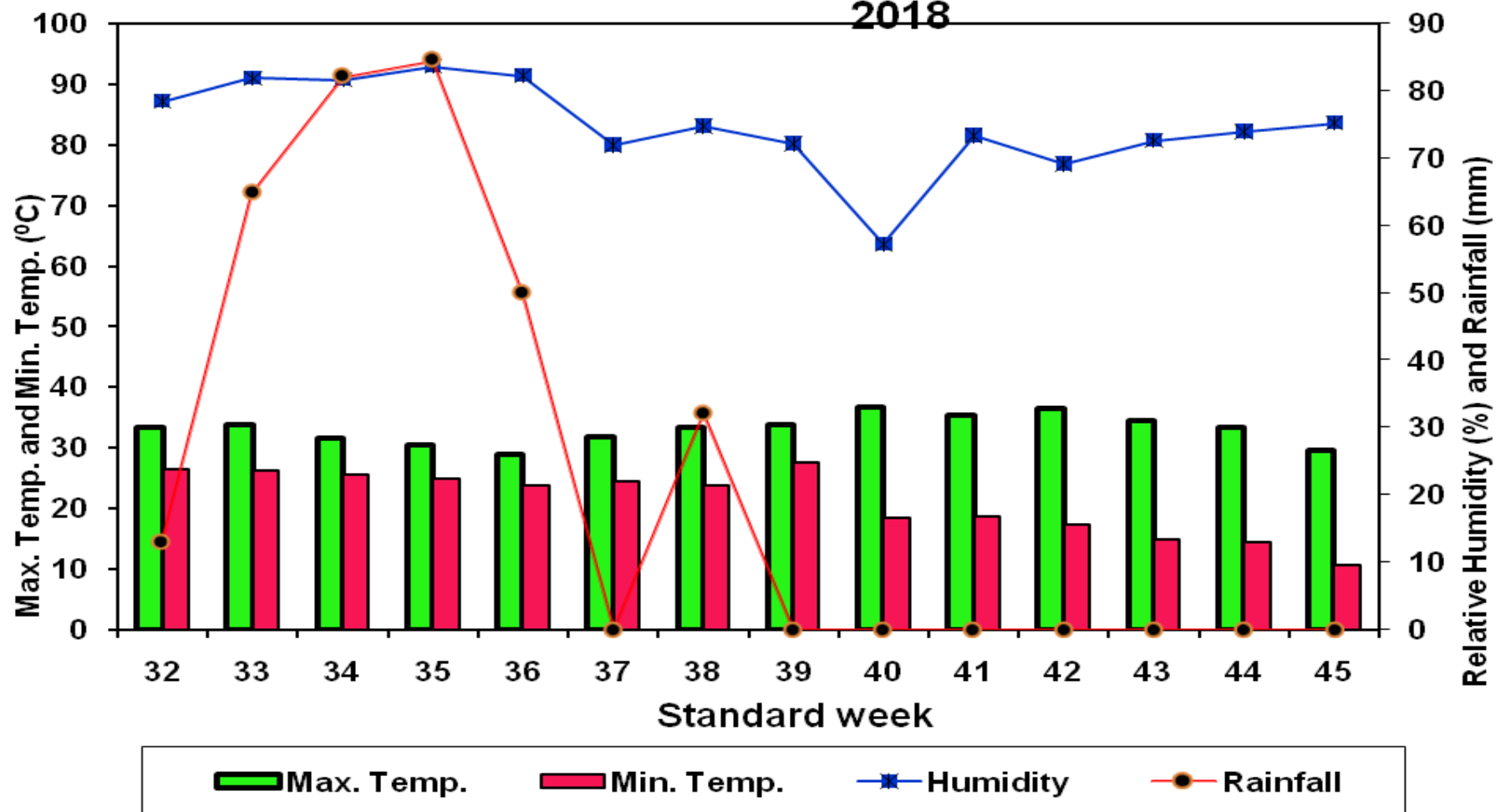
Details of the experiment:

1. Experiment No.1: Seasonal incidence of major insect-pests of sesame

Details of experiment:

Crop	:	Sesame
Variety	:	SCS-551
Plot size	:	3 × 5 m ²
Row to Row distance	:	30 cm
Plant to plant distance	:	10 cm
Sowing date	:	08-08-2018

Fig 3.1: Meteorological data during the crop season of 2018



Observation recorded:

To study the seasonal incidence of insect-pests, the crop was kept free from insecticide application. Weekly observations on different insect pests were recorded on 10 randomly selected plants starting from germination till their availability or maturity of the crop.

a) For Whitefly and Jassid: The populations of Whitefly and Jassid was counted on upper, middle and liner leaves of the plant.

b) For Til leaf roller/ Capsule borer: Number of webbed leaf per ten plants was counted for leaf roller and 50 capsule randomly selected from each plot was observed and damaged capsule was counted from there randomly selected plant.

c) For Til hawk moth: number of larvae was recorded by counting of larvae/plant on ten randomly selected plants.

d) For Gall fly: Number of webbed leaf per ten plant was counted for leaf roller and 50 capsule randomly selected from each plot was observed and damaged capsule was counted from there randomly selected plant.

e) For Mirid bug: observations were recorded on 10 plants randomly selected on shoot tip.

2. Experiment No. 2: Screening of sesame genotype against major insect-pests

Design	:	RBD
Replication	:	3
Plot size	:	2.4 x3 m ²
Plot no.	:	30

Genotypes: 10

V ₁ : TKG- 501	V ₆ : TKG-22
V ₂ : TKG-518	V ₇ : TKG-308
V ₃ : TKG-506	V ₈ : TKG-55
V ₄ : TKG-529	V ₉ : JTS-8
V ₅ : TKG-306	V ₁₀ : SCS-551

For recording observations on the number of insect pests, observations were recorded on ten plants of uniform height was selected at random from each genotype/ plot. Genotypes were screened on the basis of damage at vegetative, flowering and capsule formation stage and seed yield were recorded, assessment of different genotypes of sesame on the basis of damage.

In each replication, the observations on percent plant, flower and capsule damages by *A. catalaunalis* were recorded at different stages of plant growths viz., vegetative (30 DAS), flowering (45 DAS) and Capsule maturity stage (70 DAS). The healthy and damaged plant, flower and capsules were counted and finally percent plant, flower and capsule damage were calculated as -

$$\text{Plant damage (\%)} = \frac{\text{Number of damaged plants}}{\text{Total number of plants}} \times 100$$

$$\text{Flower damage (\%)} = \frac{\text{Number of damaged flower}}{\text{Total number of flower}} \times 100$$

$$\text{Capsule damage (\%)} = \frac{\text{Number of damaged capsule}}{\text{Total number of capsule}} \times 100$$

The resistance / susceptibility for individual line were judged on the basis of percent plant, flower and capsule damage. A rating system for percent plant, flower and capsule damage developed by sesame was followed for estimating relative resistance/ susceptibility.

Table 3.2: Susceptibility rating scale on the basis of percent plant damage at 30 DAS

Plant damage (%)	Reactions	Number of genotypes	genotypes
No Damage	Immune	-	-
<10	Resistant	-	-
10-20	Moderately resistant	-	-
21-30	Moderately susceptible	-	-
31-50	Susceptible	-	-
>50	Highly susceptible	-	-

Table 3.3: Susceptibility rating scale on the basis of percent flower damage at 45 DAS

Plant damage (%)	Reactions	Number of genotypes	genotypes
No Damage	Immune	-	-
<10	Resistant	-	-
10-20	Moderately resistant	-	-
21-30	Moderately susceptible	-	-
31-50	Susceptible	-	-
>50	Highly susceptible	-	-

Table 3.4: Susceptibility rating scale on the basis of percent capsule damage at 70 DAS

Capsule damage (%)	Reactions	Number of genotypes	genotypes
No Damage	Immune	-	-
<5	Resistant	-	-
5-10	Moderately resistant	-	-
11-15	Moderately susceptible	-	-
16-25	Susceptible	-	-
>25	Highly susceptible	-	-

1. White fly: Observations on nymphs and adults population were recorded with the ten plants per plot was observed to record the population.

2. Jassid: Observation on nymphs and adults population were recorded with the ten plants per plot was observed to record the population.

3. Til leaf roller/ capsule borer: Observations were recorded on flowers infestation at 40 days after sowing and capsule damaged by capsule borer during capsule stage, for flower damage, healthy and damaged flowers/ twig and for capsule damage, healthy and damage capsule. Plant was counted and finally flower infestation and capsule damage was worked out.

4. Gall fly: Number of webbed leaf per ten plants was counted for leaf roller and 50 capsule randomly selected from each plot was observed and damaged capsule was counted from there randomly selected plant.

5. Til hawk moth: Number of larvae was recorded by counting of larvae/ plant on ten randomly selected plants.

6. Mirid bug: Observations were recorded on 10 plants randomly selected on shoot tip.

Statistical analysis:

The data were subjected to statistical analysis after transformation. The count data were transformed to \sqrt{x} values, while percentages were transformed to \sqrt{x} whose values ranges from 0 to 30 and 70 to 100 and into angular whose values ranges from 0 to 100. The skeleton of analysis of variance is given below.

Table 3.5: Skeleton of ANOVA

Source of variation	D.F	S.S	M.S.S	F cal	F tab
Replication	(r-1)	SSR	MSR	MSR/MSE	
Treatments	(t-1)	SSTr	MSTr	MStr/MSE	
Error	(r-1)(t-1)	SSE	MSE		
Total	(rt-1)				

r - Number of replications

t - Number of treatments

The 'F' test was used for testing the significant effect of various treatments.

$$SE(m) = \sqrt{\frac{MSE}{r}}$$

Where,

'r' is the number of replications.

$$CD = SE(m) \times \sqrt{2} \times t \text{ value at 5\% level of significance for error d.f.}$$

Analysis of Correlation and regression studies:

Correlation and regression of the abiotic factors on major insects were worked out by using the formula as suggested by Snedecor and Cochran (1967).

$$\text{Correlation 'r'} = \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{\left\{ \sum x^2 - \frac{(\sum x)^2}{n} \right\} \left\{ \sum y^2 - \frac{(\sum y)^2}{n} \right\}}}$$

Regression = a + bx (R₂)

a = Intercept.

b = Regression coefficient.

R₂ = Coefficient of multiple determination.

Test of significance 'r'

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

Weather factors and the data collected on the succession and population dynamics of major insect pest of til was statistically analyzed to study the correlation and regression between meteorological data and insect pest population on sesame.

Chapter - IV

RESULTS

This chapter deals with the experimental results which are elucidated in the following heads:

Seasonal incidence of major insect pests of sesame

Observation was conducted on sesame crop from August 2018 to November, 2018. During the course of study, following major insect pests were recorded:

Table 4.1: Seasonal incidence of insect pests on sesame

S.No.	Common name	Scientific name	Order	Family
1.	White fly	<i>Bemisia tabaci</i> (Genn.)	Hemiptera	Aleurodidae
2.	Jassid	<i>Amrasca devastans</i> (Ishida)	Hemiptera	Cicadellidae
3.	Leaf roller/ capsule borer	<i>Antigastra catalaunalis</i> Duponchel	Lepidoptera	Crambidae
4.	Til Hawk moth	<i>Acherontia styx</i> Westwood	Lepidoptera	Sphingidae
5.	Gall fly	<i>Asphondylia sesame</i> Felt	Diptera	Cecidomyiidae
6.	Mirid bug	<i>Nesidiocoris</i> sp.	Hemiptera	Miridae

(i) Whitefly (*Bemisia tabaci* Genn.)

Whitefly was observed to suck the cell-sap from the lower surface of leaves. The activity of the whitefly was observed from 33rd standard week (13-19 August) upto 45th standard week (5-11November). During the activity period the population of whitefly ranged from 0.03 to 0.60 whitefly/ plant. During the activity period of whitefly the minimum and maximum temperature, morning and evening relative humidity and rainfall ranged from 10.6°C to 27.7°C, 28.9°C to 36.7°C, 37.1 to 92.9%, 27.5 to 81.4% and 000.0 to 084.4 mm, respectively (Table 4.2 and Fig4.1).

(ii) Jassids (*Amrasca devastans* Ishida)

Jassid was another major pest of sesame crops and it appeared on 33rd August 2018. The damage was caused by both nymphs and adults that sucked plant sap from the lower surface of leaves caused curling of leaves and leading to stunted growth of the plants. Jassid population was highest in the 10th to 16th September 2018. During this period temperature maximum and minimum ranged from 28.9 to 36.7°C and 10.6 to 27.7°C, respectively. Relative humidity (morning and evening) was also high as it ranged from 37.1 to 92.9% and 27.5 to 81.4% and occasional rains was also observed in SMW 35 (Table 4.2 and Fig.4.1).

(iii) Leaf roller/ capsule borer (*Antigastra catalaunalis* Duponchel)

The studies on the seasonal incidence of leaf roller revealed that the pest was first recorded on sesame in the 34th standard week (20-26 August) and remained active on the crop upto 45th standard week (5 -11 November). During the activity period of the pest the population of leaf roller ranged from 0.66 -45.33 leaf roller per plant. During the pest activity period the range of minimum and maximum temperature, morning and evening relative humidity and rainfall ranged from 28.9°C to 36.7°C, 10.6°C to 27.7°C, 37.1 to 92.9%, 27.5 to 81.4% and 000.0 to 084.4 mm, respectively. The pest population was found highest in 37th standard weeks (10 to 16 September) when the average minimum and maximum temperature, morning and evening relative humidity and rainfall were 24.6°C, 31.8°C, 79.9%, 67.4% and 082.0 mm, respectively. The pest population started declining from 45th standard week onwards (5-11November) (Table 4.2 and Fig 4.1).

As far as the capsule damaged of the capsule borer is concerned, the symptom of the damage by the pest appeared in second week of August when 38.10% damaged capsule was recorded. However, the highest damaged capsule (67.69%) was observed in the 40th standard week (1-7 October). When the average minimum and maximum temperature, morning and evening relative humidity and rainfall (24.6°C and 31.8°C, 79.9% and 67.4% and 000.0 mm) were the damaged capsule started declining from 45th standard week (5-11November). Thus damaged capsule was observed more serious from August-November.

(iv) Til Hawk moth (*Acherontia styx* Westwood)

The Til Hawk moth appeared in the 37th standard week of August 2018 and continued till the harvesting. Increasing trend was observed in this case with crop growth stages. The maximum (0.38 larvae per plant) Til hawk moth larvae per plant was recorded at 3 -9 September 2018. When, the average maximum and minimum temperature was 28.9 and 23.8^oC respectively with 91.4% and 81.4% morning and evening relative humidity and 050.0 rainfall (Table 4.2 and Fig.4.1).

(v) Gall fly (*Asphondylia sesame* Felt)

The studies on the seasonal incidence of gall fly revealed that the pest was first recorded on sesame in the 37th standard week (10 -16 Sep.) and remained active on the crop upto 45th standard week (5 -11 November). During the activity period of the pest the population of gall fly ranged from 2.66 to 20.66 gall fly per plant. During the pest activity period the range of minimum and maximum temperature, morning and evening relative humidity and rainfall ranged from 10.6^oC to 27.7^oC, 28.9^oC to 36.7^oC, 37.1 to 92.9%, 27.5 to 81.4% and 000.0 to 084.4 mm, respectively. The pest population was found highest in 37th standard weeks (1 -7 October) when the average minimum and maximum temperature, morning and evening relative humidity and rainfall were 18.5^oC, 36.7^oC, 63.6%, 44.1% and 000.0 mm, respectively. The pest population started declining from 45th standard week onwards (5 -11 November) (Table 4.2 and Fig4.1).

As far as the capsule damaged, by the gall fly is concerned, the symptom of the damage by the pest appeared in 37th standard week of August when 38.15% damaged capsule was recorded. However, the highest damaged capsule (59.31%) was observed in the 43rd standard week (22 -28 October), when the average minimum and maximum temperature, morning and evening relative humidity and rainfall (14.9^oC and 34.5^oC, 80.7% and 28.7% and 000.0 mm) were the damaged capsule started declining from 45th standard weeks (5 -11 November). Thus damaged capsule was observed from August-October but more serious during August-November.

(vi) Mirid bug (*Nesidiocoris* sp.)

Mirid bug was observed, feeding on sesame fruits by making holes. The pest infestation commenced from 20-26 August 2018 and gradually increased till the crop was harvested. Population peaked (0.36 bug/ plant) in the 3-9 September 2018, when the average maximum and minimum temperature was 28.9 and 23.8⁰C, respectively with 91.4% and 81.4% morning and evening relative humidity and occasional rain was also observed (Table 4.2 and Fig.4.1).

Correlation with meteorological parameters

(i) Whitefly (*Bemisia tabaci* Genn.)

Correlation coefficient among whitefly population and meteorological parameters revealed that the whitefly population exhibited non significant association with relative humidity evening (0.217) and temperature minimum (0.163). However, it exhibited negative correlation with temperature maximum (-0.076) and relative humidity morning (-0.225) and rainfall (-0.162) (Table4.3).

(ii) Jassids (*Amrasca devastans* Ishida)

Correlation coefficient of jassids population exhibited non significant correlation with relative humidity evening (0.381) and temperature minimum (0.277), while negative association of this character was observed with temperature maximum (-0.207) and relative humidity of morning (-0.171) and rainfall (-0.085) (Table4.3).

(iii) Leaf roller/ capsule borer (*Antigastra catalaunalis* Duponchel)

Correlation coefficient of leaf roller/ capsule borer population exhibited non significant correlation with relative humidity evening (0.202) and temperature minimum (0.133), while, it was found negative with temperature maximum (-0.200) relative humidity morning (0.300) and rainy days (-0.276) (Table4.3).

(iv) Til Hawk moth (*Acherontia styx* Westwood)

Til hawk moth were positively associated with rainy days (0.340), relative humidity evening (0.587), relative humidity morning (0.212) and temperature minimum (0.351). However, it exhibited negative association with temperature maximum (-0.525) (Table 4.3).

Table 4.3: Correlation coefficient of insect population with meteorological parameter

	Whitefly	Jassids	Leaf roller/ capsule borer	Til Hawk moth	Gall fly	Mirid bug
Temp. (Max.)	-0.076 ^{NS}	-0.207 ^{NS}	-0.200 ^{NS}	-0.525*	-0.123 ^{NS}	-0.185 ^{NS}
Temp. (min.)	0.163 ^{NS}	0.277 ^{NS}	0.133 ^{NS}	0.351 ^{NS}	-0.031 ^{NS}	0.264 ^{NS}
RH (morn.)	-0.225 ^{NS}	-0.171 ^{NS}	-0.300 ^{NS}	0.212 ^{NS}	-0.348 ^{NS}	-0.190 ^{NS}
RH (even.)	0.217 ^{NS}	0.381 ^{NS}	0.202 ^{NS}	0.587*	0.089 ^{NS}	0.355 ^{NS}
Rainfall (mm)	-0.162 ^{NS}	-0.085 ^{NS}	-0.276 ^{NS}	0.340 ^{NS}	-0.288 ^{NS}	-0.144 ^{NS}

* Significant at 5% and 1%, NS – Non Significant

(v) Gall fly (*Asphondylia sesame* Felt)

Gall fly population had non significant and positive correlation with relative humidity evening (0.089) and it was negatively associated with temperature maximum (-0.123), temperature minimum (-0.031), rainy days (-0.288) and relative humidity morning (-0.348) (Table 4.3).

(vi) Mirid bug (*Nesidiocori* ssp.)

Mirid bug population expressed non significant correlation with relative humidity evening (0.355) and other positive association *i.e.* temperature minimum (0.264). However, it was negatively associated with and temperature maximum (-0.185), relative humidity morning (-0.190) and rainfall (-0.144) (Table 4.3).

(B) Screening of sesame genotypes against major insect-pests

The sesame genotypes were screened against major insect-pests *viz.*, white fly, jassids, leaf roller/ capsule borer, Til hawk moth, gall fly and mirid bug damage during *Kharif* season 2018-19. The relative susceptibility of individual lines to major insect-pests was examined on the basis of percent damage at different stages of plant growth (vegetative, flower and capsule stage). The results obtained are described here under.

