

SEASONAL ABUNDANCE AND INTEGRATED
MANAGEMENT OF LEAF WEBBER,
***Antigastra catalaunalis* (Duponchel)**
IN SESAMUM CROP

A
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BY

VARMA HARESHKUMAR SHAMALBHAI

M.Sc. (Agri.)

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
CHIMANBHAI PATEL COLLEGE OF AGRICULTURE
SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY
SARDARKRUSHINAGAR – 385 506 [GUJARAT]

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ABSTRACT

**SEASONAL ABUNDANCE AND INTEGRATED
MANAGEMENT OF LEAF WEBBER,
Antigastra catalaunalis (Duponchel)
IN SESAMUM CROP**

Name of Student

VARMA HARESH S.

Major Advisor

Dr. I. S. PATEL

**DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
CHIMANBHAI PATEL COLLEGE OF AGRICULTURE
SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY
SARDARKRUSHINAGAR-385 506**

ABSTRACT

Sesamum leaf webber, *Antigastra catalaunalis* (Duponchel) have been studied in relation to its nature and extent of damage, seasonal abundance in relation to weather parameters, date of sowing, intercropping, varietal screening and testing of various insecticidal molecules during the year 2009 and 2011 at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Talod.

The larvae of this pest feed on leaves, flowers and capsules. The damage ranged from 2.66 to 4.02 per cent and 3.2 to 6.19 per cent on leaves, 20.52 to 47.52 per cent and 26.78 to 40.00 per cent on flowers, 6.25 to 20.25 per cent and 5.26 to 28.02 per cent on capsules in the field of sesamum crop during year 2009 and 2010, respectively.

The study on seasonal abundance revealed that the egg population started after 2nd week of sowing (28th standard week) and increased gradually

and reached to its peak (1.60 eggs/plant) in 11th and 12th week after sowing (37th and 38th standard week) in the year 2009 and 4.90 eggs/plant in the 12th week after sowing (38th standard week) in the year 2010 than declined suddenly. Thus, egg population was recorded maximum during September in both the years.

The larval population appeared in 2nd week of sowing (28th standard week) increased gradually and reached to its peak (1.33 larva/plant) in 11th and 12th week after sowing (37th and 38th standard week) in the year 2009 and 4.33 larvae/plant in the 11th week after sowing (37th standard week) in the year 2010 than declined suddenly. Thus, higher larval population was also found higher during September in both the years.

Thus minimum temperature, relative humidity and rainfall adversely affected on the abundance of leaf webber but maximum temperature favoured the development of leaf webber population on sesamum crop during *kharif* 2009 and 2010.

RT-193 variety recorded minimum flower infestation (5.01%). It was at par with the RT-127 (7.75%), RT-169 (9.18%), NIC-7800 (9.93%) and NIC-7829 (10.98%). While, GT-3 recorded highest flower infestation (34.00 %) and found highly susceptible and differed significantly from the other varieties. It was at par with GT-2 (31.23%) and GT-1 (28.24%).

RT-193 recorded minimum capsule infestation (3.24%) and was least susceptible. It was at par with the RT-169 (3.88%), RT-127(5.55%), NIC-7829 (6.19%) and NIC-7800 (7.81%). While, the genotype GT-3 recorded highest

capsule infestation (26.33%) and was found highly susceptible and differed significantly from the other varieties. It was at par with the treatment of GT-2 (23.12%).

The flower damage of leaf webber was recorded significantly minimum in crop sown on 22nd January (3.36%) and it was at par with the crop sown on 22nd February (4.61%) and 7th March (6.18%). The flower damage was significantly higher in crop sown on 14th February (14.98%) and it was at par with the crop sown on 7th February (12.21%).

Based on pooled value, significantly higher yield was obtained from 22nd January (580.87 Kg/ha). It was at par with 22nd February (566.25 kg/ha). Significantly lowest yield was recorded from 14th February (428.50 kg/ha).

The results of intercropping trial revealed that significantly lowest flower and capsule damage was recorded in sesamum intercropped with mungbean and it was at par with sesamum+ clusterbean and sesamum + pearl millet intercropping system. While, the higher flower and capsule damage was recorded in sesamum crop intercropped with groundnut.

Based on pooled value, higher yield of sesamum was obtained from sesamum + mungbean (512 kg/ha). It was at par with sesamum + pearl millet (438.00 kg/ha). Significantly lowest yield was recorded in sesamum + groundnut intercropping combination. The sesamum intercropped with cowpea could give 346.65 kg/ha which was lower than sole crop (363.40 kg/ha).

In efficacy trial, lowest flower damage was recorded in emamectin benzoate 0.001 per cent but it was at par with spark 0.036 per cent and polytrin

0.004 per cent. While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective. While, rest of the treatments were least effective.

Similarly, capsule damage was also recorded significantly lowest in emamectin benzoate 0.001 per cent but, it was at par with spark 0.036 per cent and polytrin 0.004 per cent. While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective. While the rest of the treatments were least effective.

Highest grain yield was achieved in treatment of emamectin benzoate 0.001 per cent *i.e.* 473 kg/ha. It was at par with spark 0.036 per cent (391 kg/ha). Significantly lowest yield was obtained from carbosulfan 0.05 per cent which was not differed from flubendiamide 0.002 per cent.

Increase in yield over control ranged from 13.77 to 44.00 per cent due to application of insecticides against leaf webber. Maximum yield was increased in plot treated with emamectin benzoate 0.001 per cent (44.00%) followed by the spark 0.036 per cent (41.67%). Avoidable loss in yield due to infestation of leaf webber was varied from 4.68 to 23.49 per cent in different treatments. It was lowest in (4.68%) in spark 0.036 per cent followed by thiodicarb 0.15 per cent (5.85 %) and fenvalerate 0.01 per cent (6.18%). Maximum avoidable loss was recorded in untreated *i.e.*, 23.49 per cent.

Economics of various application of insecticides evaluated against leaf webber indicated that maximum realization was obtained in plot treated with emamectin benzoate 0.001 per cent (₹ 12600) followed by spark 0.036 per cent

(₹ 11280) and polytrin 0.004 per cent (₹ 10140). Minimum net realization was recorded in carbosulfan 0.05 per cent (₹ 2520) followed by flubendamide 0.0042 per cent (₹ 4320) and profenofos 0.04 per cent (₹ 5580). Highest NCIBR was obtained in spark 0.036 per cent (1:4.48) which was followed by emamectin benzoate 0.001 per cent (1:3.14).



**SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY
CHIMANBHAI PATEL COLLEGE OF AGRICULTURE
SARDARKRUSHINAGAR – 385 506**

CERTIFICATE – I

Dated : 23/10/2012.

This is to certify that **VARMA HARESHKUMAR SHAMALBHAI** has successfully completed the comprehensive examination held on **17/03/2012** as required under the regulation for **DOCTOR OF PHILOSOPHY** in the subject of **AGRICULTURAL ENTOMOLOGY**.



(B. R. PATEL)

Professor & Head

Department of Agril. Entomology,
C.P. College of Agriculture,
S.D. Agricultural University,
Sardarkrushinagar-385 506.

SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY
CHIMANBHAI PATEL COLLEGE OF AGRICULTURE
SARDARKRUSHINAGAR – 385 506

CERTIFICATE – II

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This is to certify that the thesis entitled "**Seasonal abundance and Integrated management of leaf webber, *Antigastra catalaunalis* (Duponchel) in sesamum crop**" submitted for the degree of **DOCTOR OF PHILOSOPHY** in the subject of **AGRICULTURAL ENTOMOLOGY** embodies bonafide research work carried out by **VARMA HARESHKUMAR SHAMALBHAI** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of the thesis was also approved by Advisory Committee on 11/10/2012.



(B. R. PATEL)

Professor & Head

Department of Agril. Entomology,
C.P. College of Agriculture,
S.D. Agricultural University,
Sardarkrushinagar-385 506.



(I.S. PATEL)

Major Advisor

Research Scientist (Ento.),
Centre of Excellence for Research on Pulses,
S.D. Agricultural University,
Sardarkrushinagar-385 506.