4.1 Screening of different genotypes of sesame against white fly on the basis of percent damage at different stages of plant growth:

Ten genotypes were screened against major insect-pests under natural infestation conditions (field conditions). The data on percent plant, flower and capsule damage by major insect-pests are presented in Table 4.4 to 4.9. The percent plant damage was recorded at vegetative stages (30 DAS) by counting the number of damaged and healthy plants/ plot. The flower damage was recorded at 50% flowering stage (45 DAS) by counting the total number of damaged and healthy flowers on five plants per plot and averaged. Percent capsule damage was recorded at maturity stage of the crop (70 DAS) by counting the total number of damaged and healthy capsule on the five plants per plot and averaged.

(i) Whitefly (*Bemisia tabaci* Genn.)

(a) Percent plant damage:

The significant difference among the genotypes in recording percent plant damage was observed (Table 4.4). The plant damage was ranged from 9.32 to 55.42%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (55.42%) followed by TKG-55 (48.27%), TKG-308 (25.52%), TKG-22 (24.25%) and TKG-529 (21.65%). Lowest plant damage (9.32%) was recorded in TKG-501 followed by SCS-551 (10.94%). Other genotypes which showed less plant damage were SCS-551 (10.94%) and TKG-306 (12.31%). Further the genotypes SCS-551 and TKG-306 were found at par to each other in their respective group to record the lowest plant damage.

(i.) Grouping of sesame genotypes on the basis of percent plant damage:

The sesame genotypes were grouped into different categories based on percent plant damage (Table 4.5). None of the screened genotypes was found free from infestation. Only one genotype TKG-501 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes four genotypes showing whitefly damage in the range of 10-20 percent viz., TKG-518, TKG-506, TKG-306 and SCS-551. Three genotypes TKG-529, TKG-22 and TKG-308 were found moderately susceptible and showing plant damage in the range of 21-30 percent and one genotype i.e. TKG-55 was observed as susceptible showing infestation in the range of 31-50 percent. The only one genotype i.e. JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

(b) Percent flower damage:

The significant difference among the genotypes in recording percent flower damage was observed (Table 4.6). The flower damage ranged from 8.78 to 45.47%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent flower damage was recorded in genotype JTS-8 (45.47%) followed by TKG-55 (42.19%), TKG-308 (34.49%), TKG-22 (32.37%) and TKG-529 (24.52%). Lowest flower damage (8.78%) was recorded in SCS-551 followed by TKG-501 (12.01%). Other genotypes which showed less flower damage were TKG-506 (12.08%), TKG-518 (13.35%), and TKG-306 (18.92%). The genotypes SCS-551, TKG-501, TKG-506 and TKG-518 were found most superior in respect to record the lowest flower damage.

(i.) Grouping of sesame genotypes on the basis of percent flower damage:

The sesame genotypes were grouped into different categories based on percent flower damage (Table 4.7). None of the screened genotypes was found free from infestation. Only one genotype SCS-551 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes 4 genotypes showing whitefly damage in the range of 10-20

percent *i.e.*, TKG-501, TKG-518, TKG-506 and TKG-306. One genotype TKG-529 was found moderately susceptible and showing flower damage in the range of 21-30 percent and four genotypes *i.e.* TKG-22, TKG-308, TKG-55 and JTS-8 were observed as susceptible showing infestation in the range of 31-50 percent.

(c) Percent capsule damage:

The significant difference among the genotypes in recording percent capsule damage was observed (Table 4.8). The capsule damage ranged from 8.55 to 32.15%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent capsule damage was recorded in genotype JTS-8 (32.15%) followed by TKG-55 (28.20%), TKG-308 (27.02%) and TKG-22 (21.27%). Lowest capsule damage (8.55%) was recorded in TKG-501 followed by SCS-551 (10.21%). Other genotypes which showed less capsule damage were TKG-518 (11.82%), TKG-306 (12.69%), TKG-529 (18.70%), and TKG-506 (19.38%). The genotypes TKG-501 and SCS-551 was found most superior to other respective to record the lowest capsule damage.

(i.) Grouping of sesame genotypes on the basis of percent capsule damage:

The sesame genotypes were grouped in to different categories based on percent capsule damage (Table 4.9). None of the screened genotypes was found free from infestation. Two genotypes *viz.*, TKG-501 and SCS-551 were found moderately resistant showing whitefly damage in the range 5 to 10 percent. The moderately susceptible category includes two genotypes showing whitefly damage in the range of 11 -15 percent *i.e.*, TKG-518 and TKG-306. Three genotypes TKG-506, TKG-529 and TKG-22 were found susceptible and showing capsule damage in the range of 16 -25 percent and the three genotypes *i.e.* TKG-308, TKG-55 and JTS-8 was found as highly susceptible category with more than 25 percent capsule damage.

(ii) Jassids (*Amrasca devastans* Ishida)

(a) Percent plant damage:

The significant difference among the genotypes in recording percent plant damage were observed (Table 4.10). The plant damage was ranged

from 8.53 to 54.08%, being lowest in TKG-501 and highest in TKG-55. The highest mean percent plant damage was recorded in genotype TKG-55 (54.08%) followed by TKG-308 (48.49%), and JTS-8 (23.91%). Lowest plant damage (8.53%) was recorded in TKG-501 followed by SCS-551 (9.18%). Other genotypes which showed less plant damage were TKG-518 (10.86%), TKG-22 (10.91%), TKG-506 (14.03%), TKG-529 (17.49%) and TKG-306 (19.39%). The genotypes TKG-501, SCS-551 were found at par to each other in respect to record the lowest plant damage.

(i.) Grouping of sesame genotypes on the basis of percent plant damage:

The sesame genotypes were grouped in to different categories based on percent plant damage (Table 4.11). None of the screened genotypes was found free from infestation. Two genotypes TKG-501 and SCS-551 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes 5 genotypes showing jassids damage in the range of 10-20 percent *viz.*, TKG-518, TKG-506, TKG-529, TKG-306 and TKG-22. One genotype JTS-8 were found moderately susceptible and showing plant damage in the range of 21 -30 percent and one genotype *i.e.* TKG-308 was observed as susceptible showing infestation in the range of 31 -50 percent. The only one genotype *i.e.* TKG-55 was found as highly susceptible category with more than 50 percent plant damage.

(b) Percent flower damage:

The significant difference among the genotypes in recording percent flower damage was observed (Table 4.12). The flower damage ranged from 9.47 to 46.50%, being lowest in TKG-501 and highest in TKG-55. The highest mean percent flower damage was recorded in genotype TKG-55 (46.50%) followed by TKG-308 (41.73%), SCS-551 (29.38%), TKG-306 (22.39%) and TKG-529 (22.03%). Lowest flower damage (9.47%) was recorded in TKG-501 followed by TKG-22 (11.27%). Other genotypes which showed less flower damage were TKG-506 (12.91%), JTS-8 (13.68%), and TKG-518 (14.77%). The genotypes TKG-501, TKG-22 were found most superior in respect to record the lowest flower damage.

(i.) Grouping of sesame genotypes on the basis of percent flower damage:

The sesame genotypes were grouped in to different categories based on percent flower damage (Table 4.13). None of the screened genotypes was found free from infestation. Only one genotype TKG-501 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes four genotypes showing jassids damage in the range of 10 - 20 percent *i.e.*, TKG-518, TKG-506, TKG-22 and JTS-8. Three genotypes TKG-529, TKG-306 and SCS-551 was found moderately susceptible and showing flower damage in the range of 21 -30 percent and two genotypes *i.e.* TKG-308 and TKG-55 were observed as susceptible showing infestation in the range of 31 -50 percent.

(c) Percent capsule damage:

The significant difference among the genotypes in recording percent capsule damage was observed (Table 4.14). The capsule damage ranged from 5.24 to 33.12%, being lowest in TKG-501 and highest in TKG-55. The highest mean percent capsule damage was recorded in genotype TKG-55 (33.12%) followed by TKG-308 (26.12%) and JTS-8 (20.13%). Lowest capsule damage (5.24%) was recorded in TKG-501 followed by SCS-551 (7.92%) and TKG-518 (7.94%). Other genotypes which showed less capsule damage were TKG-22 (8.89%), TKG-506 (13.38%), TKG-306 (16.20%) and TKG-529 (17.74%). The genotypes TKG-501, SCS-551 and TKG-518 were found most superior to other respective to record the lowest capsule damage.

(i.) Grouping of sesame genotypes on the basis of percent capsule damage:

The sesame genotypes were grouped in to different categories based on percent capsule damage (Table 4.15). None of the screened genotypes was found free from infestation. Four genotypes *viz.*, TKG-501, TKG-518, TKG-22 and SCS-551 was found moderately resistant showing jassids damage in the range 5 to 10 percent. The moderately susceptible category includes One genotype showing jassids damage in the range of 11 -15

percent *i.e.*, TKG-506. Three genotypes TKG-529, TKG-306 and JTS-8 was found susceptible and showing capsule damage in the range of 16 -25 percent and the two genotypes *i.e.* TKG-308 and TKG-55 was found as highly susceptible category with more than 25 percent capsule damage.

(iii) Leaf roller/ capsule borer (*Anigastra catalaunalis*)

(a) Percent plant damage:

The significant difference among the genotypes in recording percent plant damage was observed (Table 4.16). The plant damage ranged from 9.56 to 54.43%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (54.43%) followed by SCS-551 (48.27%), TKG-55 (25.51%) and TKG-22 (20.33%). Lowest plant damage (9.56%) was recorded in TKG-501 followed by TKG-518 (9.95%). Other genotypes which showed less plant damage were TKG-506 (13.41%), TKG-529 (13.51%), TKG-306 (16.39%) and TKG-308 (17.12%). The genotypes TKG-501, TKG-518 were found at par to each other in respect to record the lowest plant damage.

(i.) Grouping of sesame genotypes on the basis of percent plant damage:

The sesame genotypes were grouped in to different categories based on percent plant damage (Table 4.17). None of the screened genotypes was found free from infestation. Two genotypes TKG-501 and TKG-518 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes four genotypes showing leaf roller/ capsule borer damage in the range of 10-20 percent *viz.*, TKG-506, TKG-529, TKG-306 and TKG-308. Two genotypes TKG-22 and TKG-55 were found moderately susceptible and showing plant damage in the range of 21-30 percent and only one genotype *i.e.*SCS-551 was observed as susceptible showing infestation in the range of 31-50 percent. The only one genotype *i.e.* JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

(b) Percent flower damage:

The significant difference among the genotypes in recording percent flower damage was observed (Table 4.18). The flower damage ranged from

9.63 to 45.43%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent flower damage was recorded in genotype JTS-8 (45.43%) followed by SCS-551 (42.19%), TKG-55 (34.49%), TKG-22 (23.52%), TKG-308 (21.67%), TKG-306 (20.63%) and TKG-529 (20.24%). Lowest flower damage (9.63%) was recorded in TKG-501 followed by TKG-518 (13.54%) and TKG-506 (18.27%).

(i) Grouping of sesame genotypes on the basis of percent flower damage:

The sesame genotypes were grouped in to different categories based on percent flower damage (Table 4.19). None of the screened genotypes was found free from infestation. Only one genotype TKG-501 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes four genotypes showing leaf roller/ capsule borer damage in the range of 10-20 percent *i.e.*, TKG-518, TKG-506, TKG-529 and TKG-306. Two genotypes TKG-22 and TKG-308 was found moderately susceptible and showing flower damage in the range of 21-30 percent and three genotypes *i.e.* TKG-55, JTS-8 and SCS-551 were observed as susceptible showing infestation in the range of 31-50 percent.

(b) Percent capsule damage:

The significant difference among the genotypes in recording percent capsule damage was observed (Table 4.20). The capsule damage ranged from 8.24 to 29.21%, being lowest in TKG-501 and highest in SCS-551. The highest mean percent capsule damage was recorded in genotype SCS-551 (29.21%) followed by TKG-55 (21.42%) and TKG-22 (18.58%). Lowest capsule damage (8.24%) was recorded in TKG-501 followed by JTS-8 (8.34%) and TKG-518 (9.89%). Other genotypes which showed less capsule damage were TKG-529 (12.82%), TKG-506 (15.58%), TKG-306 (17.53%) and TKG-308 (17.75%). The genotypes TKG-501, JTS-8 and TKG-518 were found most superior to other respective to record the lowest capsule damage.

(i) Grouping of sesame genotypes on the basis of percent capsule damage:

The sesame genotypes were grouped in to different categories based on percent capsule damage (Table 4.21). None of the screened genotypes was found free from infestation. Three genotypes viz., TKG-501, TKG-518 and JTS-8 was found moderately resistant showing leaf roller/ capsule borer damage in the range 5 to 10 percent. The moderately susceptible category includes two genotypes showing leaf roller/ capsule borer damage in the range of 11-15 percent *i.e.*, TKG-506 and TKG-529. Four genotypes TKG-306, TKG-22, TKG-308 and TKG-55 was found susceptible and showing capsule damage in the range of 16-25 percent and the one genotype *i.e.* SCS-551 was found as highly susceptible category with more than 25 percent capsule damage.

(v) Til hawk moth (*Acherontia styx* Westwood)

(a) Percent plant damage:

The significant difference among the genotypes in recording percent plant damage was observed (Table 4.22). The plant damage was ranged from 5.52 to 52.43%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (52.43%) followed by TKG-55 (46.15%), TKG-308 (24.01%), TKG-306 (22.51%) and TKG-22 (20.38%). Lowest plant damage (5.52%) was recorded in SCS-551 followed by TKG-501 (8.15%). Other genotypes which showed less plant damage were TKG-506 (9.93%), TKG-529 (16.19%) and TKG-518 (16.81%).

(i.) Grouping of sesame genotypes on the basis of percent plant damage:

The sesame genotypes were grouped in to different categories based on percent plant damage (Table 4.23). None of the screened genotypes was found free from infestation. Three genotypes TKG-501, TKG-506 and SCS-551 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes three genotypes showing til hawk moth damage in the range of 10-20 percent viz., TKG-518, TKG-529 and TKG-22. Two genotypes TKG-306 and TKG-308 were found moderately susceptible and showing plant damage in the range of 21-30 percent and only one genotype *i.e.* TKG-55 was observed as susceptible showing infestation in

the range of 31-50 percent. The only one genotype *i.e.* JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

(b) Percent flower damage:

The significant difference among the genotypes in recording percent flower damage was observed (Table 4.24). The flower damage ranged from 8.77 to 47.32%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent flower damage was recorded in genotype JTS-8 (47.32%) followed by TKG-55 (42.51%), TKG-529 (26.92%), TKG-518 (23.07%), TKG-308 (22.86%) and TKG-22 (22.31%). Lowest flower damage (8.77%) was recorded in SCS-551 followed by TKG-501 (14.75%). Other genotypes which showed less flower damage were TKG-506 (15.58%) and TKG-306 (19.47%). The genotypes TKG-501, TKG-506 were found most superior in respect to record the lowest flower damage.

(i.) Grouping of sesame genotypes on the basis of percent flower damage:

The sesame genotypes were grouped in to different categories based on percent flower damage (Table 4.25). None of the screened genotypes was found free from infestation. Only one genotype SCS-551 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes 3 genotypes showing til hawk moth damage in the range of 10-20 percent *i.e.*, TKG-501, TKG-506 and TKG-22. Four genotypes TKG-518, TKG-529, TKG-22 and TKG-308 were found moderately susceptible and showing flower damage in the range of 21-30 percent and two genotypes *i.e.* TKG-55 and JTS-8 were observed as susceptible showing infestation in the range of 31-50 percent.

(c) Percent capsule damage:

The significant difference among the genotypes in recording percent capsule damage was observed (Table 4.26). The capsule damage ranged from 7.31 to 33.15%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent capsule damage was recorded in genotype JTS-8 (33.15%) followed by TKG-55 (28.18%), TKG-306 and TKG-308 (20.25%). Lowest capsule damage (7.31%) was recorded in SCS-551 followed by TKG-

501 (9.19%). Other genotypes which showed less capsule damage were TKG-506 (11.21%), TKG-529 (17.41%), TKG-518 (18.74%) and TKG-22 (19.97%). The genotypes SCS-551 and TKG-501 were found most superior to other respective to record the lowest capsule damage.

(i.) Grouping of sesame genotypes on the basis of percent capsule damage:

The sesame genotypes were grouped into different categories based on percent capsule damage (Table 4.27). None of the screened genotypes was found free from infestation. Two genotypes *viz.*, TKG-501 and SCS-551 were found moderately resistant showing Til hawk moth damage in the range 5 to 10 percent. The moderately susceptible category includes one genotypes showing Til hawk moth damage in the range of 11-15 percent *i.e.*, TKG-506. Five genotypes TKG-518, TKG-529, TKG-306, TKG-22 and TKG-308 was found susceptible and showing capsule damage in the range of 16-25 percent and the two genotypes *i.e.* TKG-55 and JTS-8 was found as highly susceptible category with more than 25 percent capsule damage.

(i) Gall fly (*Asphondylia sesame* Felt)

(a) Percent plant damage:

The significant differences among the genotypes in recording percent plant damage were observed (Table 4.28). The plant damage was ranged from 10.69 to 56.43%, being lowest in TKG-308 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (56.43%) followed by SCS-551 (52.18%), TKG-55 (37.51%), TKG-22 (26.25%), TKG-306 (23.65%) and TKG-506 (20.01%). Lowest plant damage (10.69%) was recorded in TKG-308 followed by TKG-501 (11.59%) and TKG-518 (12.09%). Other genotypes which showed less plant damage were TKG-529 (17.95%). Further the genotypes TKG-308, TKG-501 and TKG-518 were found at par to each other in their respective group to record the lowest plant damage.

(i.) Grouping of sesame genotypes on the basis of percent plant damage:

The sesame genotypes were grouped in to different categories based on percent plant damage (Table 4.29). None of the screened genotypes were found free from infestation. The moderately resistant category includes 5 genotypes showing gall fly damage in the range of 10-20 percent viz., TKG-501, TKG-518, TKG-506, TKG-529 and TKG-308. Two genotypes TKG-306, and TKG-308 were found moderately susceptible and showing plant damage in the range of 21-30 percent and one genotype i.e. TKG-55 was observed as susceptible showing infestation in the range of 31-50 percent. The two genotypes i.e. JTS-8 and SCS-551 was found as highly susceptible category with more than 50 percent plant damage.

(a) Percent flower damage:

The significant difference among the genotypes in recording percent flower damage was observed (Table 4.28). The flower damage ranged from 17.15 to 48.45%, being lowest in TKG-501 and highest in SCS-551. The highest mean percent flower damage was recorded in genotype SCS-551 (48.45%) followed by TKG-55 (44.48%), JTS-8 (43.19%), TKG-22 (33.39%), TKG-529 (27.85%) and TKG-306 (26.81%). Lowest flower damage (17.15%) was recorded in TKG-501 followed by TKG-308 (18.12%) and TKG-518 (18.17%). Other genotypes which showed less flower damage was TKG-506 (22.86%). The genotypes TKG-501, TKG-308 and TKG-518 were found most superior in respect to record the lowest flower damage.

(i.) Grouping of sesame genotypes on the basis of percent flower damage:

The sesame genotypes were grouped in to different categories based on percent flower damage (Table 4.29). None of the screened genotypes was found free from infestation. The moderately resistant category includes three genotypes showing gall fly damage in the range of 10 -20 percent *i.e.*, TKG-501, TKG-518 and TKG-308. Three genotypes TKG-506, TKG-529 and TKG-306 were found moderately susceptible and showing flower damage in the range of 21 -30 percent and four genotypes *i.e.* TKG-22, TKG-55 JTS-8 and

SCS-551 were observed as susceptible showing infestation in the range of 31 -50 percent.

(b) Percent capsule damage:

The significant difference among the genotypes in recording percent capsule damage was observed (Table 4.30). The capsule damage ranged from 9.94 to 34.15%, being lowest in TKG-308 and highest in SCS-551. The highest mean percent capsule damage was recorded in genotype SCS-551 (34.15%) followed by JTS-8 (25.18%), TKG-506 (21.25%) and TKG-529 (20.55%). Lowest capsule damage (9.94%) was recorded in TKG-308 followed by TKG-501 (13.17%). Other genotypes which showed less capsule damage were TKG-518 (13.32%), TKG-55 (16.09%), TKG-306 (16.57%), and TKG-22 (18.27%). The genotypes TKG-501 and TKG-518 were found most superior to other respective to record the lowest capsule damage.

(i) Grouping of sesame genotypes on the basis of percent capsule damage:

The sesame genotypes were grouped in to different categories based on percent capsule damage (Table 4.31). None of the screened genotypes was found free from infestation. Only one genotypes viz., TKG-308 was found moderately resistant showing gall fly damage in the range 5 to 10 percent. The moderately susceptible category includes two genotypes showing gall fly damage in the range of 11 -15 percent *i.e.*, TKG-501 and TKG-518. Five genotypes TKG-506, TKG-529, TKG-306, TKG-22 and TKG-55 were found susceptible and showing capsule damage in the range of 16-25 percent and the two genotype *i.e.* JTS-8 and SCS-551 were found as highly susceptible category with more than 25 percent capsule damage.

(vi) Mirid bug (*Nesidiocoris* Sp.)

(a) Percent plant damage:

The significant difference among the genotypes in recording percent plant damage was observed (Table 4.32). The plant damage ranged from 6.68 to 55.27%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (55.27%) followed by TKG-308 (49.35%), SCS-551 (38.40%), TKG-306 (33.70%) and

TKG-529 (25.41%). Lowest plant damage (6.68%) was recorded in TKG-501 followed by TKG-55 and TKG-518 (9.13%). Other genotypes which showed less plant damage were TKG-506 (16.38%) and TKG-22 (17.65%). Further the genotypes TKG-501, TKG-55 and TKG-518 were found at par to each other in their respective group to record the lowest plant damage.

(i.) Grouping of sesame genotypes on the basis of percent plant damage:

The sesame genotypes were grouped in to different categories based on percent plant damage (Table 4.33). None of the screened genotypes was found free from infestation. Three genotypes TKG-501, TKG-518 and TKG-55 were found resistant showing plant damage less than 10 percent. The moderately resistant category includes two genotypes showing mirid bug damage in the range of 10 -20 percent *viz.*, TKG-506 and TKG-22. Only one genotype TKG-529 was found moderately susceptible and showing plant damage in the range of 21-30 percent and the three genotype *i.e.* TKG-306, TKG -308 and SCS -551 were observed as susceptible showing infestation in the range of 31 -50 percent. The only one genotype *i.e.* JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

(b) Percent flower damage:

The significant difference among the genotypes in recording percent flower damage was observed (Table 4.34). The flower damage ranged from 11.48 to 42.10%, being lowest in TKG-501 and highest in SCS-551. The highest mean percent flower damage was recorded in genotype SCS-551 (42.10%) followed by JTS-8 (36.24%), TKG-306 (35.76%), TKG-529 (27.17%), and TKG-308 (26.58%). Lowest flower damage (11.48%) was recorded in TKG-501 followed by TKG-55 (13.43%). Other genotypes which showed less flower damage were TKG-518 (15.64%), TKG-22 (19.55%) and TKG-506 (19.57%). The genotypes TKG-501 and TKG-55 were found most superior in respect to record the lowest flower damage.

(i.) Grouping of sesame genotypes on the basis of percent flower damage:

The sesame genotypes were grouped in to different categories based on percent flower damage (Table 4.35). None of the screened genotypes was found free from infestation. The moderately resistant category includes 5 genotypes showing mirid bug damage in the range of 10-20 percent *i.e.*, TKG-501, TKG-518, TKG-506, TKG-22 and TKG-55. Two genotypes TKG-529 and TKG-308 was found moderately susceptible and showing flower damage in the range of 21-30 percent and three genotypes *i.e.* TKG-306, JTS-8 and SCS-551 were observed as susceptible showing infestation in the range of 31-50 percent.

(c) Percent capsule damage:

The significant difference among the genotypes in recording percent capsule damage was observed (Table 4.36). The capsule damage ranged from 4.29 to 32.43%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent capsule damage was recorded in genotype JTS-8 (32.43%) followed by TKG-308 (31.14%), SCS-551 (26.67%), TKG-22 (23.43%) and TKG-306 (21.37%). Lowest capsule damage (4.29%) was recorded in TKG-501 followed by TKG-518 (7.47%) and TKG-55 (9.55%). Other genotypes which showed less capsule damage were TKG-506 (11.28%) and TKG-529 (16.57%). The genotypes TKG-518 and TKG-55 was found most superior to other respective to record the lowest capsule damage.

(i.) Grouping of sesame genotypes on the basis of percent capsule damage:

The sesame genotypes were grouped in to different categories based on percent capsule damage (Table 4.37). None of the screened genotypes was found free from infestation. Only one genotype TKG-501 was found resistant showing plant damage less than 5 percent. Two genotypes *viz.*, TKG-518 and TKG-55 was found moderately resistant showing mirid bug damage in the range 5 to 10 percent. The moderately susceptible category includes one genotypes showing mirid bug damage in the range of 11-15 percent *i.e.*, TKG-506. Three genotypes TKG-529, TKG-306 and TKG-22 was found susceptible and showing capsule damage in the range of 16-25 percent and the three genotypes *i.e.* TKG-308, JTS-8 and SCS-551 was found as highly susceptible category with more than 25 percent capsule damage.

Fig 4.1: Plant damage (%) at 30 DAS due to whitefly (*Bemisia tabaci* Genn.)

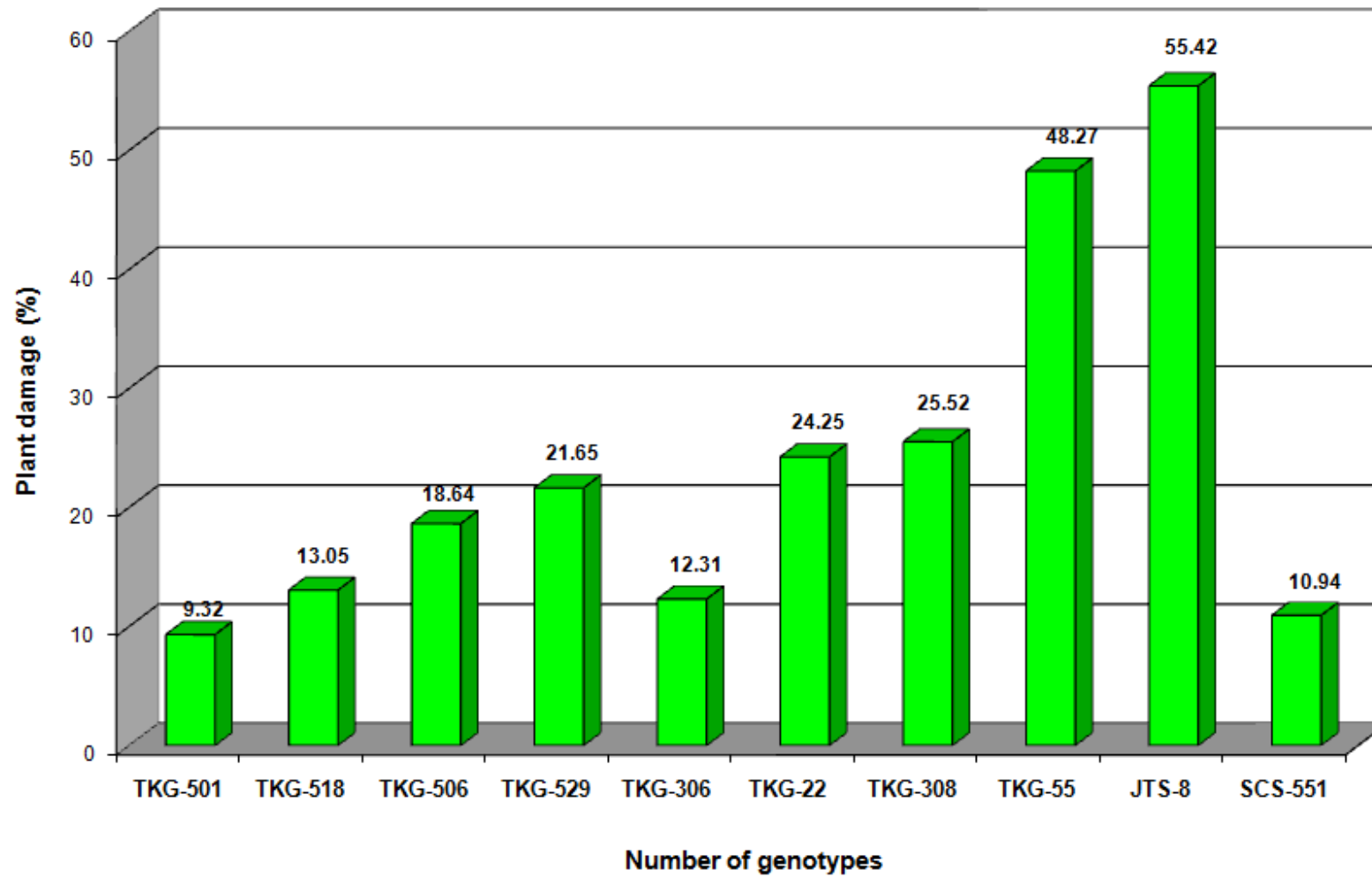


Fig 4.2: Flower damage (%) at 45 DAS due to whitefly (*Bemisia tabaci* Genn.)

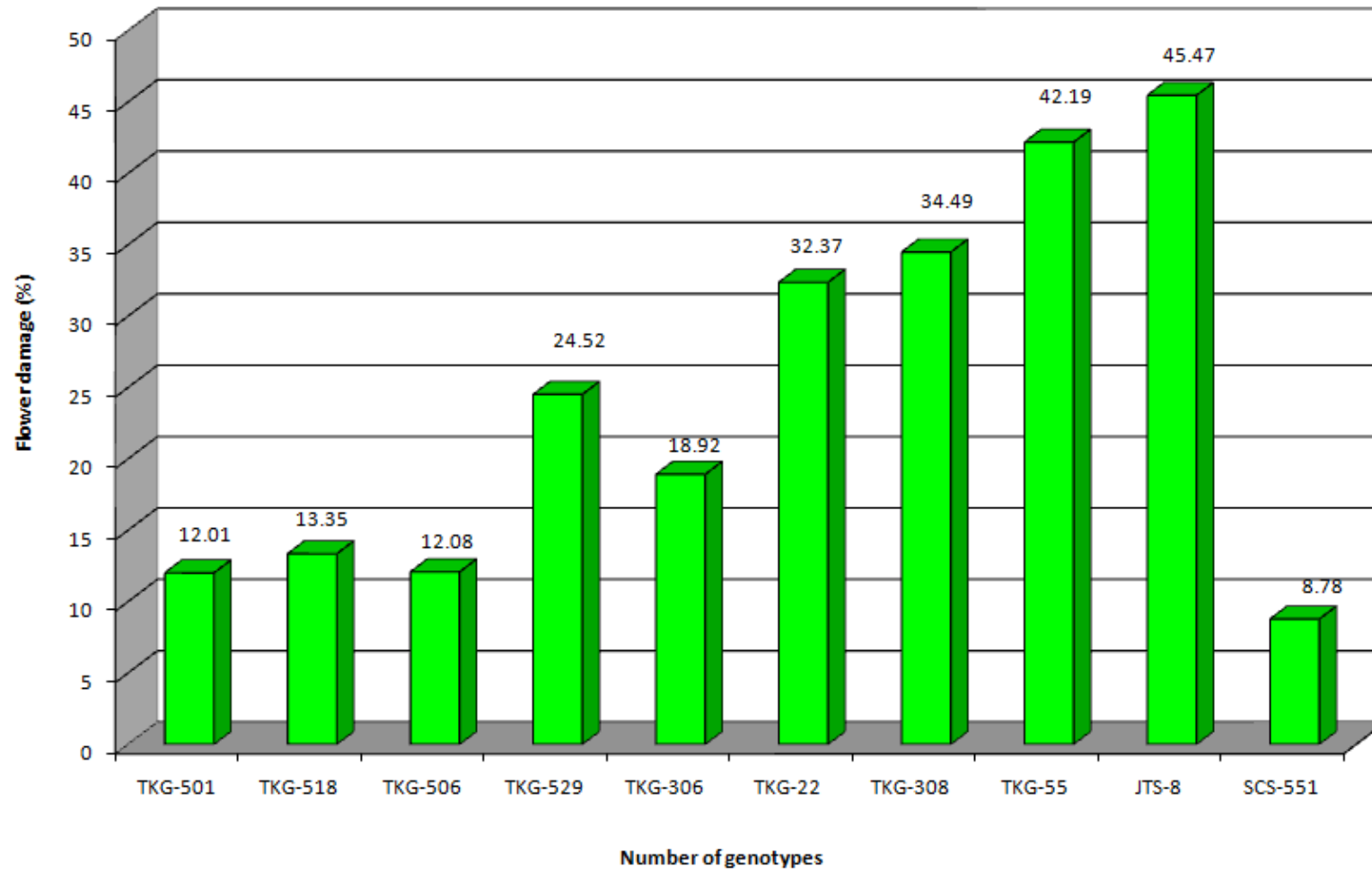


Fig 4.3: Capsule damage (%) at 70 DAS due to whitefly (*Bemisia tabaci* Genn.)

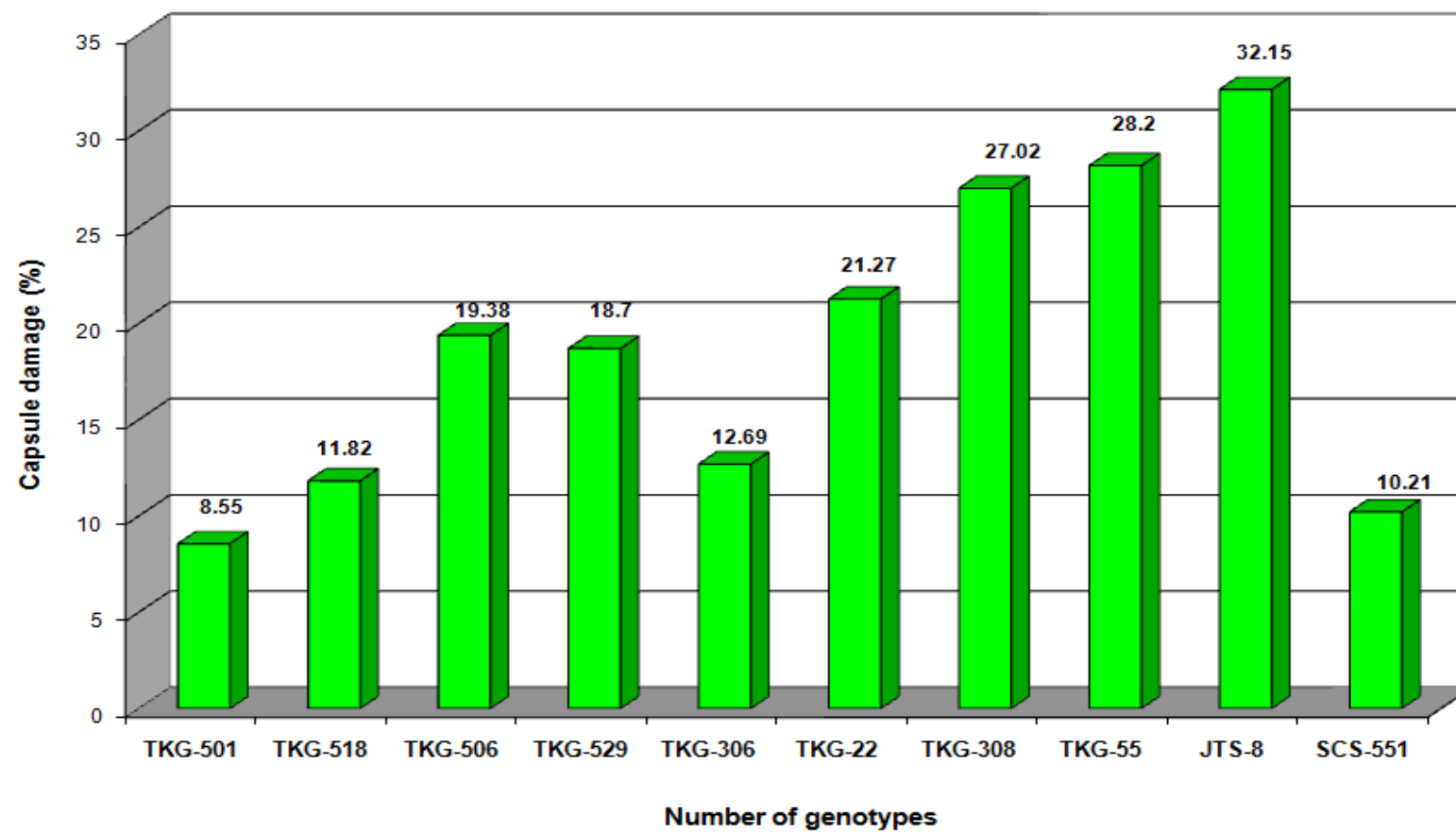


Fig 4.4: Plant damage (%) at 30 DAS due to jassid (*Amrasca devastans* Ishida)

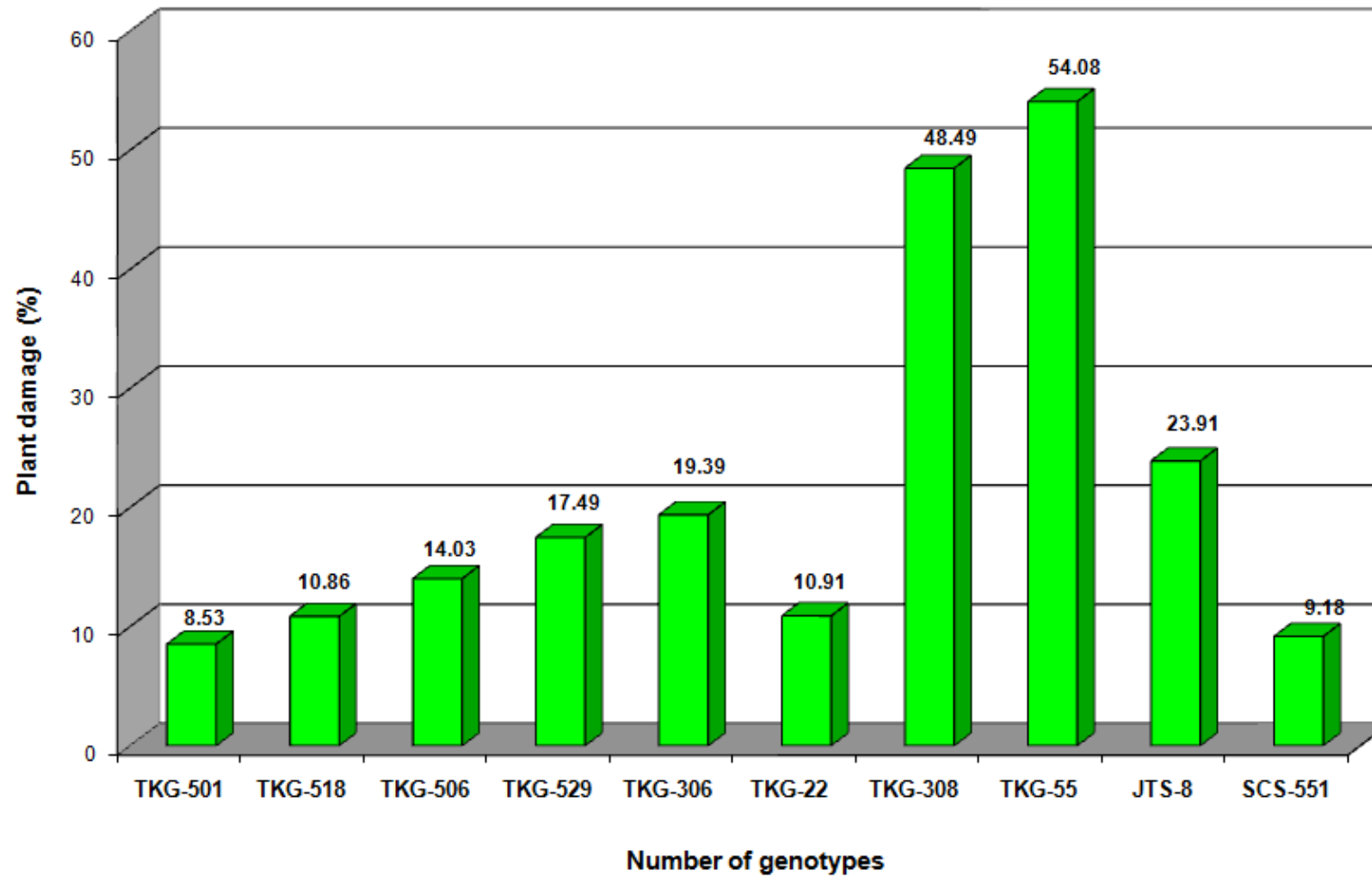


Fig 4.5: Flower damage (%) at 45 DAS due to jassid (*Amrasca devastans* Ishida)