(R.M. CHAUHAN)

Principal & Dean

C.P. College of Agriculture,
S.D. Agricultural University,
Sardarkrushinagar-385 506.

SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY
CHIMANBHAI PATEL COLLEGE OF AGRICULTURE
SARDARKRUSHINAGAR – 385 506

CERTIFICATE – III

Dated : 23/10/2012.

This is to certify that the thesis entitled "**Seasonal abundance and Integrated management of leaf webber, *Antigastra catalaunalis* (Duponchel) in sesamum crop**" submitted by **VARMA HARESHKUMAR SHAMALBHAI** to the Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in partial fulfillment of the requirement for the degree of **DOCTOR OF PHILOSOPHY** in the subject of **AGRICULTURAL ENTOMOLOGY** was after recommendation by the external examiner was defended by the candidate before the following members of the Advisory Committee. The performance of the candidate in the oral examination on this thesis has been found satisfactory; we therefore, recommend that the thesis be approved.


(B. R. PATEL)

Professor & Head

Department of Agril. Entomology,
C. P. College of Agriculture,
S. D. Agricultural University,
Sardarkrushinagar-385 506.


(I. S. PATEL)
Major Advisor

Research Scientist (Ento.),
Centre of Excellence for Research on Pulses,
S.D. Agricultural University,
Sardarkrushinagar-385 506.



APPROVED (Seal & Date)



(R.M. CHAUHAN)

Principal & Dean

C. P. College of Agriculture,
S. D. Agricultural University,
Sardarkrushinagar-385 506.


(A. G. DESAI)
Advisor


(D. A. DODIA)
Advisor


(R.K. PATEL)
Advisor


(B. H. PRAJAPATI)
Advisor


(M. S. PUROHIT)
(Dean P.G. Studies, Nominee)

**SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY
CHIMANBHAI PATEL COLLEGE OF AGRICULTURE
SARDARKRUSHINAGAR – 385 506**

CERTIFICATE – IV

Dated : 23/10/2012.

This is to certify that **VARMA HARESHKUMAR SHAMALBHAI**,
Department of **AGRICULTURAL ENTOMOLOGY**, C. P. College of
Agriculture, Sardarkrushinagar has made all corrections/modifications in the thesis
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(R.M. CHAUHAN)

Principal & Dean
C.P. College of Agriculture,
S.D. Agricultural University,
Sardarkrushinagar-385 506.

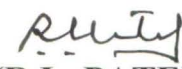

(I.S. PATEL)
Major Advisor

Research Scientist (Ento.),
Centre of Excellence for Research on Pulses,
S.D. Agricultural University,
Sardarkrushinagar-385 506.


(B. R. PATEL)
Professor & Head

Department of Agril. Entomology,
C.P. College of Agriculture,
S.D. Agricultural University,
Sardarkrushinagar-385 506.

APPROVED (Seal & Date)


(R.L. PATEL)

Director of Research &
Dean, Post-Graduate Studies,
S.D. Agricultural University,
Sardarkrushinagar-385 506.



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If it flies with its own wings"***

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(VARMA HAREESH S.)

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INTRODUCTION

I. INTRODUCTION

Sesamum belongs to the order Tubiflorae, family Pedaliaceae is commonly known as "*Til*." It is a short duration crop grown throughout the year. This crop is famous for edible oil. Due to the presence of potent antioxidant, sesame seeds are known as "the seed of immortality." The sesamum seed is rich source of edible oil. Its seed contain two important amino acids viz., methionine which is good for liver and tryptophan which is good for skin and hair. Sesamum seed also contain natural lecithin which helps to keep cholesterol in liquid form, thereby preventing gallstones (Anonymous, 2001).

About 78 per cent of sesame produced in India is used for oil extraction, 20 per cent for domestic use including preparation for sweet candies, as condiments, culinary purpose, confectionery and about 2-3 per cent is retained for next sowing. Sesamum is used as a nourishing food, as a flavoring agent and for medicinal purposes. Bulk of sesamum oil (> 82%) produced in India is utilized for edible purpose. It is widely used in the manufacturing of soaps, cosmetics, perfumes, insecticides and in pharmaceutical products. Small quantities are used in the preparation of scented hair oils and also in therapy as a vehicle for the fat soluble medicines. The oil is also used in the formation of antacids, ointments and for injecting soluble substances. It also acts as anti-inflammatory and anti-viral agent. It is also used in insecticidal sprays. Since sesame oil contains 'sesamol' a natural antioxidant preventing rancidity, it is blended with other oils to increase their stability.

The oil is also used by tanners for oiling-up tanned cow hides and goat and sheep skins.

In India, sesame is cultivated in the area of about 17.99 lakh hectare with production of 7.57 lakh tonnes of seeds with productivity of 421 kg/ha. In India, sesame is grown in Rajasthan, Gujarat, Uttar Pradesh, Orissa, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu and West Bengal.

Gujarat is the leading sesame producing state contributing 22.3 per cent of total production, followed by West Bengal (19.2%), Karnataka (13.5%), Rajasthan (9.8%), Madhya Pradesh (9.06%), Tamil Nadu (4.7%), Andhra Pradesh (4.52%) and Maharashtra (4.52%). Though, total area under sesame cultivation is highest in Gujarat, the productivity level is low as compared to West Bengal (859 kg/ha), Tamil Nadu (539 kg/ha), Karnataka (510 kg/ha) and Maharashtra (302 kg/ha) (Hegde and Sudhakar Babu, 2002).

In Gujarat, sesame is cultivated in an area of about 2.26 lakh hectares and produced about 0.80 lakh tonnes of seeds. The average productivity of the state was 356 kg/ha (Anon., 2010). In Gujarat major sesamum growing area are in Surendranagar, Banaskantha, Bhavnagar, Kachchh, Rajkot, Amreli and Mehsana. Sesame crop is attacked by as many as 29 insect pests. Insects pests damaging sesamum crop are listed as under :

- [1] Leaf webber and capsule borer, *Antigastra catalaunalis* (Duponchel),
- [2] Red hairy caterpillar, *Amsacta moorei* (Butler),
- [3] Bihar hairy caterpillar, *Spilosoma oblique* Walker,

- [4] Hawk moth, *Acherontia styx* (West wood),
- [5] Gall midge, *Asphondylia sesami* Felt.,
- [6] Mirid bug, *Cyrtopeltis tennius* Reuter,
- [7] Pentatomid bug, *Nezara viridula* (Linnaeus),
- [8] Thrips, *Thrips tabaci* (Lindeman),
- [9] Blister beetle, *Mylabris pustulata* (Thunberg), and
- [10] Yellow mite, *Polyphagotarsonomus latus*.

Among them, sesamum leaf webber and capsule borer *A. catalaunalis* (Dup.) is the key pest causing extensive damage to foliage and fruiting bodies. (Bhaduria *et al.*, 2000) (Plate I). The larvae of this pest roll together a few top leaves and feed on them in the early stage of the crop and after pod formation; the larvae get entry inside the pod and damaged them. In Gujarat, some work on this pest has been carried out by various scientists (Desai and Patel, 1965; Patel, 1973; Patel, 1978; Vora *et al.*, 1984 and Kapadia, 1997). This pest can cause yield loss to the tune of 53 to 74 per cent (Kumar and Goel, 1994a). Spray application of synthetic insecticides does not give satisfactory control of this pest as caterpillar webs/rolls the leaves/terminals and feed within.

Now a day's more emphasis is being given to evolve Integrated Pest Management strategy for a pest on crop. For the purpose, the basic information on nature of damage, seasonal abundance, susceptibility of different varieties, date of sowing, intercropping and testing of various insecticidal modules *etc.*, are very important. The studies on seasonal abundance of pest are affected by various biotic and abiotic factors. A sound knowledge of which will be helpful



EGG



LARVA



Male



Female

ADULT



PUPA

Plate I. Different developmental stages of *A. catalaunalis*

in development of suitable management strategies. Also the use of less susceptible varieties would be advantageous particularly in low input agricultural situation as it requires few insecticidal sprays and thereby minimizes the toxic residue on food and hazard to natural enemies. Planting date and intercropping system is also very useful for minimizing pests.

The information on population fluctuation of this pest in relation to weather parameters is also scanty. Screening of different genotypes should be a continuous process in a breeding programme for evolving resistant genotypes against any insect pest.

Keeping these views in mind, attempts have been made to study following aspects for the management of leaf webber and capsule borer.

- [1] Seasonal abundance of leaf webber, *A.catalaunalis* and its relationship with weather parameters in sesamum crop
- [2] Reaction of certain varieties/genotypes of sesamum for resistance to *A. catalaunalis*
- [3] Effect of date of sowing on the incidence of *A.catalaunalis* in sesamum
- [4] Impact of intercropping system on the incidence of *A. catalaunalis* in sesamum crop
- [5] Testing of various insecticidal molecules for its efficacy against *A.catalaunalis* in sesamum crop



REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Sesamum leaf webber, *Antigastra catalaunalis* (Dup.) is one the major limiting factor in achieving desirable yield in sesamum crop. But, little information is available on *A.catalaunalis* on selected aspects; hence an attempt is made to review the available literature

2.1 NATURE AND EXTENT OF DAMAGE

Lefroy and Howlett (1909) and Pillai (1921) reported that the larvae of leaf webber rolled the leaves of the host plant and bored into the pod.

Ghosh (1923) observed that the larvae rolled the top leaves and also bored in the pods of sesame grown in Burma.

The caterpillar of *A.catalaunalis* was observed to feed on the tender shoots and in leaves by webbing the leaves together and also boring into the green pods of the plant. As much as 30 per cent pods of sesamum were found damaged by the larvae (Anonymous, 1926).

Menon *et al.* (1960) observed that if the pest infestation took place at early stage of the crop growth, the plant may die without producing any branch or shoot or the crop infested at later stage, the production of flowers stopped beyond the point of infestation, the larvae bored into green pods and destroyed the pod contents partly or wholly.

According to Bhattacharjee and Lal (1960), when the infestation occurred in early stage of growth, the plants died without producing tillers, whereas if attacked at later stage, the plant growth stopped beyond the point of infestation and the infested flowers did not produced seed at Pusa, Bihar.

According to Narayan (1961), the larvae fed on the tender leaves and remained inside the webs and sometimes it bored into the stem and pod at Pusa in Bihar.

Desai and Patel (1965) observed that when flowering started in the crop, the larvae entered the buds and flowers, which consequently affected the formulation of pods. They also observed that the infestation of the pest was considerably reduced after pod development. They recorded 28.60 and 42.50 per cent infested plant in the year 1961-62, whereas 1962-63, 15.90 and 20.20 per cent plant infestation was observed, respectively at Junagadh (Gujarat).

Deshpande and Singh (1969) observed 3.35 to 8.39 per cent pod damage due to *A. catalaunalis*.

Jakhmola and Yadav (1975) reported that the percentage of plants attacked by the larvae of *A. catalaunalis* varied from 2.0 to 24.4 per cent in Madhya Pradesh. The newly hatched larvae acted as leaf miner and fed on the leaf tissue between the two surfaces of the leaf and then began to feed on the leaf by folding tender leaves (Patel 1978).

According to Zumreoglu (1982), the larvae caused up to 87 per cent infestation in Turkey. The larvae webbed together the leaves and flowers and fed on them, bored into the young shoots and eventually entered the pods to feed on the seeds within.

Vora *et al.* (1984) observed that the newly hatched larvae rolled together a few top leaves and started feeding and forming the webs if

infestation took place at early stage and the plant died without producing any branch or shoot.

Cheema and Singh (1987) reported that the damage was caused by the larvae of leaf webber rolled the host plants or bored into the pods, when infestation took place in the early stage of the crop, plants died of without producing any branch or shoot. If the crop was infested at later stage, the production of flowers stopped beyond the point of infestation. The pest was difficult to control because of its concealed feeding in all stages of the crop growth. The field studied further revealed that 28.50 per cent of the branches were damaged. The flowers and pods were infested to the extent of 27.8 and 9.9 per cent, respectively.

Vaghela (1988) observed that sesamum variety HT-1 infested by the larvae entered between the leaf epidermis and fed on the mesodermis then fed outside the leaf epidermis by folding the leaf.

According to Jakhmola and Yadav (1990), *A.catalaunalis* damaged 11.1 per cent flowers and 2.68 per cent capsules in Madhya Pradesh.

According to Rohilla and Singh (1992), the reduction in grain yield, oil, nitrogen, protein, reducing sugar and total sugars content of the seeds damaged by *A. catalaunalis* to the level of 63.93, 11.96, 13.82, 12.12, 10.10, 24.04 and 20.31 per cent, respectively.

Kumar and Goel (1995) from Haryana stated that the sesamum leaf webber was regular pest and major constraint in the successful cultivation of the crop, causing yield loss up to 74.00 per cent. *A.catalaunalis* caused up to

90 per cent yield loss to sesamum in India reported by Ahuja and Bakhietia (1995).

Selvanarayan and Baskaran (1966) observed that in profusely branching varieties the larval population and damage levels were highest. According to Sengar (2003), the larvae initially fed on the mesodermal layer as a result of which papery spots appeared on the leaf. The later instar larvae folded the leaves and fed within. At flowering stage, the larvae webbed the terminal leaves and flower folded and fed within. The larvae also observed feeding on the ovary of the flowers devouring it completely and later on moving to another flowers and also excreta inside the flowers.

2.2 SEASONAL ABUNDANCE OF *A. catalaunalis*

Sinha and Prasad (1992) reported that *A. catalaunalis* started appearing on sesame in August and maximum activity was recorded in the second week of September when average temperature, relative humidity and rainfall were $28.7 \pm 4.0^{\circ}\text{C}$, 85.5% and 29.2 mm, respectively.

According to Singh *et al.* (1992), maximum larval population was recorded during the second week of September-1988, when the average temperature, relative humidity and rainfall were $28.7 \pm 4.0^{\circ}\text{C}$, 85.50 per cent and 29.2 mm, respectively. They recorded minimum population in the first week of August when the average temperature and rainfall were $30.3 \pm 3.90^{\circ}\text{C}$ and 9.2 mm, respectively. The difference in the population during different weeks of different months were not so much as there was little fluctuation in the different meteorological parameter during the period of observations and as

such there was no significant correlation between the pest population and meteorological parameters. However, it was inferred that the pest remain more active from the last week of August to second week of September as the population was maximum during this week period.

In Uttar Pradesh, Kumar and Goel (1994a) observed that the pest was active from germination to harvesting of sesamum crops grown in the year 1989 to 1990. The larval population reached to its peak in the first and second week of October. The larval population showed a significantly high relative correlation with maximum temperature and afternoon relative humidity, where as the correlation was comparatively low and non significant with maximum temperature, morning relative humidity and rainfall. Average weekly temperatures, 28.85 to 29.75°C and relative humidity, 71.21 to 72.20 per cent coupled with no rainfall were found most congenial environment condition.

According to Talpur *et al.* (2002) the population of leaf roller/webber was highest during capsule formation and early vegetative stage, while the lowest population was recorded during flowering. Sengar (2003) observed that higher egg population was observed in September months in both year and the larval population was found during September to October *i.e.*, in the later period of the crop.

Kumar *et al.* (2009) reported that *til* leaf webber, *A. catalaunalis* were recorded from sowing to harvesting stages of the crop.

Viroja (2011) reported that the pest population was reached at peak during 8th week after sowing at Junagadh. While, one week early 7th week after

sowing at Targadia (Rajkot) which causes 89 per cent or more plant damage. Further, it was also found that the weather parameters which favoured highest pest population at both the locations were temperature maximum 31 to 32°C and minimum 25°C with relative humidity, morning (maximum) 87 to 92 per cent and evening (minimum) 71 to 78 per cent, sunshine hours 2 to 3 rainy days in a week.

2.3 REACTION OF CERTAIN VARIETIES/GENOTYPES OF SESAMUM FOR ITS RESISTANCE TO *A. catalaunalis*.

Bhattacharjee and Rattan Lal (1962) reported that NP-2 and NP-6 were being early maturing and flowering varieties had higher population as compared to the variety NP 29. They further reported that varieties NP-2 had higher pest infestation as compared to NP-6. It was found that only lateness of maturity was significantly associated with low levels of infestation (Prasad, 1970).