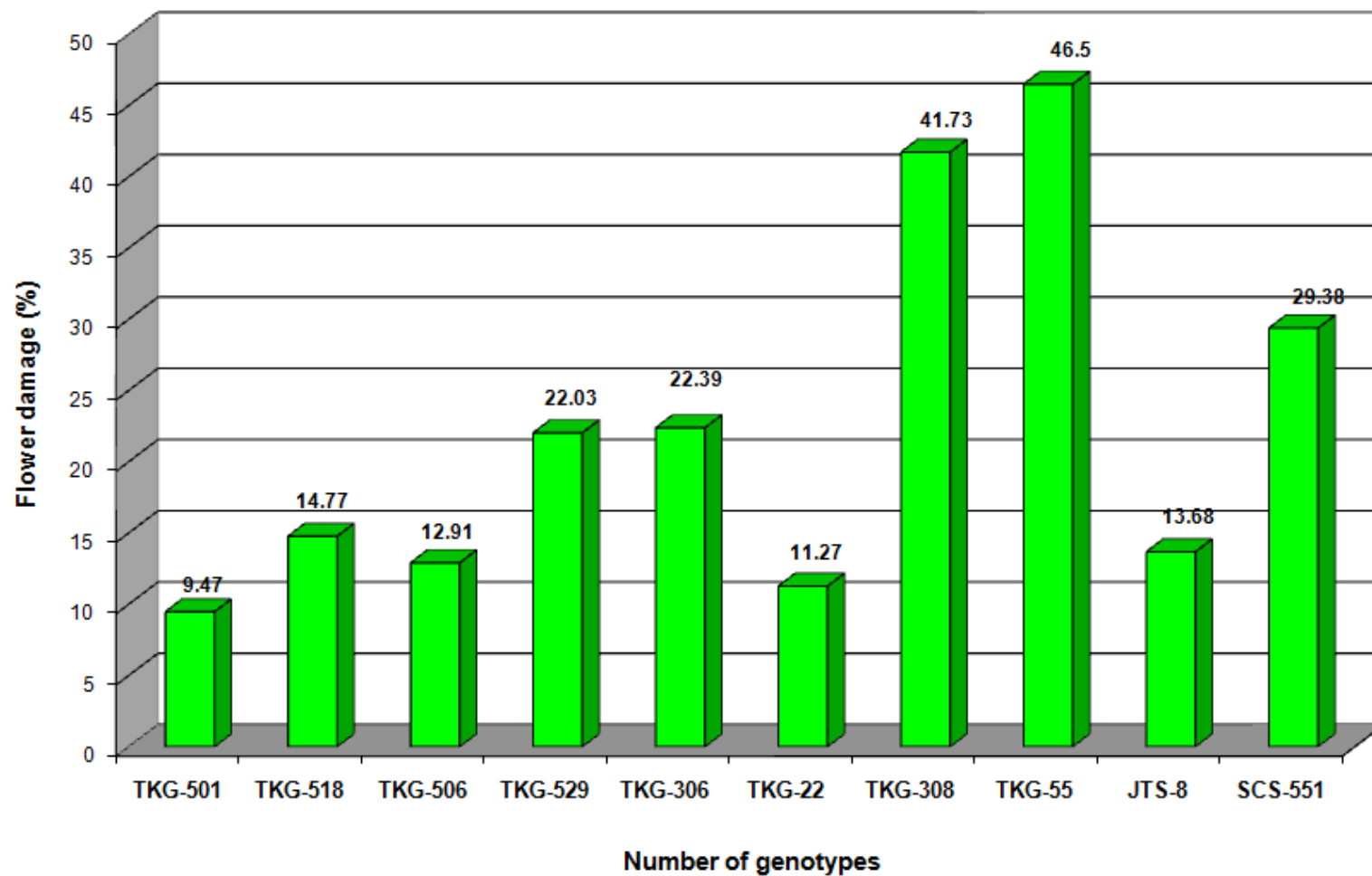


Fig 4.6: Capsule damage (%) at 70 DAS due to jassid (*Amrasca devastans* Ishida)

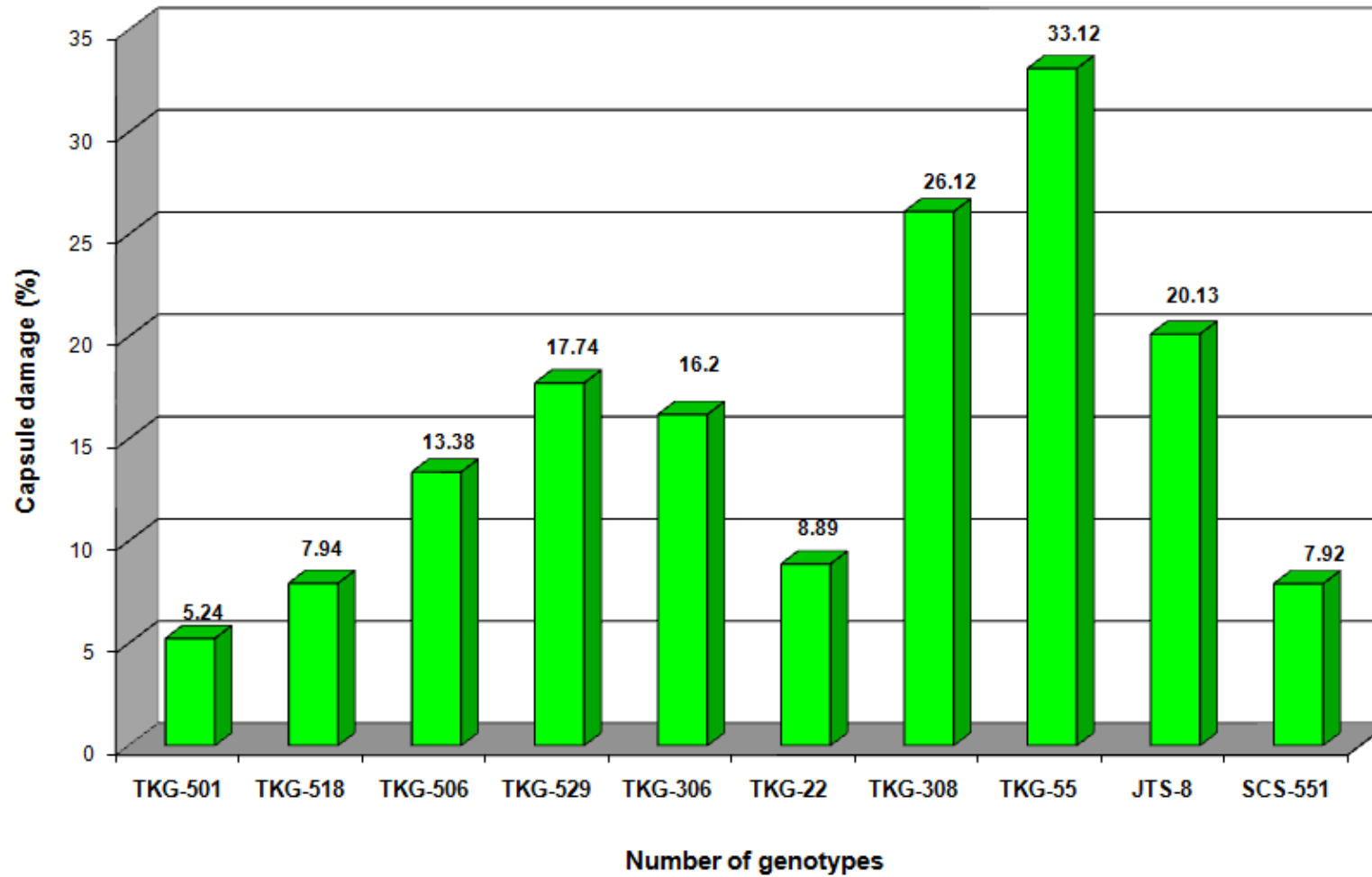


Fig 4.7: Plant damage (%) at 30 DAS due to leaf roller / capsule borer (*Anigastra catalaunalis*)

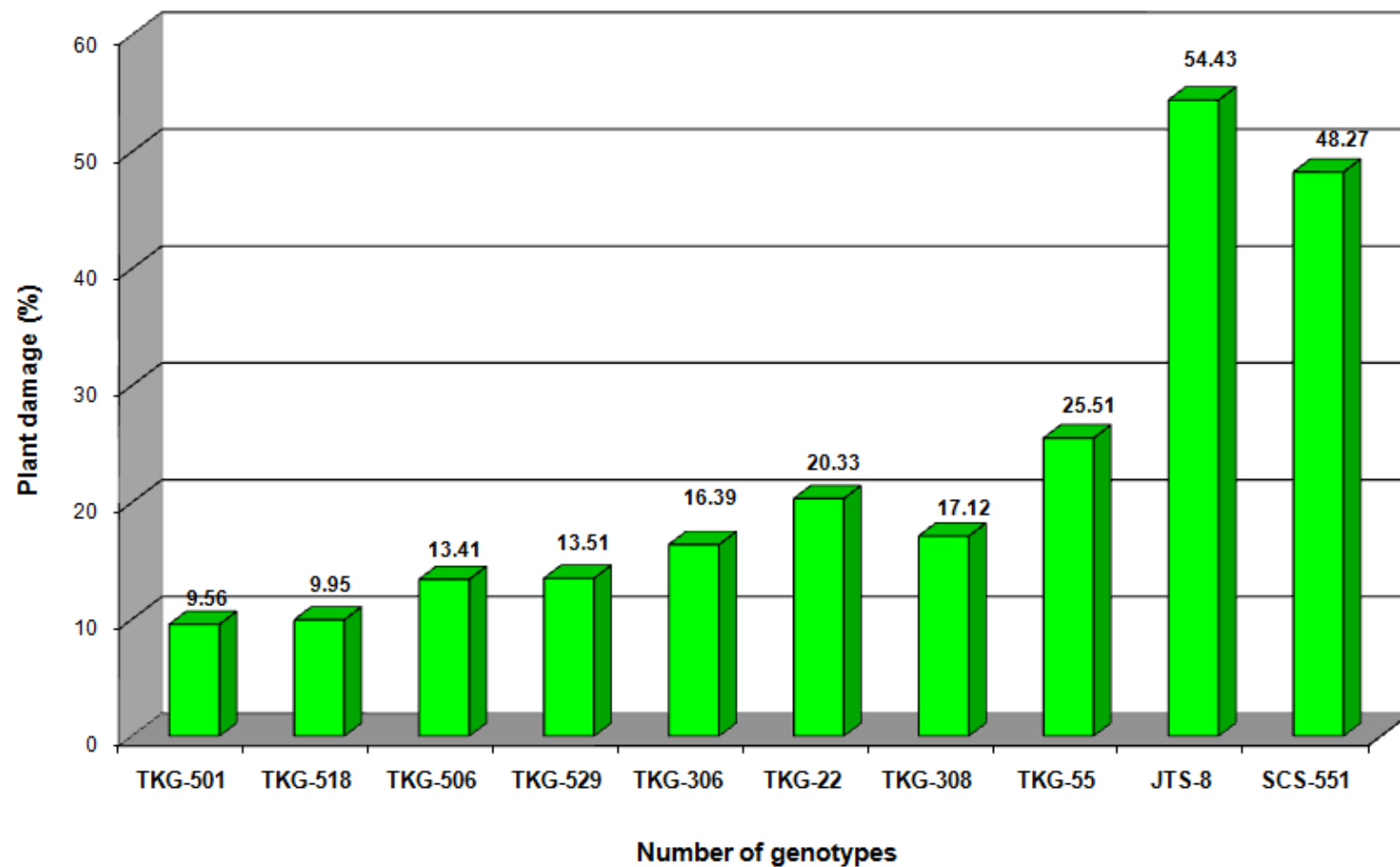


Fig 4.8: Flower damage (%) at 45 DAS due to leaf roller/ capsule borer (*Anigastra catalaunalis*)

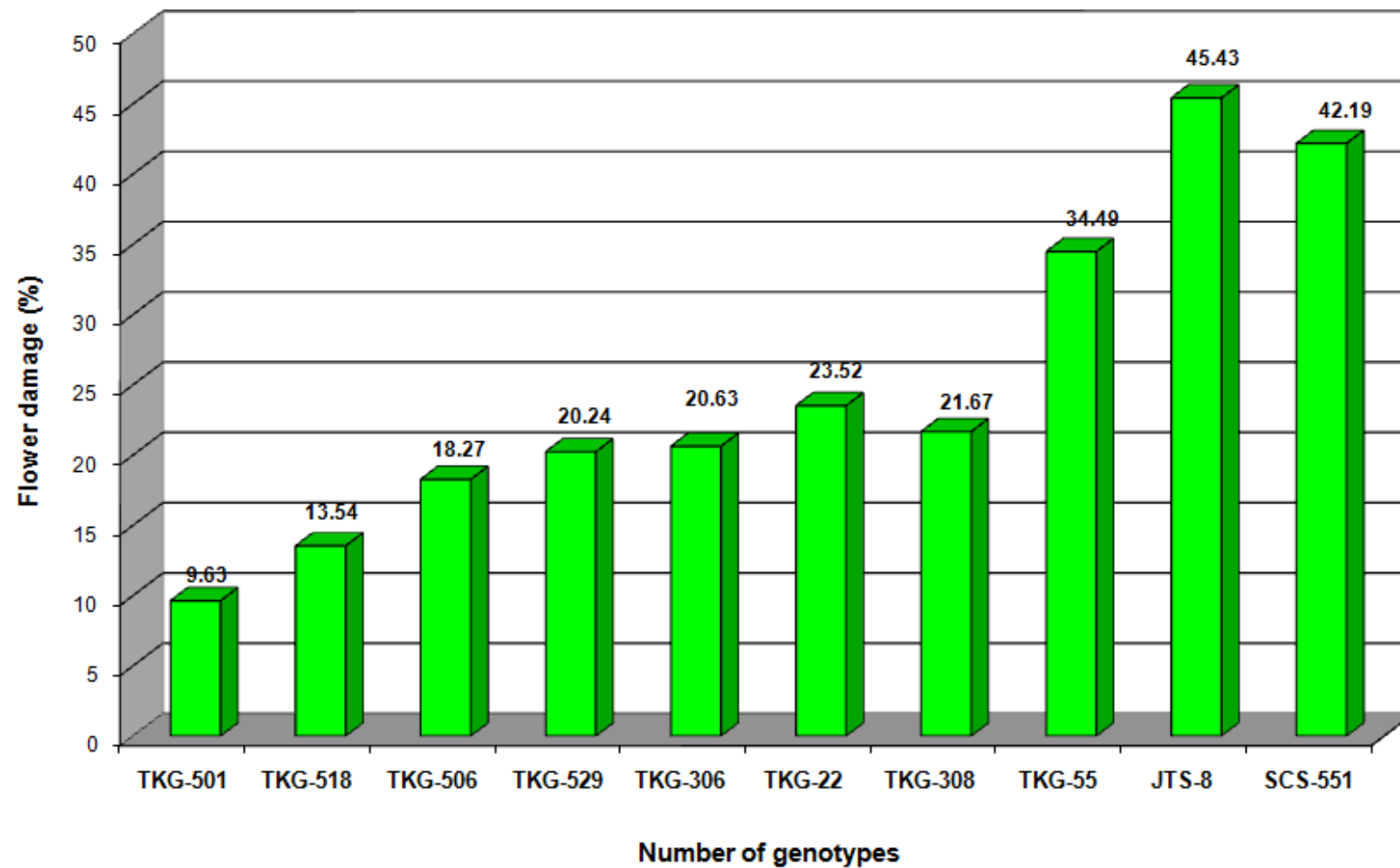


Fig 4.9: Capsule damage (%) at 70 DAS due to leaf roller/ capsule borer (*Anigastra catalaunalis*)

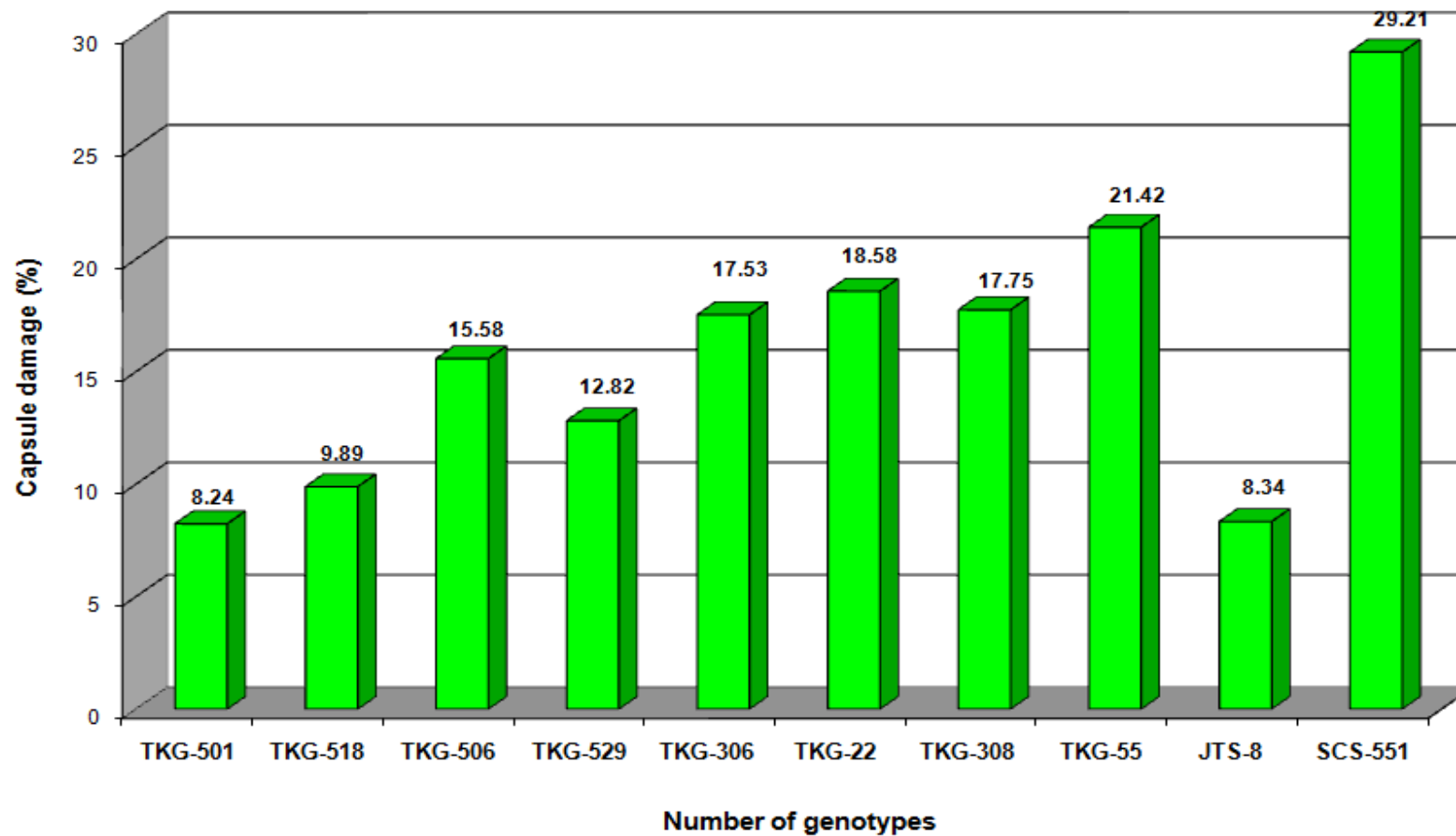


Fig 4.10: Plant damage (%) at 30 DAS due to til hawk moth (*Acherontia styx* Westwood)