According to Patel (1973), B-9, Mrung-1, B-74, UT-43, Patan-64, Kundala-1-8, Mrung-1, Mt-67-52, T-4, J.R.15, Annand-13 and Patan-64 were resistant to *A. catalaunalis*.

According to Mahadevan (1988), EC 22, SI 250 and EC 12 were highly resistant to *A. catalaunalis*. Singh *et al.* (1990) reported lower percentage of pod infestation by *A. catalaunalis* at harvesting in the sesamum genotypes, TLC 88b, TLC 75, TLC 83, and TLC 88A and TLC 77 during *kharif* season in Haryana.



According to Muralibaskaran *et al.* (1994), seven entries viz. SI 3315/11, SI 53, SI 882, 59-1-1, PDK 31 and SSI 990 were moderately resistant under *in vitro* condition and two entries viz., ES 22, SI 250 were resistant in both the condition at Vridhachalam during rainy season 1988.

Manimegalai and Mahalingam (1997) found IS 99 and SI 250 as resistant; while ES 34, KIS 302, RT 106, OT 81, SI 1029, SI 2928, SI 53, SI 3232, ICRR 1, S 0551, SI 1778, SI 3315/4 and SI 73 were found moderately resistant.

Rath *et al.* (1997) reported that OMT 30 showed least damage followed by B-67 and OMT-32 in 1995. Out of 26 sesamum genotypes, IVT-17 was found most resistant, while IVT-7 found susceptible cultivar during *kharif* 1994 in Jammu and Kashmir (Gurs and Husain, 1998).

According to Shrivastava *et al.* (2002), flower and capsule damage by capsule borer ranged from 2.0 to 75.0 per cent and from 1.4 to 31.2 per cent, respectively. Germplasm line SI-73 was found free from capsule borer at harvest stage. Seven germplasm lines viz., SI-1729, SI-3239, IC-132246, IC-204137, IC-205071, IC-2050S2 and IC-205304 were found to be promising as these lines can be used in breeding programmes as donors for resistance to leaf roller and capsule borer.

Anand and Selvanarayanan (2005) reported that five sesame accessions (IVTS-2001-20, IVTS-2001-23, IVTS-2001-24, IVTS-2001-25 and IVTS-2001-26) were evaluated for their resistance to the shoot webber (*Antigastra catalaunalis*) during August to October 2002 and January to March

2003 in Vridhachalam, Tamil Nadu, India, IVTS-2001-26 was found promising against *A. catalaunalis*.

According to Karuppaiah *et al.* (2009), twenty one species of sesame genotypes were evaluated to determine the mechanism of resistance to *A. catalaunalis*, only four genotypes viz., ES 22, UMA, SI 250 and KMR 14 were less preferred for oviposition. The lowest number of eggs was laid on UMA (12.33 ± 2.33). The egg laying of *A. catalaunalis* was positively correlated ($r = 0.749$) with the trichome density in the leaf. The growth index of *A. catalaunalis* was low in the resistant genotypes ES 22, SI 250 and UMA and high in susceptible genotypes TMV 3, TMV 4, TMV 5, TMV 6 and TC 25 indicated antibiosis mechanism. The total phenols in the leaves, flowers and pods were negatively correlated with damage of *A. catalaunalis*.

2.4 EFFECT OF DATE OF SOWING ON THE INCIDENCE OF *A. catalaunalis* IN SESAMUM

According to Abraham *et al.* (1977), the incidence of *A. catalaunalis* was highest in crops sown in February.

Rai (1999) concluded that sowing on 23rd July recorded the lowest damage, *i.e.*, 6.7, 14.3 and 8.3 per cent in leaves, flowers and pods, respectively, and produced a significantly higher yield. However, sowing on later dates (30th July, 6th and 13th August) recorded significantly higher damage to leaves, flowers and pods. The crop sown 23rd July recorded low larval population and gradually increased with the delay in sowing. Sowing during 23rd July also recorded significantly low shoot webber and pod borer incidence

in plants, flowers and pods, which resulted significantly higher grain yield than the subsequent sowing dates (Rai *et al.*, 2002).

According to Sengar (2003), the genotypes, AT-113, At-112, At-106 and AT-104 recorded less than 15 per cent infestation in flowers as well as found significantly less susceptible to *A. catalaunalis*. The genotypes, G.Til-1 and G.Til-2 recorded more than 40 per cent infestation and were at par and found significantly more susceptible to *A. catalaunalis*.

2.5 IMPACT OF INTERCROPPING SYSTEM ON THE INCIDENCE OF *A. Catalaunalis* IN SESAMUM CROP

According to Bhaskaran *et al.* (1991), intercropping sesame with pearl millet (1:4) or groundnut reduced the infestations of *A. catalaunalis* in Tamil Nadu.

According to Nath *et al.* (2003), sesamum in association with pearl millet significantly reduced the incidence of leaf webber, which recorded minimum damage.

Ahuja (2005) reported that intercropping of sesamum with green gram in 1:1 ratio reduced infestation of leaf webber compared to sole sesamum.

2.6 TESTING OF VARIOUS INSECTICIDAL MOLECULES FOR ITS EFFICACY AGAINST *A. catalaunalis* IN SESAMUM CROP

Among the organochlorine group of insecticides, endosulfan 0.07 per cent proved very effective in reducing capsule damage Yadav *et al.* (1985); Vaghela (1988); Shrivastav *et al.* (1989), Saxena and Jakhmola (1983); Muralibaskaran *et al.* (1993); Ghorpade and Thakur (1995) and Hegde and Sudhakar Babu (2002) and monocrotophos 0.04% (Paul and Shantanu, 1997),

0.035 kg a.i./ha. (Mishra and Patnaik, 1994). According (Hegde and Sudhakar Babu, 2002), to 4% methyl parathion dust @ 25 kg/ha. were reported to be effective against *A. catalaunalis*. chlorpyrifos @ 0.05% Patel and Bhalani (1986), dimethoate @ 0.05% Shrivastava *et al.* (1989), leptophos @ 400 ml a.i./ha. Sood and Sindhu (1984), malathion 5% dust @ 25 kg/ha. Hegde and Sudhakar Babu (2002), monocrotophos @ 0.04% Yadav *et al.* (1985) and Vaghela (1988) and 0.05% Patel and Bhalani (1986) phenthoate 2% dust at 25 kg/ha. Singh and Jakhmola (1984); phosphamidon @ 0.04% Jagtap *et al.* (1986), phosalone 4% dust @ 25 kg/ha Hegde and Sudhakar Babu (2002), profenofos @ 0.04% Vaghela (1988) and 0.05% profenofos Tripathi *et al.* (2007) and quinalphos @ 500g a.i./ha. Kumar and Goel (1994b) and @ 0.05 % Hegde and Sudhakar Babu (2002) were found effective against *A. catalaunalis*.

Among the carbamate group of insecticides, carbaryl @ 0.1% Desai and Patel (1965); Patel (1973) and Vora *et al.* (1984), 0.15% Rohilla and Singh (1992), 0.2% Mathur *et al.* (1971); Yadav *et al.* (1985); Jagtap *et al.* (1986) and Jakhmola and Yadav (1990), 0.25% Hegde and Sudhakar Babu (2002) and BPMC @ 0.03% Singh and Jakhmola (1984) were reported to be effective against *A. catalaunalis*.

Among the synthetic pyrethroids, cypermethrin @ 37.5 g a.i./ha. Singh and Grewal (1989), 40g a.i./ha. Kumar and Goel (1994b), 50g a.i./ha. Singh *et al.* (1991), 60 g a.i./ha. Kumar and Goel (1994b), 50 g a.i./ha. Singh *et al.* (1991), 60g a.i./ha. Kumar and Goel (1995) and 0.05% Singh and Jakhmola (1984); deltamethrin @ 8.75 g a.i./ha. Singh and Grewal (1989),

10.5g a.i./ha. Singh *et al.* (1991) and 12.5g a.i./ha. Kumar and Goel (1994b) and Kumar and Goel (1995); fenvalerate @ 37.5 a.i./ha. Singh and Gravel (1989), 50 a.i./ha Singh *et al.* (1991) and 0.01% Singh and Jakhmola (1984) and fluvalinate @ 50g and 75 g a.i./ha. Kumar and Goel (1994b) were effective against *A. catalaunalis*. Sengar (2003) found that spark 36 EC a ready mix (deltamethrin 1% + triazophos 35%) insecticides @ 0.036% while neem based insecticides, neem seed kernel extract used @ 5% suspension were found most effective treatments for the control of *A. catalaunalis*.