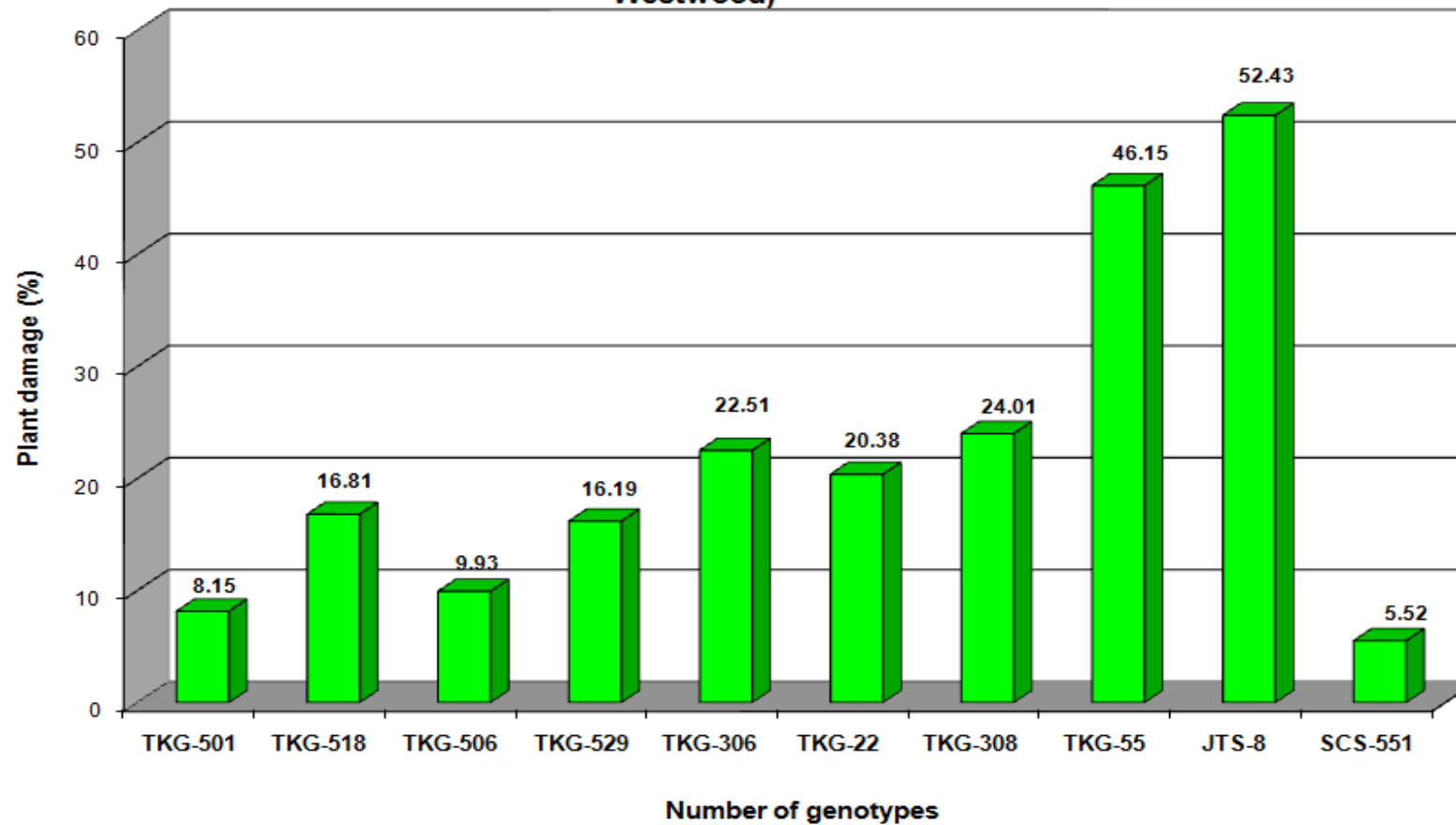


Fig 4.11: Flower damage (%) at 45 DAS due to til hawk moth (*Acherontia styx* Westwood)

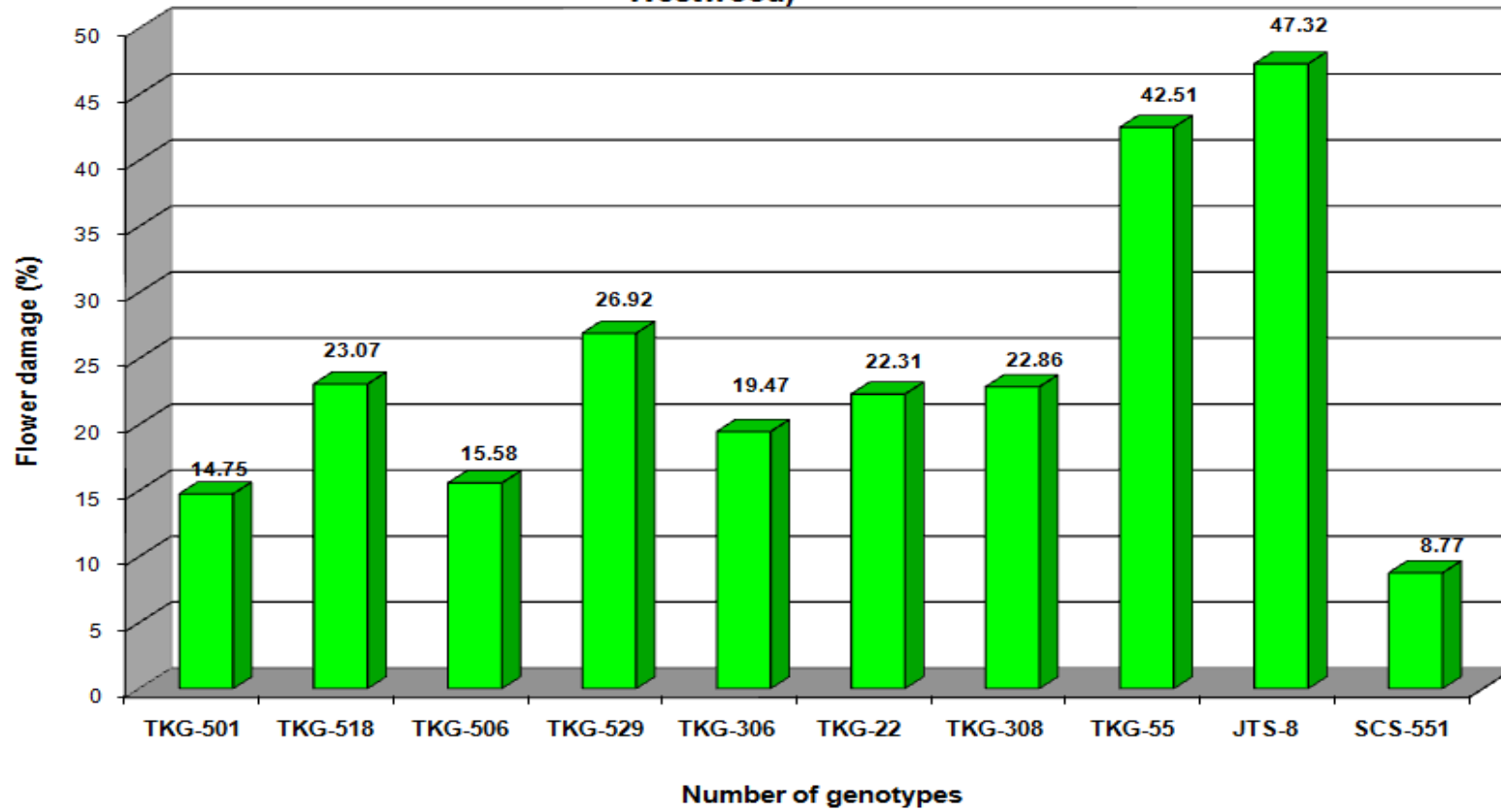


Fig 4.12: Capsule damage (%) at 70 DAS due to til hawk moth (*Acherontia styx* Westwood)

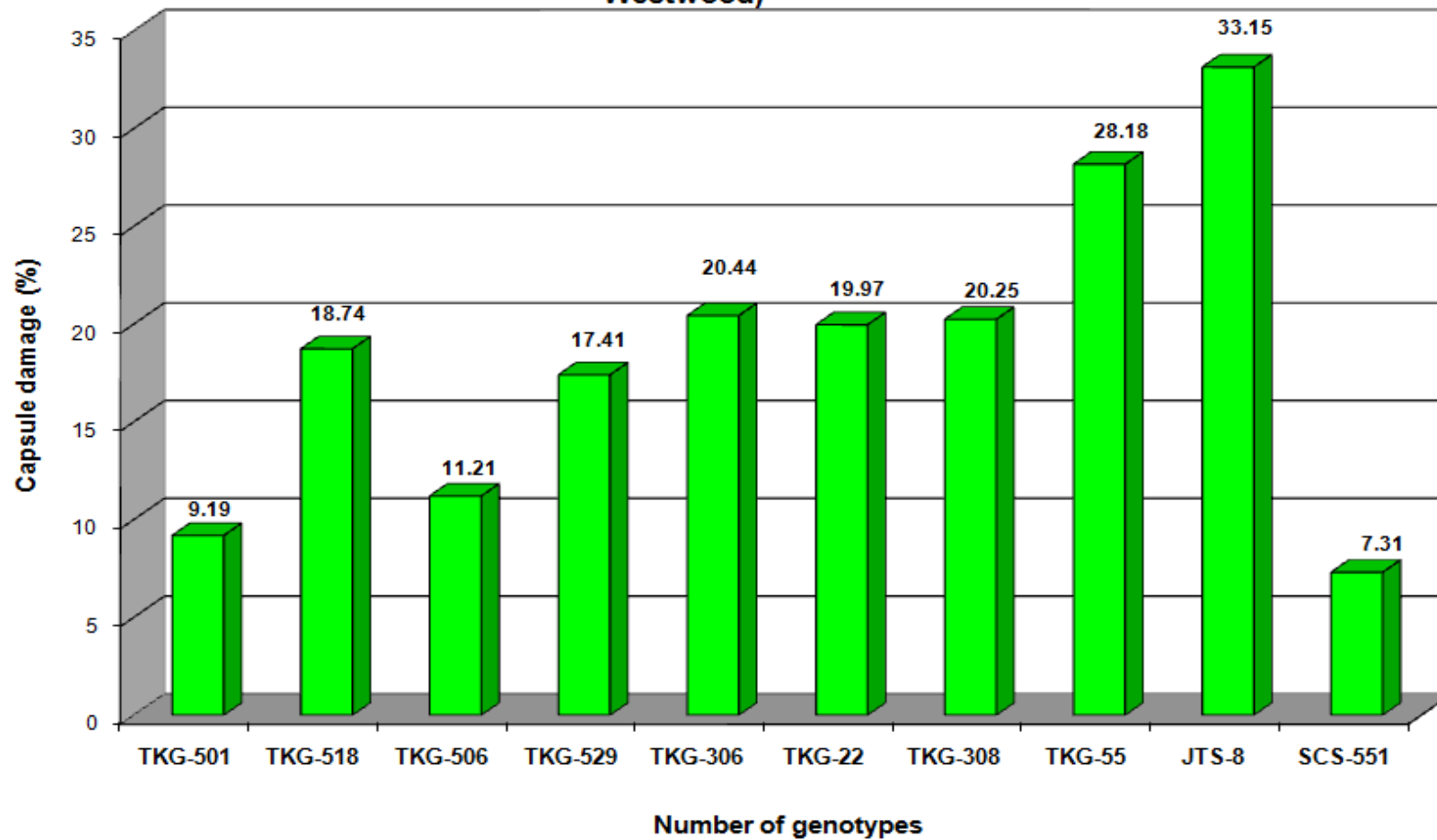


Fig 4.13: Plant damage (%) at 30 DAS due to Gall fly (*Asphondylia sesame* Felt)

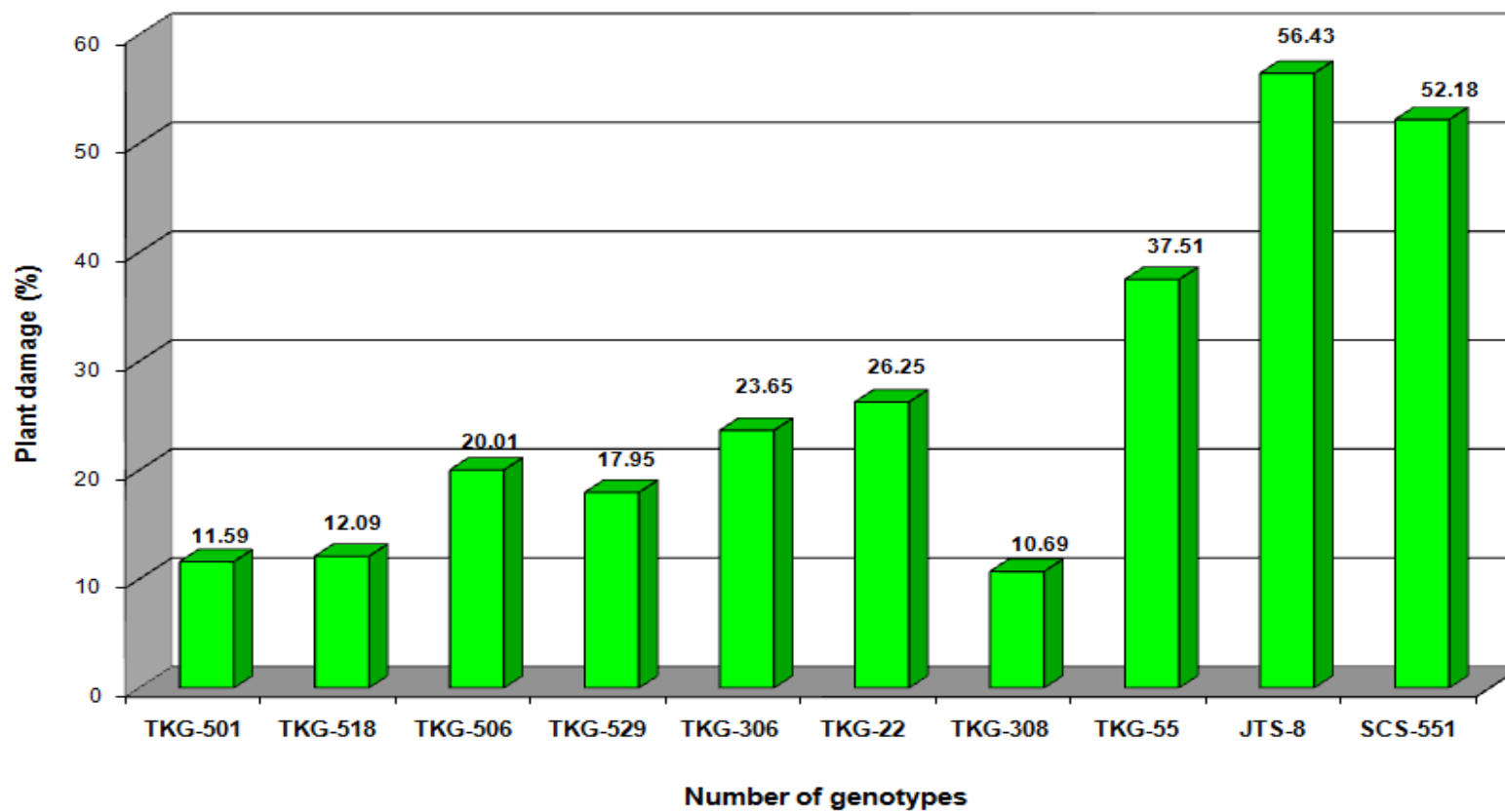


Fig 4.14: Capsule damage (%) at 70 DAS due to Gall fly (*Asphondylia sesame* Felt)

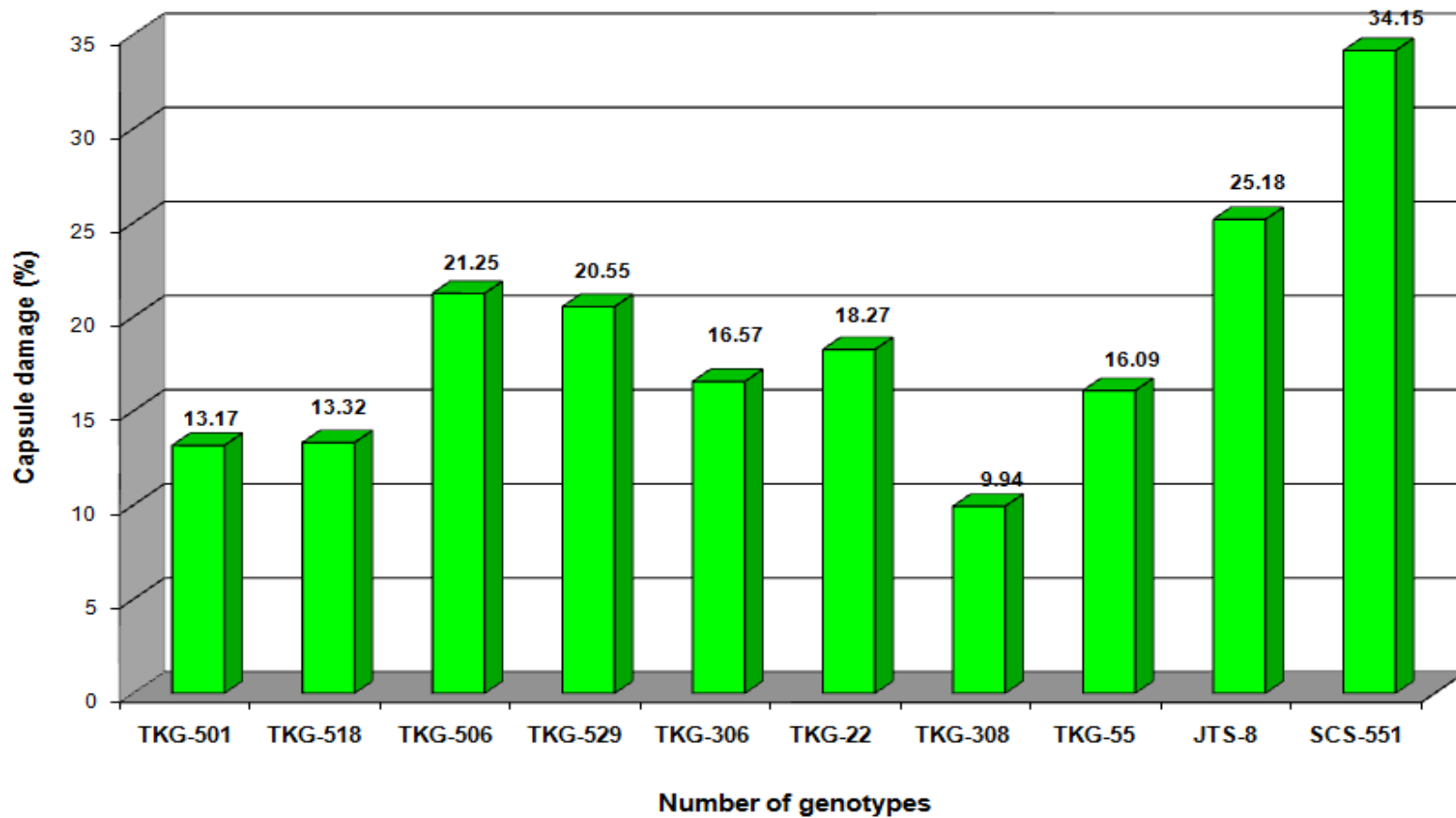


Fig 4.15: Plant damage (%) at 30 DAS due to Mirid bug (*Nesidiocoris* sp.)

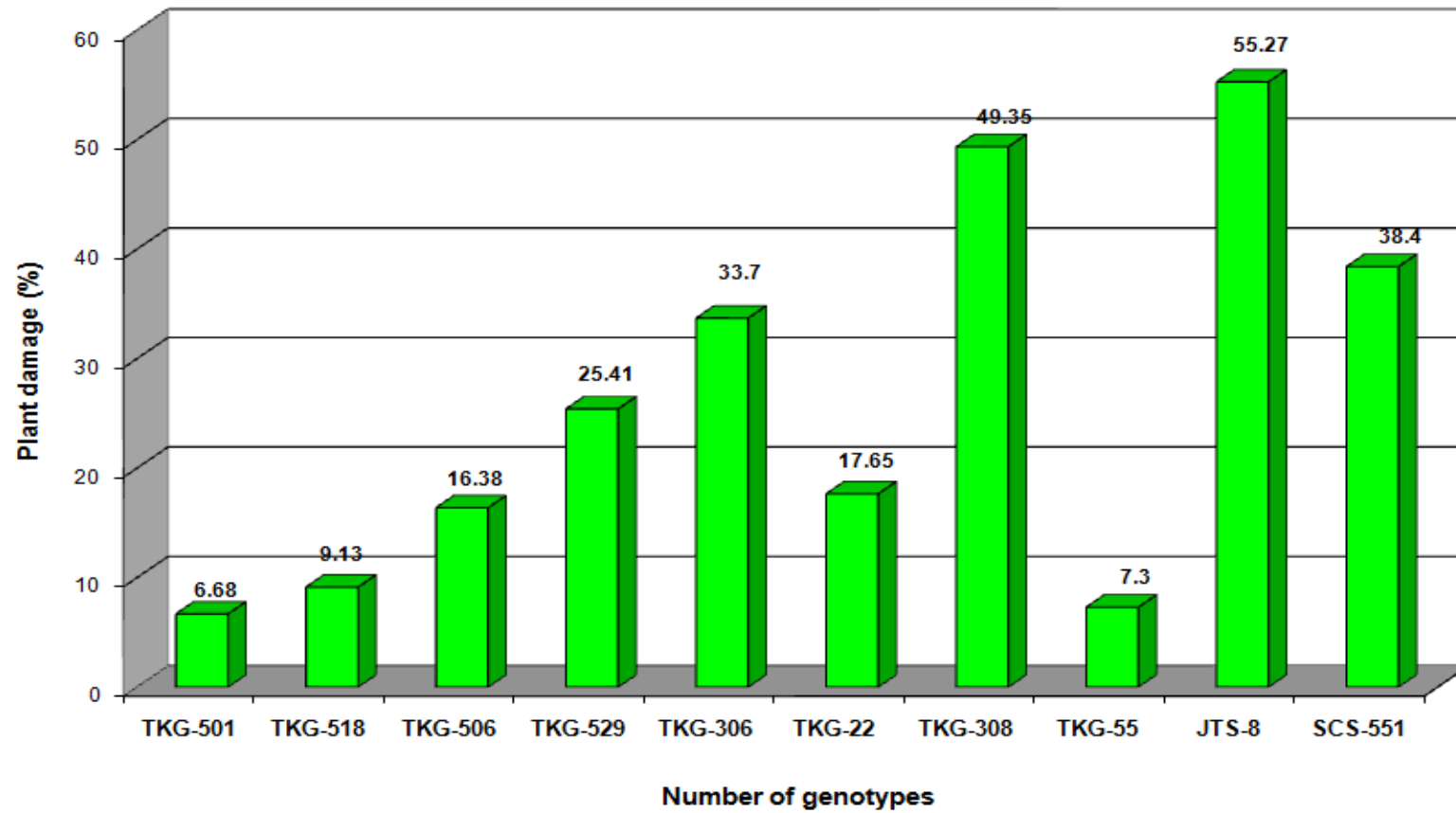


Fig 4.16: Flower damage (%) at 45 DAS due to Mirid bug (*Nesidiocoris* sp.)

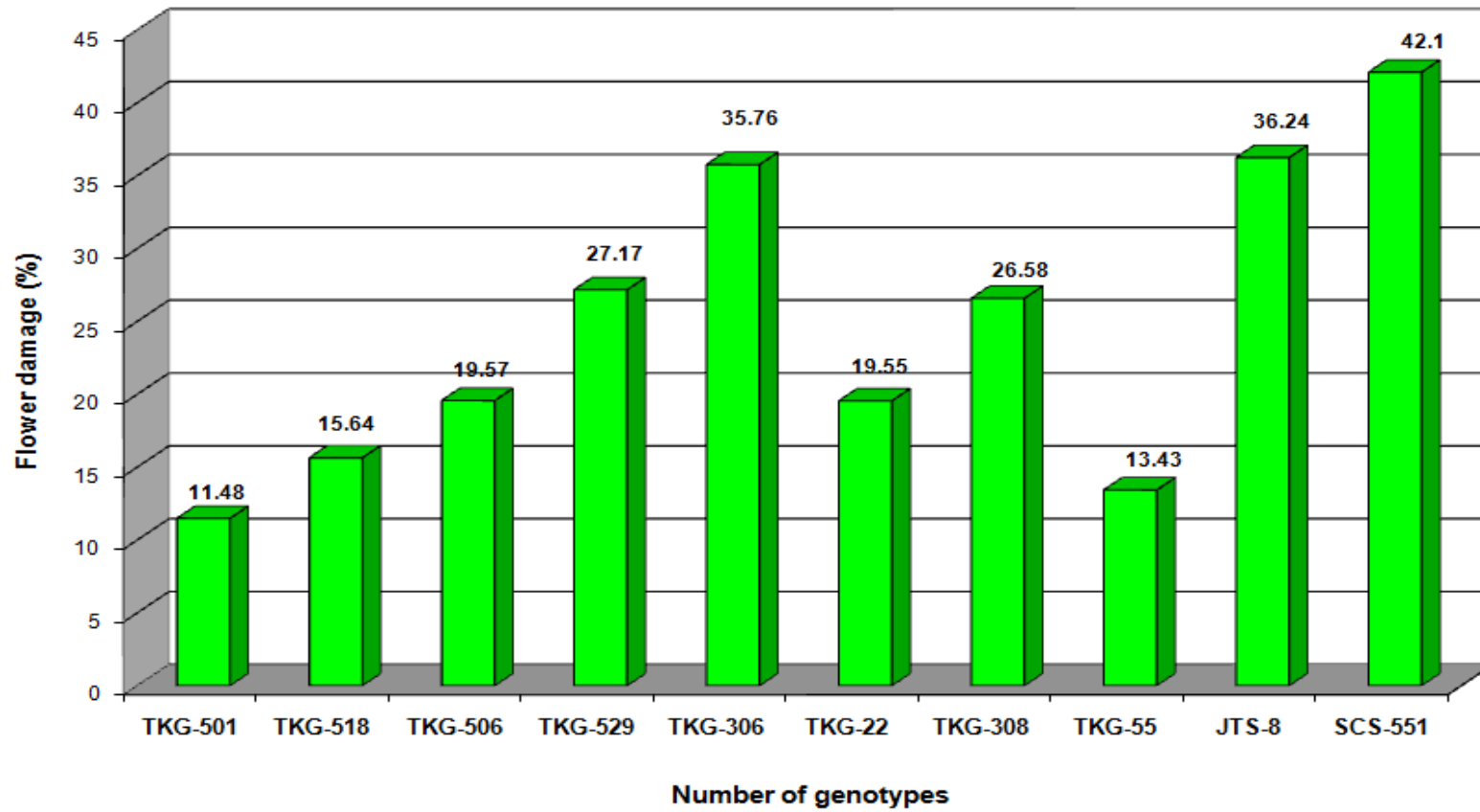
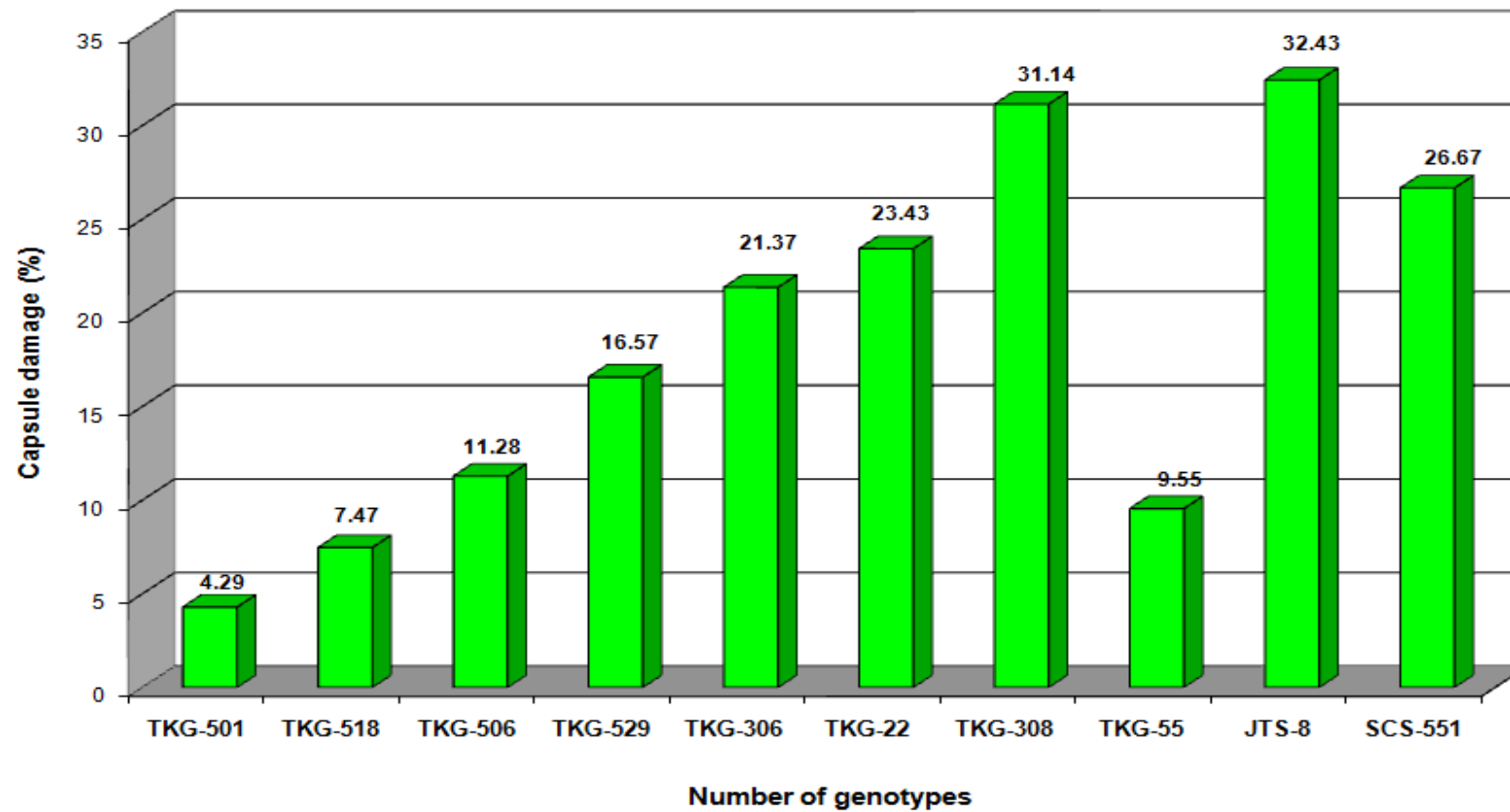


Fig 4.17: Capsule damage (%) at 70 DAS due to Mirid bug (*Nesidiocoris* sp.)



Chapter- V

DISCUSSION

The results of the experiments conducted are being discussed in this chapter.

5.1 Seasonal incidence of major insect pests in sesame

During the course of study from August 2018 to November 2018, White fly (*B. tabaci* Genn.), Jassid (*A. devastans* Ishida), leaf roller/ capsule borer (*A. catalaunalis* Duponchel), Til Hawk moth (*A. styx* West wood), Gall fly (*A. sesame* Felt) and Mirid bug (*Nesidiocoris* sp.) were found infesting the sesame crop at different crop growth stage were recorded at Gwalior in different years by the workers. These insect pests were also reported by Muzaffar *et al.* (2002), Kumar *et al.* (2009), Kumar *et al.* (2010a) and Choudhary *et al.* (2015).

5.1.1 Whitefly (*Bemisia tabaci*)

B. tabaci appeared in 32nd standard week (6 -12 August) and peak during 37th standard week (10 -16 September) 2018 and remained active until the harvest of the crop. *B. tabaci* population ranged from 0.03 to 0.60 /plant. Similar findings have been reported by Kumar *et al.* (2010a). They also reported that, *B. tabaci* to be an important sucking pest of sesame and were present throughout the growing period of the crop. Kumar *et al.* (2010a) found that the *B. tabaci* population peaked (13 Whitefly/ 10 cm twig) during first week of March.

Correlation coefficient among whitefly population and meteorological parameter revealed that the whitefly population was positively but non significantly associated with relative humidity evening (0.217) and temperature minimum (0.163). However, it exhibited negative correlation with temperature maximum (-0.076) and relative humidity morning (-0.225) and rainfall (-0.162). Present findings are in accordance with those of Laurentin *et al.* (2003) and Berlinger *et al.* (1983) and Kumar *et al.* (2010a)

5.1.2 Jassid (*Amrasca devastans*)

A. devastans population was highest (0.40/ plant) in the 37th standard week (10 to 16 September) 2018. During this period temperature maximum and minimum ranged from 28.9⁰C to 36.7⁰C and 10.6 to 27.7⁰C, respectively. Relative humidity (morning) are also high in 63.6% to 92.9 and occasional rains was also observed. The damage was caused by both nymphs and adults that suck plant sap from the lower surface of leaves causing curling of leaves and leading to stunted growth of the plants. They excrete honey dew on the leaves on which the black sooty moulds grow which adversely affects photosynthesis. Present observations were more or less similar with the results of earlier workers Kumar (2008) reported that the *A. devastans* appeared in the 1st week of January.

Correlation coefficient of jassids population exhibited non-significant correlation with relative humidity evening (0.381) and temperature minimum (0.277), while negative association of this character was observed with temperature maximum (-0.207) and relative humidity of morning (-0.171) and rainfall (-0.085).

5.1.3 Leaf roller/ capsule borer (*A. catalaunalis*)

Maximum population (45.33 /plant) of leaf roller/ capsule borer was found in during the 37th standard week (10 -16 September) 2018, when temperature was maximum (31.8⁰C) and minimum (24.6⁰C), relative humidity was also high in morning hours *i.e.* (79.9%). Thus, the pest was present throughout the growing stage of the crop. It caused defoliation, stunted growth of plants.

The symptom of the damage by the pest appeared in 3rd week of August when 40.59% damaged capsule was recorded. However, the highest damaged capsule (67.69%) was observed in the 40th standard week (1-7 October). When the average minimum and maximum temperature, morning and evening relative humidity and rainfall (18.5⁰C and 36.7⁰C, 63.6% and 44.1% and 000.0 mm) were the damaged capsule started declining from 45th standard week (5-11 November).

Present findings are in accordance with those of Chaudhuri *et al.*, (2001), Reddy and Kumar (2004), Umesh and Onukwu (2005).

Correlation coefficient of leaf roller/ capsule borer population exhibited non-significant association with relative humidity evening (0.202) and temperature minimum (0.133), while, it was found negative with temperature maximum (-0.200) relative humidity morning (0.300) and rainy days (-0.276).

5.1.4 Til Hawk moth (*A. styx*)

The Til Hawk moth appeared in the 34th standard week of 20 -26 August 2018 and continued till the harvesting. Increasing trend was observed in this case with crop growth stages. The maximum (0.38 larvae per plant) til hawk moth larvae per plant was recorded at 36th standard week (3 -9 September) 2018. When, the average maximum and minimum temperature was 28.9 and 23.8⁰C respectively with 91.4% and 81.4% morning and evening relative humidity and 050.0 rainfall. Present findings are in accordance with those of Gravena (1999), Chaudhuri *et al.* (2001), Asalatha (2002) and Reddy and Kumar (2004), Kharpuse (2005) revealed that the maximum (76.67 %) leaf infestation by *L. trifolii* was recorded at middle of the March.

Til hawk moth properly were positively associated with rainy days (0.340), relative humidity evening (0.587), relative humidity morning (0.212) and temperature minimum (0.351). However, it exhibited negative association with temperature maximum (-0.525). These findings are in agreement with that of Bagmare *et al.* (1995), Asalatha (2002) and Kumar *et al.*, (2010c).

5.1.5 Gall fly (*A. sesame*)

The pest was first recorded on sesame in the 37th standard week (10-16 September) and remained active on the crop up to 45th standard week (5-11 November). During the activity period of the pest the population of gall fly ranged from 2.66 to 20.66 gall fly per plant. The pest population was found highest in 40th standard weeks (1-7 October) when the average minimum and maximum temperature, morning and evening relative humidity and rainfall were

18.5°C, 36.7°C, 63.6%, 44.1% and 000.0 mm, respectively. The pest population started declining from 45th standard week onwards (5-11 November).

The symptom of the damage by the pest appeared in 37th standard week of August when 38.15% damaged capsule was recorded. However, the highest damaged capsule (59.31%) was observed in the 43rd standard week (22-28 October). When the average minimum and maximum temperature, morning and evening relative humidity and rainfall (14.9°C and 34.5°C, 80.7% and 28.7% and 000.0 mm) were the damaged capsule started declining from 45th standard weeks (5-11 November).

Present findings are in accordance with those of Raj kumar *et al.* (2002) and Goncalves *et al.* (2004).

Gall fly population had no significant and positive correlation with relative humidity evening (0.089) and it was negatively associated with temperature maximum (-0.123), temperature minimum (-0.031), rainy days (-0.288) and relative humidity morning (-0.348).

5.1.6 Mirid bug (*Nesidiocoris* sp.)

Mirid bug of this pest was observed, feeding on sesame fruits by making holes. The pest infestation commenced from 34th standard week (20-26 August 2018) and gradually increased till the crop was harvested. Population peaked (0.36 bug/ plant) in the 36th standard week (3 to 9 September 2018), when, the average maximum and minimum temperature was 28.9 and 23.8°C, respectively with 91.4% and 81.4% morning and evening relative humidity and occasional rain was also observed. The pest was present during the entire reproductive stage of the crop and caused circular or irregular holes on the surface of the fruit and bore inside it.

Present findings are in accordance with those of Srinivasan (1993), Nair (1995), Gravena (1999), Rudednko *et al.* (2001), Chaudhary *et al.* (2001), Reddy and Kumar (2004).

Mirid bug population expressed non significant correlation with relative humidity evening (0.355) and other positive association *i.e.* temperature minimum (0.264). However, it was negative associated with and

temperature maximum (-0.185), relative humidity morning (-0.190) and rainfall (-0.144). These findings are in agreement with that of Kakati *et al.* (2005).