Kumar and Goel (1995) stated that sesame leaf webber/capsule borer was a regular pest and major constraint in the successful cultivation of the crop, causing yield loss up to 74 per cent.

Kapadia (1996) reported that seed damage in infested pods was 73.4 per cent and weight loss of damaged seed was 100.0 per cent due to infestation *A. catalaunalis*.

Gupta *et al.* (2002) assessed yield loss due to the incidence of leaf roller/capsule borer, *A. catalaunalis* in sixteen cultivars of sesame during *kharif* seasons of 1986 to 1998 except in 1994 at Trikamgarh, Madhya Pradesh (India). Three sprays of 0.007% endosulfan significantly reduced capsule damage caused by *A. catalaunalis* larvae and increased the grain yield in all the cultivars. The mean avoidable loss in grain yield ranged from 6.2 to 43.1 per cent.

Patel *et al.* (2009) concluded an experiment at Dryland Research Station, Junagadh Agricultural University, Targadia, Rajkot (Gujarat) on

estimation of yield losses due to sesamum leaf webber for consecutive seven years *i.e.*, from 1999 to 2005. The results revealed that the loss in yield was maximum 34.31 per cent when average pest population over crop period was 0.65 larvae/plant during 2005. While, minimum 7.69 per cent yield loss with 0.2 larvae/plant during 2001. Further, it was found that the average 15.85 per cent yield loss over seven year recorded.

According to Viroja (2011), NSKE 3 to 5 per cent, NLE 2 to 4 per cent and azadiractin 0.00045 per cent were found highly effective with 93 to 83 per cent pest mortality and economical treatments with 48 to 39 per cent yield increased with maximum net return for the control of the sesamum leaf webber during *kharif* 2010 at Targadia (Rajkot).



MATERIALS AND METHODS

III. MATERIALS AND METHODS

Various field trials of different aspects *viz.*, seasonal abundance, varietal screening, date of sowing, intercropping, and testing of various insecticidal molecules were conducted at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Talod during *kharif* 2009 and *kharif* 2010. Details of methodology adopted for the present investigation are described in following headings.

3.1. SEASONAL ABUNDANCE OF LEAF WEBBER, *A. Catalaunalis* AND ITS RELATION WITH WEATHER PARAMETERS IN SESAMUM CROP

A field trial was conducted on variety G.Til-2. Trial was laid out under randomized block design replicated thrice for two consecutive *kharif* season 2009 and 2010. All agronomic practices were followed as per recommendation. Plot was kept unsprayed throughout the season.

G.til-2 variety was sown in an area of 500 m² at Agricultural Research Station, S. D. Agricultural University, Talod during *kharif* 2009 and 2010 for the study of seasonal abundance. From the field, fifteen plants were selected and tagged. Selected plants were critically observed at weekly interval for recording the observation. From the selected plants, damaged flower and leaves were counted for computing flower and leaves percent damage due to leaf webber. Similar healthy and damaged capsules were also counted for computing percent capsule damage. Eggs and larva were also recorded from the same selected plant at weekly intervals.

The meteorological data on *viz.*, temperature (maximum and minimum), relative humidity, rainfall, in different standard weeks were obtained from meteorological observatory of Agricultural Research Station, S. D. Agricultural University, Talod. With a view to study the impact of different weather parameters on the pest population, a simple correlation was worked out.

3.2. REACTION OF CERTAIN VARIETIES/GENOTYPES OF SESAMUM FOR RESISTANCE TO *A. catalaunalis*

To screen out certain sesamum genotypes for their reaction to *A. catalaunalis*, field trial was carried out under Randomized Block Design with three replications at Agricultural Research Station, S. D. Agricultural University, Talod during two consecutive *kharif* season 2009 and *kharif* 2010. Twenty lines *viz.*, RT-45, RT-54, RT-103, RT-125, RT-127, RT-162, RT-169, RT-193, NIC-7800, NIC-7816, NIC-7819, NIC-7828, NIC-7829, NIC-7834, NIC-7835, NIC-7836, NIC-7837, GT-1, GT-2 and GT-3 were selected for the study purpose. The net plot size for the experiment was 6.0 x 1.8 m. Each variety/genotype was grown in five lines spaced at 45 x 15 cm.

Five plants were selected randomly from each variety and tagged. The observations on number of healthy and damaged flower on selected plants were made at weekly interval starting from 6th week of sowing. Such six observations were made. The observation on number of healthy and damaged capsules per plant was also made before harvest. The data were converted to per cent damaged flowers and per cent damaged capsules. Data, so obtained

were subjected to appropriate transformation and statistically analysed for interpretation. The data were pooled over weeks and year.

3.3 EFFECT OF DATE OF SOWING ON THE INCIDENCE OF

A. catalaunalis (Dup.) IN SESAMUM

The field trial was carried out during Summer-2010 and 2011. GT-2 variety of sesamum was sown at five different dates. Trial was laid out under Randomized Block Design replicated four times. The experimental plot was kept unsprayed throughout the season. The details of the experiment are given as under.

Year of sowing	: Summer 2010 and 2011
Design	: Randomized Block Design
Plot size	: Gross : 6.0 x 2.7 m; Net : 6.0 x 1.8 m
Replications	: 4
Spacing	: 45 cm x 15 cm
Variety	: GT-2

Treatments (Sowing date) :

- (1) 22nd January
- (2) 7th February
- (3) 22nd February
- (4) 7th March
- (5) 22nd March

3.3.1 Methodology : Vide supra. 3.1

3.4 IMPACT OF INTERCROPPING SYSTEM ON THE INCIDENCE OF *A. catalaunalis* (Dup.) IN SESAMUM CROP

A trial on intercropping system was sown during *kharif* season in year 2009 and 2010 at Agriculture Research Station, S. D. Agricultural University, Talod. The details of the trial are given hereunder.

3.4.1 Details of experiment

Year of sowing	: <i>Kharif</i> -2009 and 2010
Design	: Randomized Block Design
Plot size	: Gross: 6.0 x 2.7 m; Net : 6.0 x 1.8 m
Replications	: 4
Spacing	: 45 cm x 15 cm
Variety	: Sesamum (GT-2), Cowpea (GC-5), Pearlmillet (GCH-558), Mungbean (GM-4), Clusterbean, (GC-4), Urid (G.U-1) and Groundnut (GG-20).

3.4.2 Treatments details

- (1) Sole sesamum
- (2) Sesamum + Mungbean (1:1)
- (3) Sesamum + Cow pea (1:1)
- (4) Sesamum + Urid (1:1)
- (5) Sesamum + Clusterbean (1:1)
- (6) Sesamum + Groundnut (1:1)
- (7) Sesamum + Pearlmillet (1:1)

3.4.3 Methodology : Vide supra. 3.1

3.5. TESTING OF VARIOUS INSECTICIDAL MOLECULES FOR ITS EFFICACY AGAINST *A. catalaunalis* (Dup.)

A field trial was laid out at Agriculture Research Station, Talod, S. D. Agricultural University to find out effective insecticidal molecule against *A. catalaunalis* (Dup.) in sesamum crop. The details of the trial are given hereunder.

3.5.1 Details of experiment

Year of sowing	: <i>Kharif</i> -2009 and 2010
Design	: Randomized Block Design
Plot size	: Gross : 6.0 x 2.7 m; Net : 6.0 x 1.8 m
Replications	: 3
Spacing	: Between rows : 45 cm; Within rows : 15 cm
Method of Sowing	: Line Sowing
Seed rate	2.5 kg/ha
Fertilizer application (kg/ha)	: N-P-K 50-25-0
Details of treatments	: 9 + 1 (Control) as per Table 1

3.5.2 Method of recording observations

The insecticides were evaluated based on per cent flower capsule infestation. The methodology used to take observations on damage was same as described *vide supra*. 3.1 The observations were made before spray as well as one, three, seven and fifteen days after spray.