(B) Screening of sesame genotypes against major insect-pests

1. Whitefly (*Bemisia tabaci* Genn.)

(a) Percent plant damage

The significant difference among the genotypes in recording percent plant damage was observed. The plant damage ranged from 9.32 to 55.42%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (55.42%) followed by TKG-55 (48.27%), TKG-308 (25.52%), TKG-22 (24.25%) and TKG-529 (21.65%). Lowest plant damage (9.32%) was recorded in TKG-501 followed by SCS-551 (10.94%). Other genotypes which showed less plant damage were SCS-551 (10.94%) and TKG-306 (12.31%). The sesame genotypes were grouped in to different categories based on percent plant damage. None of the screened genotypes were found free from infestation. Only one genotype TKG-501 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes four genotypes showing whitefly damage in the range of 10-20 percent *viz.*, TKG-518, TKG-506, TKG-306 and SCS-551. 3 genotypes TKG-529, TKG-22 and TKG-308 were found moderately susceptible and showing plant damage in the range of 21-30 percent and one genotype *i.e.* TKG-55 was observed as susceptible showing infestation in the range of 31-50 percent. The only one genotype *i.e.* JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

Our results are in conformity with the results of Kumar *et al.* (2009) and Karuppaiah and Nadarajan (2011) was reported that the varieties (TKG-309 and CST-2001-3 showed resistance against whitefly, leaf hopper, and stink bug only the vegetative stage of plant growth. Present finding are also supported by the findings of Choudhary *et al.* (2017) they reported that out of 15 varieties of sesame screened against *A. catalaunalis* none was found immune. The varieties, RT-358 (4.63), RT_370 (4.38) and RT-371 (4.18) were ranked as least susceptible, while (LT-8 (7.93), TC-25 (6.78) and RT-46 (7.88) as highly susceptible.

(b) Percent flower damage

The significant difference among the genotypes in recording percent flower damage was observed. The flower damage was ranged from 8.78 to 45.47%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent flower damage was recorded in genotype JTS-8 (45.47%) followed by TKG-55 (42.19%), TKG-308 (34.49%), TKG-22 (32.37%) and TKG-529 (24.52%). Lowest flower damage (8.78%) was recorded in SCS-551 followed by TKG-501 (12.01%). Other genotypes which showed less flower damage were TKG-506 (12.08%), TKG-518 (13.35%), and TKG-306 (18.92%). The sesame genotypes were grouped in to different categories based on percent flower damage. None of the screened genotypes was found free from infestation. Only one genotype SCS-551 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes 4 genotypes showing whitefly damage in the range of 10-20 percent *i.e.*, TKG-501, TKG-518, TKG-506 and TKG-306. One genotype TKG-529 was found moderately susceptible and showing flower damage in the range of 21-30 percent and four genotypes *i.e.* TKG-22, TKG-308, TKG-55 and JTS-8 were observed as susceptible showing infestation in the range of 31-50 percent. Present findings are supported by the findings of Balaji and Selvanarayanan (2016) they screened 140 accessions against leaf webber/ capsule borer and reported that, only one accession, NIC7875, showed high resistance to leaf, flower and capsule damages of plant growths against *A. catalaunalis*.

(c) Percent capsule damage

The significant difference among the genotypes in recording percent capsule damage was observed. The capsule damage ranged from 8.55 to 32.15%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent capsule damage was recorded in genotype JTS-8 (32.15%) followed by TKG-55 (28.20%), TKG-308 (27.02%) and TKG-22 (21.27%). Lowest capsule damage (8.55%) was recorded in TKG-501 followed by SCS-551 (10.21%). Other genotypes which showed less capsule damage were TKG-518 (11.82%), TKG-306 (12.69%), TKG-529 (18.70%), and TKG-506 (19.38%). The sesame genotypes were grouped in to different categories based on percent capsule damage. None of the screened genotypes were

found free from infestation. Two genotypes *viz.*, TKG-501 and SCS-551 was found moderately resistant showing whitefly damage in the range 5 to 10 percent. The moderately susceptible category includes 2 genotypes showing whitefly damage in the range of 11-15 percent *i.e.*, TKG-518 and TKG-306. Three genotypes TKG-506, TKG-529 and TKG-22 was found susceptible and showing capsule damage in the range of 16-25 percent and the three genotypes *i.e.* TKG-308, TKG-55 and JTS-8 was found as highly susceptible category with more than 25 percent capsule damage.

Present findings are supported by the findings of Karuppaiah *et al.* (2009) evaluated 43 sesame genotypes against whitefly and leaf roller/capsule borer *Antigastra catalaunalis* (Dup.) using 0-9 scale scoring technique. The differential response of the genotypes was noticed at the various crop growth stages. The genotypes, SI-250, ES-22 and UMA showed resistance at all the three stages, *i.e.*, vegetative, flowering and pod maturity. However, TKG-309 and CST-2001-3 showed resistance only at the vegetative stage; KMR-14 and VRI-1 exhibited resistance pod maturity stage. Based on the overall grading, SI-250 and UMA genotypes were found resistant, and ES-22 was highly resistant.

2. Jassids (*Amrasca devastans* Ishida)

(a) Percent plant damage

The significant difference among the genotypes in recording percent plant damage was observed. The plant damage ranged from 8.53 to 54.08%, being lowest in TKG-501 and highest in TKG-55. The highest mean percent plant damage was recorded in genotype TKG-55 (54.08%) followed by TKG-308 (48.49%), and JTS-8 (23.91%). Lowest plant damage (8.53%) was recorded in TKG-501 followed by SCS-551 (9.18%). Other genotypes which showed less plant damage were TKG-518 (10.86%), TKG-22 (10.91%), TKG-506 (14.03%), TKG-529 (17.49%) and TKG-306 (19.39%). The sesame genotypes were grouped in to different categories based on percent plant damage. None of the screened genotypes were found free from infestation. Two genotypes TKG-501 and SCS-551 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes 5

genotypes showing jassids damage in the range of 10-20 percent *viz.*, TKG-518, TKG-506, TKG-529, TKG-306 and TKG-22. One genotype JTS-8 were found moderately susceptible and showing plant damage in the range of 21-30 percent and one genotype *i.e.* TKG-308 was observed as susceptible showing infestation in the range of 31-50 percent. The only one genotype *i.e.* TKG-55 was found as highly susceptible category with more than 50 percent plant damage.

(b) Percent flower damage

The significant difference among the genotypes in recording percent flower damage was observed. The flower damage ranged from 9.47 to 46.50%, being lowest in TKG-501 and highest in TKG-55. The highest mean percent flower damage was recorded in genotype TKG-55 (46.50%) followed by TKG-308 (41.73%), SCS-551 (29.38%), TKG-306 (22.39%) and TKG-529 (22.03%). Lowest flower damage (9.47%) was recorded in TKG-501 followed by TKG-22 (11.27%). Other genotypes which showed less flower damage were TKG-506 (12.91%), JTS-8 (13.68%), and TKG-518 (14.77%). The sesame genotypes were grouped in to different categories based on percent flower damage. None of the screened genotypes were found free from infestation. Only one genotype TKG-501 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes 4 genotypes showing jassids damage in the range of 10-20 percent *i.e.*, TKG-518, TKG-506, TKG-22 and JTS-8. Three genotypes TKG-529, TKG-306 and SCS-551 was found moderately susceptible and showing flower damage in the range of 21-30 percent and two genotypes *i.e.* TKG-308 and TKG-55 were observed as susceptible showing infestation in the range of 31-50 percent.

(c) Percent capsule damage

The significant difference among the genotypes in recording percent capsule damage was observed. The capsule damage ranged from 5.24 to 33.12%, being lowest in TKG-501 and highest in TKG-55. The highest mean percent capsule damage was recorded in genotype TKG-55 (33.12%) followed by TKG-308 (26.12%) and JTS-8 (20.13%). Lowest capsule damage (5.24%) was recorded in TKG-501 followed by SCS-551 (7.92%) and TKG-

518 (7.94%). Other genotypes which showed less capsule damage were TKG-22 (8.89%), TKG-506 (13.38%), TKG-306 (16.20%) and TKG-529 (17.74%). The sesame genotypes were grouped in to different categories based on percent capsule damage. None of the screened genotypes was found free from infestation. Four genotypes viz., TKG-501, TKG-518, TKG-22 and SCS-551 was found moderately resistant showing jassids damage in the range 5 to 10 percent. The moderately susceptible category includes 1 genotype showing jassids damage in the range of 11-15 percent i.e., TKG-506. Three genotypes TKG-529, TKG-306 and JTS-8 was found susceptible and showing capsule damage in the range of 16-25 percent and the two genotypes i.e. TKG-308 and TKG-55 was found as highly susceptible category with more than 25 percent capsule damage.

3. Leaf roller/ capsule borer (*Anigastra catalaunalis*)

(a) Percent plant damage

The significant difference among the genotypes in recording percent plant damage was observed. The plant damage ranged from 9.56 to 54.43%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (54.43%) followed by SCS-551 (48.27%), TKG-55 (25.51%) and TKG-22 (20.33%). Lowest plant damage (9.56%) was recorded in TKG-501 followed by TKG-518 (9.95%). Other genotypes which showed less plant damage were TKG-506 (13.41%), TKG-529 (13.51%), TKG-306 (16.39%) and TKG-308 (17.12%). The sesame genotypes were grouped in to different categories based on percent plant damage. None of the screened genotypes were found free from infestation. Two genotypes TKG-501 and TKG-518 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes 4 genotypes showing leaf roller/ capsule borer damage in the range of 10-20 percent viz., TKG-506, TKG-529, TKG-306 and TKG-308. Two genotypes TKG-22 and TKG-55 were found moderately susceptible and showing plant damage in the range of 21-30 percent and only one genotype i.e. SCS-551 was observed as susceptible showing infestation in the range of 31-50 percent. The only one genotype i.e. JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

Our results are in conformity with the results of Karuppaiah and Nadarajan (2011) they reported that the varieties (TKG-309 and CST-2001-3) showed resistance against leaf webber/ capsule borer at only the vegetative stage of plant growth. Present findings are also supported by the findings of Choudhary *et al.* (2017) they reported that out of 15 varieties of sesame screened against *A. catalaunalis* none was found immune. The varieties, RT-358 (4.63), RT-370 (4.38) and RT-371 (4.18) were ranked as least susceptible, while (LT-8 (7.93), TC-25 (6.78) and RT-46 (7.88) as highly susceptible.

(b) Percent flower damage

The significant difference among the genotypes in recording percent flower damage was observed. The flower damage ranged from 9.63 to 45.43%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent flower damage was recorded in genotype JTS-8 (45.43%) followed by SCS-551 (42.19%), TKG-55 (34.49%), TKG-22 (23.52%), TKG-308 (21.67%), TKG-306 (20.63%) and TKG-529 (20.24%). Lowest flower damage (9.63%) was recorded in TKG-501 followed by TKG-518 (13.54%) and TKG-506 (18.27%). The sesame genotypes were grouped into different categories based on percent flower damage. None of the screened genotypes were found free from infestation. Only one genotype TKG-501 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes 4 genotypes showing leaf roller/ capsule borer damage in the range of 10-20 percent *i.e.*, TKG-518, TKG-506, TKG-529 and TKG-306. Two genotypes TKG-22 and TKG-308 were found moderately susceptible and showing flower damage in the range of 21-30 percent and three genotypes *i.e.* TKG-55, JTS-8 and SCS-551 were observed as susceptible showing infestation in the range of 31-50 percent. Present findings are supported by the findings of Balaji and Selvanarayanan (2016) they screened 140 accessions against leaf webber/ capsule borer and reported that, only one accession, NIC7875, showed high resistance to leaf, flower and capsule damages of plant growths against *A. catalaunalis*. Shrivastava *et al.* (2002) screened seven hundred and eighty two germplasm lines of sesame (*Sesamum indicum* L.) against leaf roller/ capsule borer (*Antigastra*

catalaunalis Dup.). Revealed seven germplasm lines viz., SI-1729, SI-3239, IC-132246, IC-204137, IC-205071, IC-2050S2 and IC-205304 were found to be least susceptible.

(c) Percent capsule damage

The significant difference among the genotypes in recording percent capsule damage was observed. The capsule damage ranged from 8.24 to 29.21%, being lowest in TKG-501 and highest in SCS-551. The highest mean percent capsule damage was recorded in genotype SCS-551 (29.21%) followed by TKG-55 (21.42%) and TKG-22 (18.58%). Lowest capsule damage (8.24%) was recorded in TKG-501 followed by JTS-8 (8.34%) and TKG-518 (9.89%). Other genotypes which showed less capsule damage were TKG-529 (12.82%), TKG-506 (15.58%), TKG-306 (17.53%) and TKG-308 (17.75%). The sesame genotypes were grouped in to different categories based on percent capsule damage. None of the screened genotypes were found free from infestation. Three genotypes viz., TKG-501, TKG-518 and JTS-8 was found moderately resistant showing leaf roller/ capsule borer damage in the range 5 to 10 percent. The moderately susceptible category includes 2 genotypes showing leaf roller/ capsule borer damage in the range of 11-15 percent i.e., TKG-506 and TKG-529. Four genotypes TKG-306, TKG-22, TKG-308 and TKG-55 was found susceptible and showing capsule damage in the range of 16-25 percent and the one genotype i.e. SCS-551 was found as highly susceptible category with more than 25 percent capsule damage.

Present findings are supported by the findings of Karuppaiah *et al.* (2009) evaluated 43 sesame genotypes against leaf roller/ capsule borer *Antigastra catalaunalis* (Dup.) using 0-9 scale scoring technique. The differential response of the genotypes was noticed at the various crop growth stages. The genotypes, SI-250, ES-22 and UMA showed resistance at all the three stages, i.e., vegetative, flowering and pod maturity. However, TKG-309 and CST-2001-3 showed resistance only at the vegetative stage; KMR-14 and VRI-1 exhibited resistance pod maturity stage. Based on the overall grading, SI-250 and UMA genotypes were found resistant, and ES-22 was highly resistant. Earlier Murli Baskaran *et al.* (1990) also reported resistance in terms of capsule damage in different germplasm and reported more or less similar

results. Five entries viz., SI-241 (6.16%), NIC-6.42%), NIC-16359 (6.51%), JLT-8 (6.55%), KMR-4 (6.83%), were found promising with least susceptibility to *Antigastra* at capsule stage.

4. Til hawk moth (*Acherontia styx* Westwood)

(a) Percent plant damage

The significant difference among the genotypes in recording percent plant damage was observed. The plant damage ranged from 5.52 to 52.43%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (52.43%) followed by TKG-55 (46.15%), TKG-308 (24.01%), TKG-306 (22.51%) and TKG-22 (20.38%). Lowest plant damage (5.52%) was recorded in SCS-551 followed by TKG-501 (8.15%). Other genotypes which showed less plant damage were TKG-506 (9.93%), TKG-529 (16.19%) and TKG-518 (16.81%). The sesame genotypes were grouped in to different categories based on percent plant damage. None of the screened genotypes were found free from infestation. Three genotypes TKG-501, TKG-506 and SCS-551 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes 3 genotypes showing til hawk moth damage in the range of 10-20 percent viz., TKG-518, TKG-529 and TKG-22. Two genotypes TKG-306 and TKG-308 were found moderately susceptible and showing plant damage in the range of 21-30 percent and only one genotype *i.e.* TKG-55 was observed as susceptible showing infestation in the range of 31-50 percent. The only one genotype *i.e.* JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

Our results are in conformity with the results of Kumar *et al.* (2009) studied pest succession on sesame. Among the population were recorded while sesame gallfly, bihar hairy caterpillars were active from flowering to capsule stage of crop. Til leaf roller/ capsule borer was active from seedling to harvesting stages and til hawk moth was active from capsule formation to capsule maturity stage of crop.

(b) Percent flower damage

The significant difference among the genotypes in recording percent flower damage was observed. The flower damage ranged from 8.77 to 47.32%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent flower damage was recorded in genotype JTS-8 (47.32%) followed by TKG-55 (42.51%), TKG-529 (26.92%), TKG-518 (23.07%), TKG-308 (22.86%) and TKG-22 (22.31%). Lowest flower damage (8.77%) was recorded in SCS-551 followed by TKG-501 (14.75%). Other genotypes which showed less flower damage were TKG-506 (15.58%) and TKG-306 (19.47%). The sesame genotypes were grouped in to different categories based on percent flower damage. None of the screened genotypes were found free from infestation. Only one genotype SCS-551 was found resistant showing flower damage less than 10 percent. The moderately resistant category includes 3 genotypes showing til hawk moth damage in the range of 10-20 percent *i.e.*, TKG-501, TKG-506 and TKG-22. Four genotypes TKG-518, TKG-529, TKG-22 and TKG-308 was found moderately susceptible and showing flower damage in the range of 21-30 percent and two genotypes *i.e.* TKG-55 and JTS-8 were observed as susceptible showing infestation in the range of 31-50 percent. Present findings are supported by the findings of Kumar *et al.* (2009) studied pest succession on sesame. Among their population were recorded while sesame gallfly, bihar hairy caterpillars were active from flowering to capsule stage of crop. Til leaf roller/ capsule borer was active from seedling to harvesting stages and til hawk moth was active from capsule formation to capsule maturity stage of crop.

(c) Percent capsule damage

The significant difference among the genotypes in recording percent capsule damage was observed. The capsule damage ranged from 7.31 to 33.15%, being lowest in SCS-551 and highest in JTS-8. The highest mean percent capsule damage was recorded in genotype JTS-8 (33.15%) followed by TKG-55 (28.18%), TKG-306 (20.44) and TKG-308 (20.25%). Lowest capsule damage (7.31%) was recorded in SCS-551 followed by TKG-501 (9.19%). Other genotypes which showed less capsule damage were TKG-506 (11.21%), TKG-529 (17.41%), TKG-518 (18.74%) and TKG-22 (19.97%). The

sesame genotypes were grouped in to different categories based on percent capsule damage. None of the screened genotypes were found free from infestation. Two genotypes viz., TKG-501 and SCS-551 was found moderately resistant showing til hawk moth damage in the range 5 to 10 percent. The moderately susceptible category includes one genotypes showing til hawk moth damage in the range of 11-15 percent *i.e.*, TKG-506. Five genotypes TKG-518, TKG-529, TKG-306, TKG-22 and TKG-308 was found susceptible and showing capsule damage in the range of 16-25 percent and the two genotypes *i.e.* TKG-55 and JTS-8 was found as highly susceptible category with more than 25 percent capsule damage.

Present findings are supported by the findings of Kumar *et al.* (2009) studied pest succession on sesame. Among their population were recorded while sesame gallfly, bihar hairy caterpillars were active from flowering to capsule stage of crop. Til leaf roller/ capsule borer was active from seedling to harvesting stages and til hawk moth was active from capsule formation to capsule maturity stage of crop.

5. Gall fly (*Asphondylia* Felt)

(a) Percent plant damage

The significant difference among the genotypes in recording percent plant damage was observed. The plant damage was ranged from 10.69 to 56.43%, being lowest in TKG-308 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (56.43%) followed by SCS-551 (52.18%), TKG-55 (37.51%), TKG-22 (26.25%), TKG-306 (23.65%) and TKG-506 (20.01%). Lowest plant damage (10.69%) was recorded in TKG-308 followed by TKG-501 (11.59%) and TKG-518 (12.09%). Other genotypes which showed less plant damage were TKG-529 (17.95%). The sesame genotypes were grouped in to different categories based on percent plant damage. None of the screened genotypes were found free from infestation. The moderately resistant category includes 5 genotypes showing gall fly damage in the range of 10-20 percent viz., TKG-501, TKG-518, TKG-506, TKG-529 and TKG-308. Two genotypes TKG-306, and TKG-308 were found moderately susceptible and showing plant damage in the range of 21-

30 percent and one genotype i.e. TKG-55 was observed as susceptible showing infestation in the range of 31-50 percent. The two genotypes i.e. JTS-8 and SCS-551 was found as highly susceptible category with more than 50 percent plant damage.

Our results are in conformity with the results of Kumar *et al.* (2009) studied pest succession on sesame. Among the pests whitefly, Leaf hopper and stink bug, remained active from vegetative stage of crop and their population were recorded while sesame gallfly were active from flowering to capsule stage of crop.

(a) Percent flower damage

The significant difference among the genotypes in recording percent flower damage was observed. The flower damage ranged from 17.15 to 48.45%, being lowest in TKG-501 and highest in SCS-551. The highest mean percent flower damage was recorded in genotype SCS-551 (48.45%) followed by TKG-55 (44.48%), JTS-8 (43.19%), TKG-22 (33.39%), TKG-529 (27.85%) and TKG-306 (26.81%). Lowest flower damage (17.15%) was recorded in TKG-501 followed by TKG-308 (18.12%) and TKG-518 (18.17%). Other genotypes which showed less flower damage were TKG-506 (22.86%). The sesame genotypes were grouped in to different categories based on percent flower damage. None of the screened genotypes were found free from infestation. The moderately resistant category includes three genotypes showing gall fly damage in the range of 10-20 percent *i.e.*, TKG-501, TKG-518 and TKG-308. Three genotypes TKG-506, TKG-529 and TKG-306 was found moderately susceptible and showing flower damage in the range of 21-30 percent and four genotypes *i.e.* TKG-22, TKG-55 JTS-8 and SCS-551 were observed as susceptible showing infestation in the range of 31-50 percent. Present findings are supported by the findings of Kumar *et al.* (2009) studied pest succession on sesame. Among the pests whitefly, Leaf hopper and stink bug, remained active from vegetative stage of crop and their population were recorded while sesame gallfly, bihar hairy caterpillars were active from flowering to capsule stage of crop.

(b) Percent capsule damage

The significant difference among the genotypes in recording percent capsule damage was observed. The capsule damage ranged from 9.94 to 34.15%, being lowest in TKG-308 and highest in SCS-551. The highest mean percent capsule damage was recorded in genotype SCS-551 (34.15%) followed by JTS-8 (25.18%), TKG-506 (21.25%) and TKG-529 (20.55%). Lowest capsule damage (9.94%) was recorded in TKG-308 followed by TKG-501 (13.17%). Other genotypes which showed less capsule damage was TKG-518 (13.32%), TKG-55 (16.09%), TKG-306 (16.57%), and TKG-22 (18.27%). The sesame genotypes were grouped in to different categories based on percent capsule damage. None of the screened genotypes were found free from infestation. Only one genotypes *viz.*, TKG-308 was found moderately resistant showing gall fly damage in the range 5 to 10 percent. The moderately susceptible category includes 2 genotypes showing gall fly damage in the range of 11-15 percent *i.e.*, TKG-501 and TKG-518. Five genotypes TKG-506, TKG-529, TKG-306, TKG-22 and TKG-55 was found susceptible and showing capsule damage in the range of 16-25 percent and the two genotype *i.e.* JTS-8 and SCS-551 was found as highly susceptible category with more than 25 percent capsule damage.

Present findings are supported by the findings of Kumar *et al.* (2009) studied pest succession on sesame. Among the pests whitefly, Leaf hopper and stink bug, remained active from vegetative stage of crop and their population were recorded while sesame gallfly, bihar hairy caterpillars were active from flowering to capsule stage of crop.

6. Mirid bug (*Nesidiocoris* Sp.)

(a) Percent plant damage

The significant difference among the genotypes in recording percent plant damage was observed. The plant damage ranged from 6.68 to 55.27%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent plant damage was recorded in genotype JTS-8 (55.27%) followed by TKG-308 (49.35%), SCS-551 (38.40%), TKG-306 (33.70%) and TKG-529 (25.41%). Lowest plant damage (6.68%) was recorded in TKG-501 followed

by TKG-55 and TKG-518 (9.13%). Other genotypes which showed less plant damage were TKG-506 (16.38%) and TKG-22 (17.65%). The sesame genotypes were grouped in to different categories based on percent plant damage. None of the screened genotypes were found free from infestation. Three genotypes TKG-501, TKG-518 and TKG-55 was found resistant showing plant damage less than 10 percent. The moderately resistant category includes 2 genotypes showing mirid bug damage in the range of 10-20 percent *viz.*, TKG-506 and TKG-22. Only one genotype TKG-529 were found moderately susceptible and showing plant damage in the range of 21-30 percent and the three genotype *i.e.* TKG-306, TKG-308 and SCS-551 was observed as susceptible showing infestation in the range of 31-50 percent. The only one genotype *i.e.* JTS-8 was found as highly susceptible category with more than 50 percent plant damage.

(b) Percent flower damage

The significant difference among the genotypes in recording percent flower damage was observed. The flower damage was ranged from 11.48 to 42.10%, being lowest in TKG-501 and highest in SCS-551. The highest mean percent flower damage was recorded in genotype SCS-551 (42.10%) followed by JTS-8 (36.24%), TKG-306 (35.76%), TKG-529 (27.17%), and TKG-308 (26.58%). Lowest flower damage (11.48%) was recorded in TKG-501 followed by TKG-55 (13.43%). Other genotypes which showed less flower damage were TKG-518 (15.64%), TKG-22 (19.55%) and TKG-506 (19.57%). The sesame genotypes were grouped in to different categories based on percent flower damage. None of the screened genotypes were found free from infestation. The moderately resistant category includes 5 genotypes showing mirid bug damage in the range of 10-20 percent *i.e.*, TKG-501, TKG-518, TKG-506, TKG-22 and TKG-55. Two genotypes TKG-529 and TKG-308 was found moderately susceptible and showing flower damage in the range of 21-30 percent and three genotypes *i.e.* TKG-306, JTS-8 and SCS-551 were observed as susceptible showing infestation in the range of 31-50 percent.

(c) Percent capsule damage

The significant difference among the genotypes in recording percent capsule damage was observed. The capsule damage was ranged from 4.29 to 32.43%, being lowest in TKG-501 and highest in JTS-8. The highest mean percent capsule damage was recorded in genotype JTS-8 (32.43%) followed by TKG-308 (31.14%), SCS-551 (26.67%), TKG-22 (23.43%) and TKG-306 (21.37%). Lowest capsule damage (4.29%) was recorded in TKG-501 followed by TKG-518 (7.47%) and TKG-55 (9.55%). Other genotypes which showed less capsule damage were TKG-506 (11.28%) and TKG-529 (16.57%). The sesame genotypes were grouped in to different categories based on percent capsule damage. None of the screened genotypes were found free from infestation. Only one genotype TKG-501 was found resistant showing plant damage less than 5 percent. Two genotypes *viz.*, TKG-518 and TKG-55 was found moderately resistant showing mirid bug damage in the range 5 to 10 percent. The moderately susceptible category includes one genotypes showing mirid bug damage in the range of 11-15 percent *i.e.*, TKG-506. Three genotypes TKG-529, TKG-306 and TKG-22 was found susceptible and showing capsule damage in the range of 16-25 percent and the three genotypes *i.e.* TKG-308, JTS-8 and SCS-551 was found as highly susceptible category with more than 25 percent capsule damage.

Chapter - VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

The present investigations were undertaken in *Kharif* 2018-19 at college of Agriculture research farm, Gwalior to study on the major insect-pests of sesame (*Sesamum indicum* L.). The results obtained are summarized and concluded here under:

SEASONAL INCIDENCE OF MAJOR INSECT PESTS OF SESAME

(i) *Whitefly (Bemisia tabaci Genn.)*

B. tabaci appeared in 32nd standard week (6 -12 August) and peak during 37th standard week (10 -16 September 2018) and remained active until the harvest of the crop. *B. tabaci* population ranged from 0.03 to 0.60/ plant.

Correlation coefficient among whitefly population and meteorological parameters revealed that the whitefly population was positively but not significantly associated with relative humidity evening (0.217) and temperature minimum (0.163). However, it exhibited negative correlation with temperature maximum (-0.076) and relative humidity morning (-0.225) and rainfall (-0.162).

(ii) *Jassids (Amrasca devastans Ishida)*

A. devastans population was highest (0.40/ plant) in the 37th standard week (10 -16 September) 2018. During this period temperature maximum and minimum ranged from 28.9 to 36.7^oC and 10.6 to 27.7^oC, respectively. Relative humidity (morning) are also high in 37.1% to 92.9 and occasional rains was also observed.

Correlation coefficient of jassids population exhibited non-significant and positive with relative humidity evening (0.381) and temperature minimum (0.277), while negative association of this character was observed with temperature maximum (-0.207) and relative humidity of morning (-0.171) and rainfall (-0.085).

(iii) *Leaf roller/ capsule borer (Antigastra catalaunalis Duponchel)*

Maximum population (45.33 /plant) of leaf roller/ capsule borer was found in during the 37th standard week (10 -16 September) 2018, when temperature was maximum (31.8^oC) and minimum (24.6^oC), relative humidity was also high in morning hours *i.e.* (79.9%).

The symptom of the damage by the pest appeared in 3rd week of August when 40.59% damaged capsule was recorded. However, the highest damaged capsule (67.69%) was observed in the 40th standard week (1 -7 October). When the average minimum and maximum temperature, morning and evening relative humidity and rainfall (18.5^oC and 36.7^oC, 63.6% and 44.1% and 000.0 mm) were the damaged capsule started declining from 45th standard week (5 -11 November).

Correlation coefficient of leaf roller/ capsule borer population exhibited non-significant and positive with relative humidity evening (0.202) and temperature minimum (0.133), while, it was found negative with temperature maximum (-0.200) relative humidity morning (0.300) and rainy days (-0.276).

(iv) Til Hawk moth (Acherontia styx Westwood)

Til Hawk moth appeared in the 34th standard week of August 2018 and continued till the harvesting. Increasing trend was observed in this case with crop growth stages. The maximum (0.38 larvae per plant) til hawk moth larvae per plant was recorded at 36th standard week (3 -9 September) 2018. When, the average maximum and minimum temperature was 28.9 and 23.8^oC respectively with 91.4% and 81.4% morning and evening relative humidity and 050.0 rainfalls.

Til hawk moth were positively associated with rainy days (0.340), relative humidity evening (0.587), relative humidity morning (0.212) and temperature minimum (0.351). However, it exhibited negative association with temperature maximum (-0.525).

(v) Gall fly (Asphondylia sesame Felt)

The pest was first recorded on sesame in the 37th standard week (10-16 September) and remained active on the crop upto 45th standard week (5-11 November). During the activity period of the pest the population of gall fly

ranged from 2.66 to 20.66 gall fly per plant. The pest population was found highest in 40th standard weeks (10-16 Oct.) when the average minimum and maximum temperature, morning and evening relative humidity and rainfall were 18.5°C, 36.7°C, 63.6%, 44.1% and 000.0 mm, respectively. The pest population started declining from 45th standard week onwards (5-11 November).

The symptom of the damage by the pest appeared in 37th Standard week of Sep. when 38.15% damaged capsule was recorded. However, the highest damaged capsule (59.31%) was observed in the 43th standard week (22-28 October). When the average minimum and maximum temperature, morning and evening relative humidity and rainfall (14.9°C and 34.5°C, 80.7% and 28.7% and 000.0 mm) were the damaged capsule started declining from 45th standard weeks (5-11 November).

Gall fly population had no significant and positive correlation with relative humidity evening (0.089) and it was negatively associated with temperature maximum (-0.123), temperature minimum (-0.031), rainy days (-0.288) and relative humidity morning (-0.348).

(vi) Mirid bug (*Nesidiocoris* sp.)

The pest infestation commenced from 34th standard week (20 -26 August) 2018 and gradually increased till the crop was harvested. Population peaked (0.41 bug/ plant) in the 37th standard week (10 to 16 September 2018), when, the average maximum and minimum temperature was 31.8°C, and 24.6°C, respectively with 79.9% and 67.4% morning and evening relative humidity and occasional rain was also observed.

Mirid bug population expressed no significant and positive correlation with relative humidity evening (0.355) and other positive association *i.e.* temperature minimum (0.264). However, it was negative associated with and temperature maximum (-0.185), relative humidity morning (-0.190) and rainfall (-0.144).

SCREENING OF SESAME GENOTYPES AGAINST MAJOR INSECT-PESTS

Ten genotypes sesame was screened against whitefly under natural infestation condition (field condition). The data on percent plant, flower/capsule damages by major insect pests (whitefly, jassids, leaf roller/capsule borer, til hawk moth, gall fly, mired bug) were recorded at vegetative (30 DAS), flowering (45 DAS) and capsule maturity stage of the crop (70 DAS).

The significant differences among the genotypes in recording percent plant damage were observed.

The highest mean percent plant damage, flower damage and capsule damage by whitefly was recorded in genotypes JTS-8. The lowest mean percent plant damage and capsule damage by whitefly was recorded in TKG-501, flower damage was recorded in SCS-551.

The highest mean percent plant damage, flower damage and capsule damage by jassids was recorded in genotype TKG-55. The lowest mean percent plant damage, flower damage and capsule damage by jassid was recorded in TKG -501.

The highest mean percent plant damage and flower damage by leaf roller /capsule borer was recorded in genotype JTS-8, capsule damage genotype SCS -551. The lowest mean percent plant damage flower damage and capsule damage by leaf roller/ capsule borer was recorded in TKG-501.

The highest mean percent plant damage, flower damage and capsule damage by til hawk moth was recorded in genotype JTS-8. The lowest mean percent plant damage, flower damage and capsule damage by til hack moth was recorded in SCS-551.

The highest mean percent plant damage by gall fly was recorded in genotype JTS -8, flower damage and capsule damage genotype SCS-551. The lowest mean percent plant damage and capsule damage by gall fly was recorded in TKG -308, flower damage genotype TKG-501.

The highest mean percent plant damage and capsule damage by mirid bug was recorded in genotype JTS-8, flower damage genotype SCS -551. The lowest mean percent plant damage, flower damage and capsule damage by mirid bug was recorded in TKG-501.

CONCLUSION

The genotype TKG-501 was found resistant to whitefly plant damage, genotype SCS-551 was found resistant to flower damage, genotype *viz.* TKG-501, SCS-551 was found moderately resistant to capsule damage. The genotype *i.e.* JTS-8 was found as highly susceptible to whitefly plant damage, genotypes *i.e.* TKG-22, TKG-308, TKG-55 and JTS-8 were observed as susceptible to flower damage, genotypes *i.e.* TKG-308, TKG-55 and JTS-8 was found as highly susceptible to capsule damage.

The genotypes TKG-501 and SCS-551 was found resistant to jassid plant damage, genotype TKG-501 was found resistant to flower damage, genotypes *viz.*, TKG-501, TKG-518, TKG-22 and SCS-551 was found moderately resistant to capsule damage. The genotype *i.e.* TKG-55 was found as highly susceptible to jassid plant damage, genotypes *i.e.* TKG-308 and TKG-55 were observed as susceptible to flower damage, genotype TKG-55 was found as highly susceptible to capsule damage.

The genotypes TKG-501 and TKG-518 was found resistant to leaf roller / capsule borer plant damage, genotype TKG-501 was found resistant to flower damage, genotypes *viz.*, TKG-501, TKG-518 and JTS-8 was found moderately resistant to capsule damage. The genotype *i.e.* JTS-8 was found as highly susceptible to leaf roller / capsule borer plant damage, genotypes *i.e.* TKG-55, JTS-8 and SCS-551 were observed as susceptible to flower damage, genotype *i.e.* SCS-551 was found as highly susceptible to capsule damage.

The genotypes TKG-501, TKG-506 and SCS-551 was found resistant to til hack moth plant damage, genotype SCS-551 was found resistant to flower damage, genotypes *viz.*, TKG-501 and SCS-551 was found moderately resistant to capsule damage. The genotype *i.e.* JTS-8 was found as highly susceptible to til hack moth plant damage, genotypes *i.e.* TKG-55 and JTS-8 was found as highly susceptible to flower damage, genotypes *i.e.* TKG-55 and JTS-8 were observed as susceptible to capsule damage.

The moderately resistant to gall fly plant damage genotype *viz.*, TKG-501, TKG-518, TKG-506, TKG-529 and TKG-308, genotype *i.e.*, TKG-501,

TKG-518 and TKG-308, was found moderately resistant to flower damage, genotypes *viz.*, TKG-308 was found moderately resistant to capsule damage. The two genotypes *i.e.* JTS-8 and SCS-551 was found as highly susceptible to plant damage, genotypes *i.e.* TKG-22, TKG-55 JTS-8 and SCS-551 were observed as susceptible to flower damage, genotype *i.e.* JTS-8 and SCS-551 was found as highly susceptible to capsule damage.

The genotypes TKG-501, TKG-518 and TKG-55 was found resistant to mirid bug plant damage, moderately resistant category includes genotypes showing flower damage, TKG-501, TKG-518, TKG-506, TKG-22 and TKG-55, genotype TKG-501 was found resistant to capsule damage. The genotype *i.e.* JTS-8 was found as highly susceptible to mirid bug plant damage, genotypes *i.e.* TKG-306, JTS-8 and SCS-551 were observed as susceptible showing flower damage, genotypes *i.e.* TKG-308, JTS-8 and SCS-551 was found as highly susceptible to capsule damage.

SUGGESTIONS FOR FURTHER WORK

1. Experiment on seasonal incidence should be repeated for confirmation the activity of pest in the region.
2. Estimation of losses due to insect pests in sesame.

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APPENDIX-I

Values of mean sum of squares for population of whitefly

Source of variation	d.f.	Whitefly		
		Plant damage at 30 DAS	Flower damage at 45 DAS	Capsule damage at 70 DAS
Replication	2	0.4368	2.9390	0.2381
Treatment	9	751.9356**	542.3741**	201.7104**
Error	18	0.7193	0.8567	1.4476

** - Significant at $p = 0.05$

APPENDIX-II

Values of mean sum of squares for population of jassid

Source of variation	d.f.	Jassid		
		Plant damage at 30 DAS	Flower damage at 45 DAS	Capsule damage at 70 DAS
Replication	2	2.1024	0.8815	1.2919
Treatment	9	805.6925**	506.3092**	239.3591**
Error	18	1.5459	1.9154	3.6287

** - Significant at $p = 0.05$

APPENDIX-III

Values of mean sum of squares for population of leaf roller/ capsule borer

Source of variation	d.f.	Leaf roller/ capsule borer		
		Plant damage at 30 DAS	Flower damage at 45 DAS	Capsule damage at 70 DAS
Replication	2	1.4169	0.7955	10.3468
Treatment	9	750.1660**	423.6843**	127.4511**
Error	18	0.6340	1.6191	3.2429

** - Significant at $p = 0.05$

APPENDIX-IV

Values of mean sum of squares for population of til hawk moth

Source of variation	d.f.	Til hawk moth		
		Plant damage at 30 DAS	Flower damage at 45 DAS	Capsule damage at 70 DAS
Replication	2	0.8883	2.6888	0.9292
Treatment	9	728.4127**	435.8896**	194.5647**
Error	18	0.9133	3.1690	2.0984

** - Significant at $p = 0.05$

APPENDIX-V

Values of mean sum of squares for population of gall fly

Source of variation	d.f.	Gall fly		
		Plant damage at 30 DAS	Flower damage at 45 DAS	Capsule damage at 70 DAS
Replication	2	0.4913	2.3503	1.1619
Treatment	9	826.2792**	415.9237**	146.0293**
Error	18	2.2520	2.3602	1.3140

** - Significant at $p = 0.05$

APPENDIX-VI

Values of mean sum of squares for population of mirid bug

Source of variation	d.f.	Mirid bug		
		Plant damage at 30 DAS	Flower damage at 45 DAS	Capsule damage at 70 DAS
Replication	2	10.2114	4.8442	9.1377
Treatment	9	928.2508**	334.8629**	304.1400**
Error	18	4.2905	4.0236	1.8913

** - Significant at $p = 0.05$

VITA

Name of author : **Sanjay Bhura**
Father's name : Sh. Virendra Singh
Date of birth : 02/04/1993
Address : Village & Post. Rotla, Dist. Jhabua
(M.P.) 457661

Academic qualifications:

Examination passed	Year of passing	Name of Board/USniversity	Division	Percentage OGPA (out of 10 Point scale)
High School	2009	M.P. Board, Bhopal, (M.P.)	Second	46.10%
Higher Secondary (10+2)	2011	M.P. Board, Bhopal, (M.P.)	Second	57.40%
B.Sc. (Ag)	2017	R.V.S.K.V.V., Gwalior (M.P.)	First	67.30%
M.Sc. (Ag) Entomology	2020	R.V.S.K.V.V., Gwalior (M.P.)	Second	67.70% (Approx.)

Date:

Place: **Gwalior**

(Sanjay Bhura)