Table 1 : Details of insecticidal molecules tested against *A. catalaunalis* in sesamum crop

Sr. No.	Technical Name	Trade Name	Formulation	Conc. (%)	Source
1.	Thiodicarb	Larvin	75 % WP	0.15	Bayer Crop Science, Mumbai.
2.	Fenvalerate	Fighter	20 % EC	0.01	Serrate (India) Ltd., Mumbai.
3.	Profenofos	Curaçron	50 % EC	0.05	Novartis India Ltd. Mumbai.
4.	Carbosulfan	Marshal	25 % EC	0.05	Rallis India Ltd. Mumbai.
5.	Cartap hydrochloride	Padan	50 SP	0.1	Coromandal Indug Product India Ltd., Chennai.
6.	Flubendiamide	Takumi	480 SL	0.002	Bayer crop science, Mumbai.
7.	Emamectin benzoate	Proclaim	5% SG	0.001	Sygenta India Ltd., Mumbai.
8.	Deltamethrin1% + Triazophos 35%	Spark	36 EC	0.036	Aventis Crop Science India Ltd., Ahmedabad.
9.	Profenofos 40EC + Cypermethrin 4 EC	Polytrin	44 EC	0.004	Novartis India Ltd. Mumbai.

3.5.3 Yield, avoidable loss and economics

3.5.3.1 Yield

The yield is an important criterion for comparing the efficacy of different treatments. The sesamum crop was harvested at proper time. Yield was recorded from net plot area (kg/plot) and finally converted to kg/ha.

3.5.3.2 Avoidable loss

On the basis of yield of various treatments under study, the avoidable losses due to leaf webber, damage was calculated by applying the following formula suggested by Paul (1976).

$$\text{Avoidable loss (\%)} = \frac{\text{Yield in treatment which gave the highest yield} - \text{Yield in the treatment}}{\text{Yield in treatment which gave the highest yield}} \times 100$$

3.5.3.3 Economics

In order to know the economics of different treatments evaluated against leaf webber in sesamum crop, the Incremental Cost Benefit Ratio (ICBR) of each treatment was worked out. For the purpose, total cost of insecticides application per hectare was calculated for each treatment based on the prevailing market price. The increased yield over control was calculated by subtracting the yield obtained in control treatment from the yield obtained from the respective treatment. Then, the gross realization over control was worked out for each treatment based on the increased yield of grain (kg/ha) over control. The net gain (₹/ha) for each treatment was computed by deducting the cost of insecticide treatment from the value of gross realization over control. The ICBR *i.e.*, net gain in rupees per rupee cost of insecticide treatment was calculated by dividing net gain with the cost of treatment. This gives values of

gross ICBR. To calculate the value of net ICBR (NICBR) *i.e.*, additional profit gained per rupee cost of treatment, one rupee was subtracted from ICBR obtained in each treatment.

3.5.3.4 Statistical analysis of data

Data on the per cent flower damage and per cent capsule damage were subjected to ANOVA after transforming them into arc sin on computer. The periodical data on per cent flower damaged were also pooled over periods and over years to see consistency or otherwise of treatment performance.



RESULTS AND DISCUSSION

IV. RESULTS AND DISCUSSION

The results of the various studies carried out on various aspects of *A. catalaunalis* in sesamum crop conducted at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Talod are presented and described hereunder. The results are discussed in light of available literature.

4.1 NATURE AND EXTENT OF DAMAGE

In field, larvae initially rolled together a few top leaves, started feeding and remained inside the folded leaves. During the later stage, the larvae damaged more leaves. The upper growing portion was completely destroyed in case of heavy infestation (Plate II). At flowering stage larvae webbed the terminal leaves and flowers and fed within. The larvae entered in the bud and flower. Inner whorls of the flowers were affected (Plate III).

At capsule stage, it bore the capsule, entered inside and fed on the seeds of the capsules (Plate IV). Similar nature of damage at capsule stage was also reported by Kumar and Goel (1994a), Sengar (2003) and Thakor (2006).

In laboratory, the newly hatched larvae acted as leaf miner and fed on the leaf tissue between the two surfaces of leaf. Second instar larvae came out from leaf tissue and began to feed on the leaf by folding tender leaves. While, third and fourth instar larvae webbed the leaves. The fifth instar larvae continue to remain hidden in the web and fed on the leaves. Similar observations were also recorded by Patel (1970) and Thakor (2006).

The data on extent of damage caused by *A. catalaunalis* on leaves, flowers and capsules are presented in Table 2 & 3. It is cleared from the data



Webbed leaves



Larvae damaging flower

**Plate II. Leaf webber larvae damaging leaves and flowers of
sesamum**

Table 2 : Damage due to *A. catalaunalis* in sesamum crop during July to September, 2009

Date of observation	Damage (%)		
	Leaves	Flower	Capsules
8 July	2.66	-	-
15 July	2.85	-	-
22 July	3.69	-	-
29 July	4.02	-	-
5 August	-	20.52	-
12 August	-	22.17	-
19 August	-	34.28	-
26 August	-	36.84	6.25
2 September	-	42.37	6.95
9 September	-	47.52	7.74
16 September	-	-	8.88
23 September	-	-	14.50
30 September	-	-	20.45

Table 3 : Damage due to *A. catalaunalis* in sesamum crop during July to September, 2010

Date of observation	Damage (%)		
	Leaves	Flower	Capsules
6 July	3.2	-	-
13 July	4.28	-	-
21 July	5.71	-	-
28 July	6.19	-	-
4 August	-	26.78	-
11 August	-	33.33	-
18 August	-	40.00	-
25 August	-	30.30	5.26
1 September	-	32.97	5.76
8 September	-	37.25	17.23
15 September	-	-	23.68
22 September	-	-	28.02



Healthy Flower



Damaged Flower

Plate III. Healthy and damaged flowers of sesamum crop due to attack of *A. catalaunalis*

that in the early stage of the crop, the percentage of damaged leaves ranged from 2.66 to 4.02 per cent and 3.2 to 6.19 per cent during 2009 to 2010, respectively. At flowering stage of the crop, the percentage of damaged flower ranged from 20.52 to 47.52 per cent and 26.78 to 40.00 per cent during 2009 to 2010, respectively. While, capsule damage was ranged from 6.25 to 20.25 per cent and 5.26 to 28.02 per cent during 2009 and 2010, respectively. Earlier 40.0 per cent (Kumar and Goel, 1994a) and 2.81 to 3.94 per cent (Sengar, 2003) flower damage to flowers and 4.82 per cent (Kumar and Goel, 1994a) and 5.29 to 20.25 per cent (Sengar, 2003) capsule damage have been reported by various workers in India.

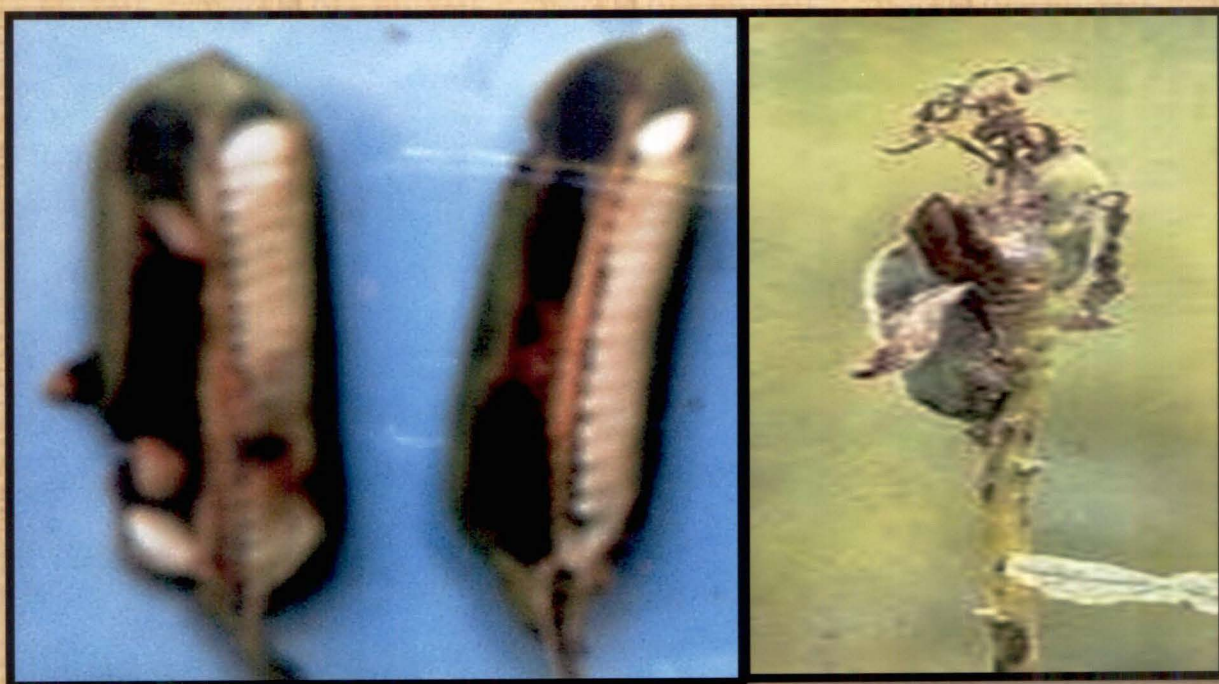
4.2 SEASONAL ABUNDANCE AND CORRELATION

The data on average number of eggs and average number of larvae of *A.catalaunalis* at different meteorological weeks in the year 2009 and 2010 are presented in Table 4 & 5 and graphically depicted in Figure 1 and 2 for the respective year.

The observation on egg population recorded during year 2009 indicated that the egg population started after 2nd week of sowing (28th standard week) increased gradually and reached to its peak (1.60 eggs/plant) in 11th and 12th week after sowing (37th and 38th standard week) in the year 2009 and 4.90 eggs/plant in the 12th week after sowing (38th standard week) in the year 2010 than declined suddenly. Thus, egg population was recorded maximum during September in both the years.



Healthy Capsule



Damaged Capsule

Plate IV. Healthy and damaged capsules of sesamum crop due to attack of *A. catalaunalis*

Table 4 : Egg and larval population of *A. catalaunalis* in sesamum crop during July to October, 2009

Period of observation	Meteorological Week	Week after sowing	Average number of egg(s)/plant	Average number of larva(e)/plant
July-2009				
II	28	2	0.20	0.13
III	29	3	0.40	0.33
IV	30	4	0.60	0.50
V	31	5	0.80	0.73
August-2009				
I	32	6	0.90	0.80
II	33	7	1.00	0.80
III	34	8	1.20	1.10
IV	35	9	1.33	1.20
September-2009				
I	36	10	1.40	1.13
II	37	11	1.60	1.33
III	38	12	1.60	1.33
IV	39	13	1.40	1.20
October-2009				
I	40	14	1.20	1.00

Table 5 : Egg and larval population of *A. catalaunalis* in sesamum crop during July to October, 2009

Period of observation	Meteorological Week	Week after sowing	Average number of egg(s)/plant	Average number of larva(e)/plant
July-2010				
II	28	2	0.33	0.13
III	29	3	0.80	0.27
IV	30	4	1.87	0.73
V	31	5	2.93	1.67
August-2010				
I	32	6	2.60	2.33
II	33	7	3.27	2.40
III	34	8	3.33	2.87
IV	35	9	3.60	3.13
September-2010				
I	36	10	4.47	3.27
II	37	11	4.60	4.33
III	38	12	4.90	3.70
IV	39	13	4.40	2.40
October-2010				
I	40	14	3.80	1.60

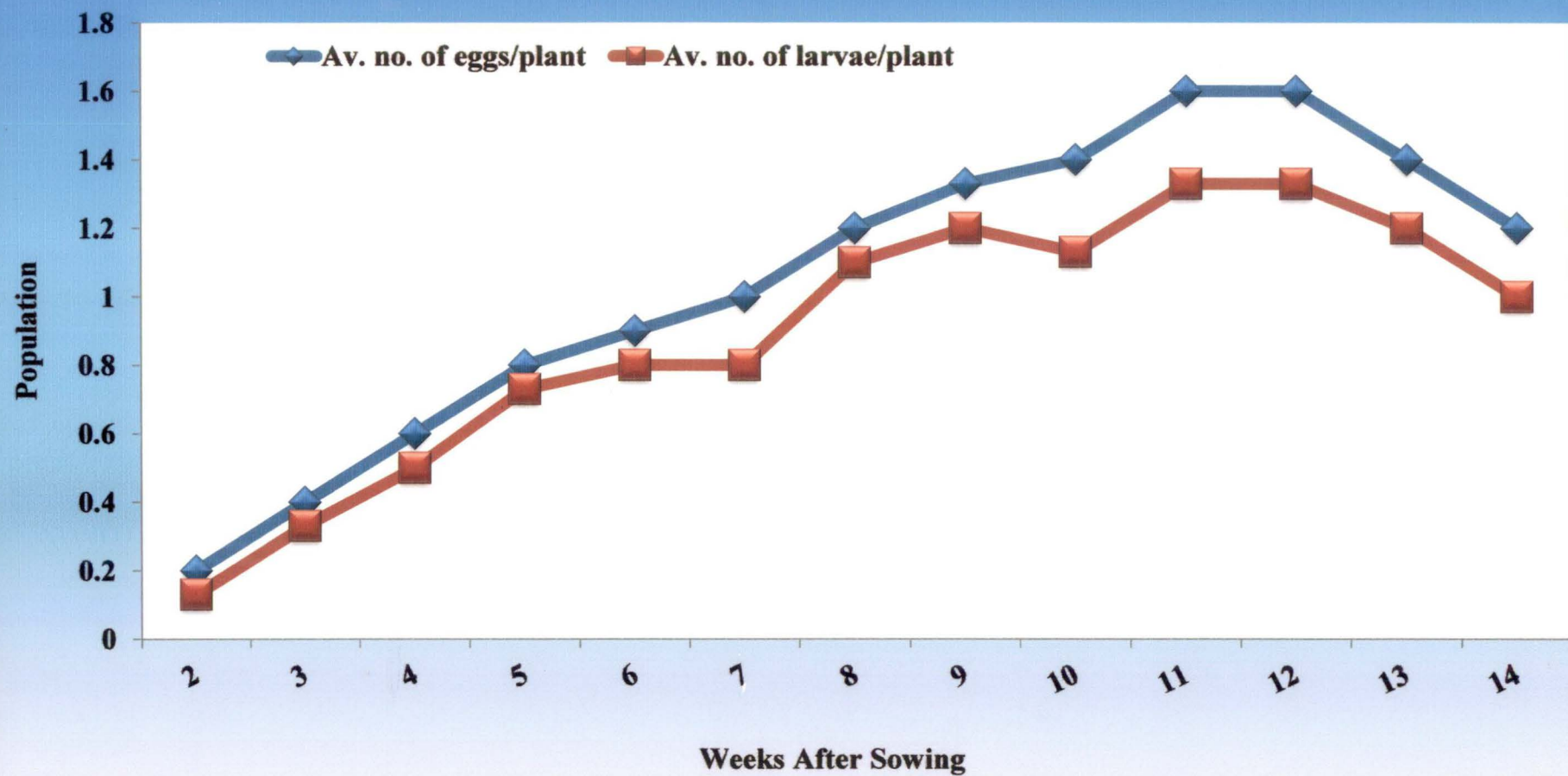


Fig. 1. Population of eggs and larvae of *A. catalaunalis* in sesamum (2009)

The data on larval population also indicated more or less similar trend of population fluctuation. The larval population appeared in 2nd week of sowing (28th standard week) increased gradually and reached to its peak (1.33 larva/plant) in 11th and 12th week after sowing (37th and 38th standard week) in the year 2009 and 4.33 larvae/plant in the 11th week after sowing (37th standard week) in the year 2010 than declined suddenly. Thus, higher larval population was also found higher during September in both the years. The report on higher population of *A. catalaunalis* in the month of september in sesamum crop at Samastipur in Bihar (Singh *et al.*1992) tally with the present observation. However, Kumar and Goel (1994a) reported that higher larval population of *A. catalaunalis* in the first and second week of October in Uttar Pradesh, which slightly differed from present observation.

The correlation co-efficient values presented in Table 6 indicated that the egg population of leaf webber exhibited significant and negative correlation with minimum temperature ($r = -0.6354$), average temperature ($r = -0.1328$), relative humidity (-0.6055) and rain fall ($r = -0.3333$). While, positive correlation was observed with maximum temperature ($r = 0.3274$).

Table 6: Correlation coefficient of *A. catalaunalis* with weather parameter during 2009-10 and 2010-11

Stage	Temperature (°C)			Relative humidity	Rainfall (mm)
	Maximum	Minimum	Average		
	X ₁	X ₂	X ₃		
Eggs	0.3274	-0.6354	-0.1328	-0.6055	-0.3333
Larva	0.2770	-0.6487	-0.1667	-0.5837	-0.3396

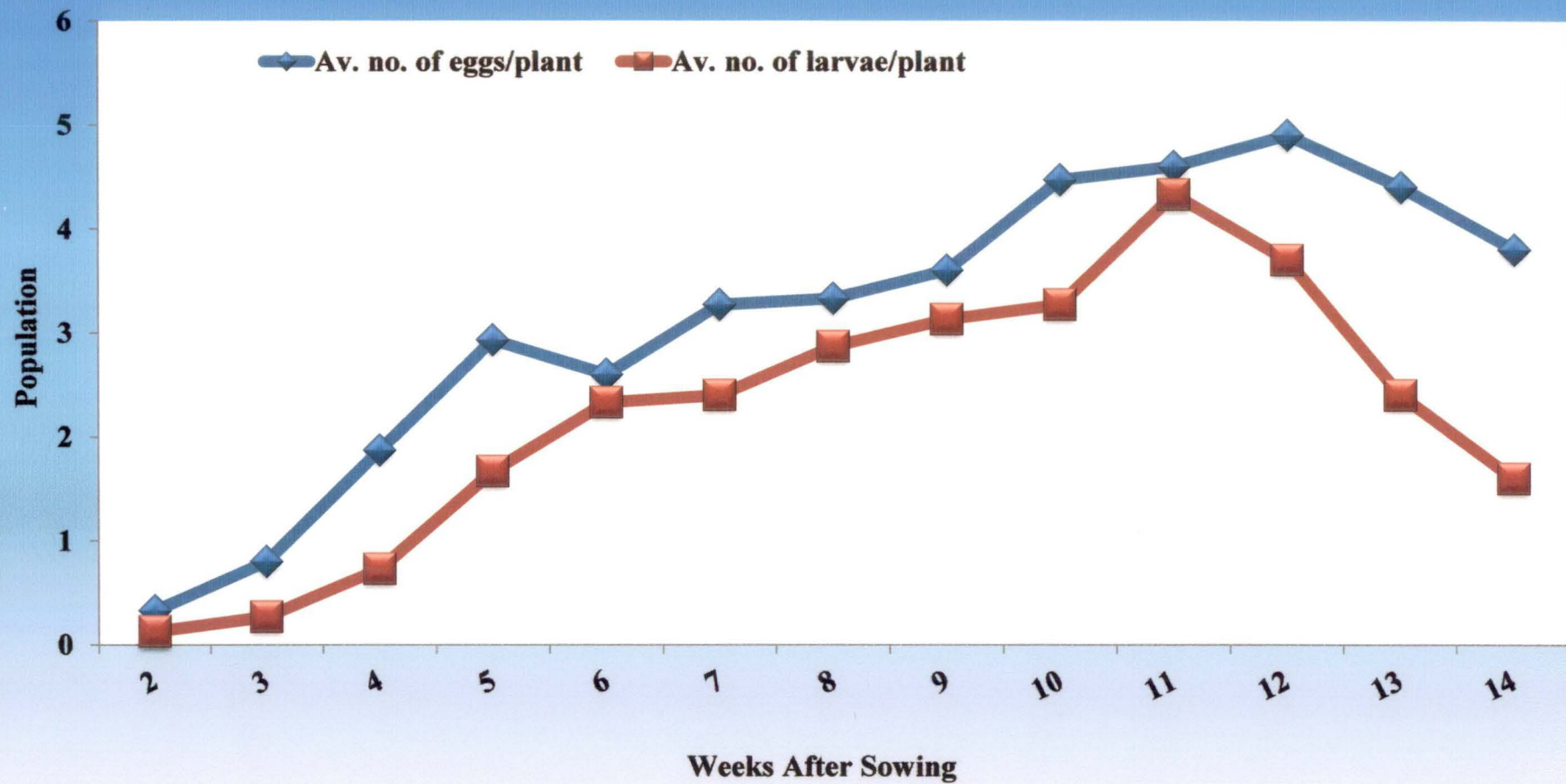


Fig. 2. Population of eggs and larvae of *A. catalaunalis* in sesamum (2010)

The correlation co-efficient values presented in Table 6 indicated that the larval population of leaf webber exhibited significant and negative correlation with minimum temperature ($r = -0.6487$), average temperature ($r = -0.1667$), relative humidity (-0.5837) and rain fall ($r = -0.3396$). While, positive correlation was observed with maximum temperature ($r = 0.2770$). The peak larval population was recorded during the 3rd week of September (4.33 larvae/plant in 39th standard week), when maximum temperature was 37.8°C, minimum temperature was 22.3°C, relative humidity was 82.0 per cent and rainfall was 0.00 mm. The leaf webber infestation was started from the 2nd week of July (0.25 larvae/plant in 29th standard week), when maximum temperature was 39.5°C, minimum temperature was 24.5°C, relative humidity was 72.0 per cent and rainfall was 0.00 mm. The pest population was gradually increased with increase relative humidity. The rainfall had negative effect on pest population. If, the number of rainy days were more in the week, the pest population was reduced (*i.e.*, 1.20 larvae/plant) in the fourth week of August.

Thus minimum temperature, relative humidity and rainfall adversely affected on the abundance of leaf webber but maximum temperature favoured the development of leaf webber population on sesamum crop during *kharif* 2009 and 2010. Kumar and Goel (1994a) stated that the larval population showed a significantly high negative correlation with minimum temperature and evening relative humidity, whereas non-significant with maximum temperature, morning relative humidity and rainfall. Rakholiya (2000) reported that the population of leaf webber exhibited

significant and negative correlation with minimum temperature, morning relative humidity and evening relative humidity. Its population initially remained at low level during rainy weeks in august and increased steadily attaining its peak in 3rd week of September. Thakor (2006) reported that the larval population had significant and negative correlation with minimum temperature, while, it had negative correlation with maximum temperature, evening relative humidity, wind velocity and rainfall. Thus, larval population had positive correlation with morning relative humidity.

4.3 REACTION OF CERTAIN VARIETIES/GENOTYPES OF SESAMUM TO *A. catalaunalis*.

Twenty genotypes/varieties of sesamum were evaluated for their susceptibility against *A. catalaunalis* during *kharif* season of 2009 and 2010. These genotypes/varieties have been evaluated based on flower and capsule infestation (Plate V). Data thus obtained are analysed and presented in Table 7 and graphically depicted in Figure 3.

4.3.1 Susceptibility based on per cent flower infestation

During 2009, significantly lowest flower damage was recorded in RT-193 (5.12%) and it was differed significantly from the rest of the genotypes. It was at par with RT-127 (8.08%), RT-169 (9.30%), NIC-7800 (10.08%) and NIC-7829 (10.66%). Variety GT-3 had highest flower damage (35.17%) and was at par with GT-2 (30.17%). During 2010, the lowest flower damage was recorded in genotype RT-193 (4.90) and it was at par with RT-127 (7.47%), RT-169 (9.05), NIC-7800 (9.77%) and NIC-7829 (11.30%).



Healthy Field



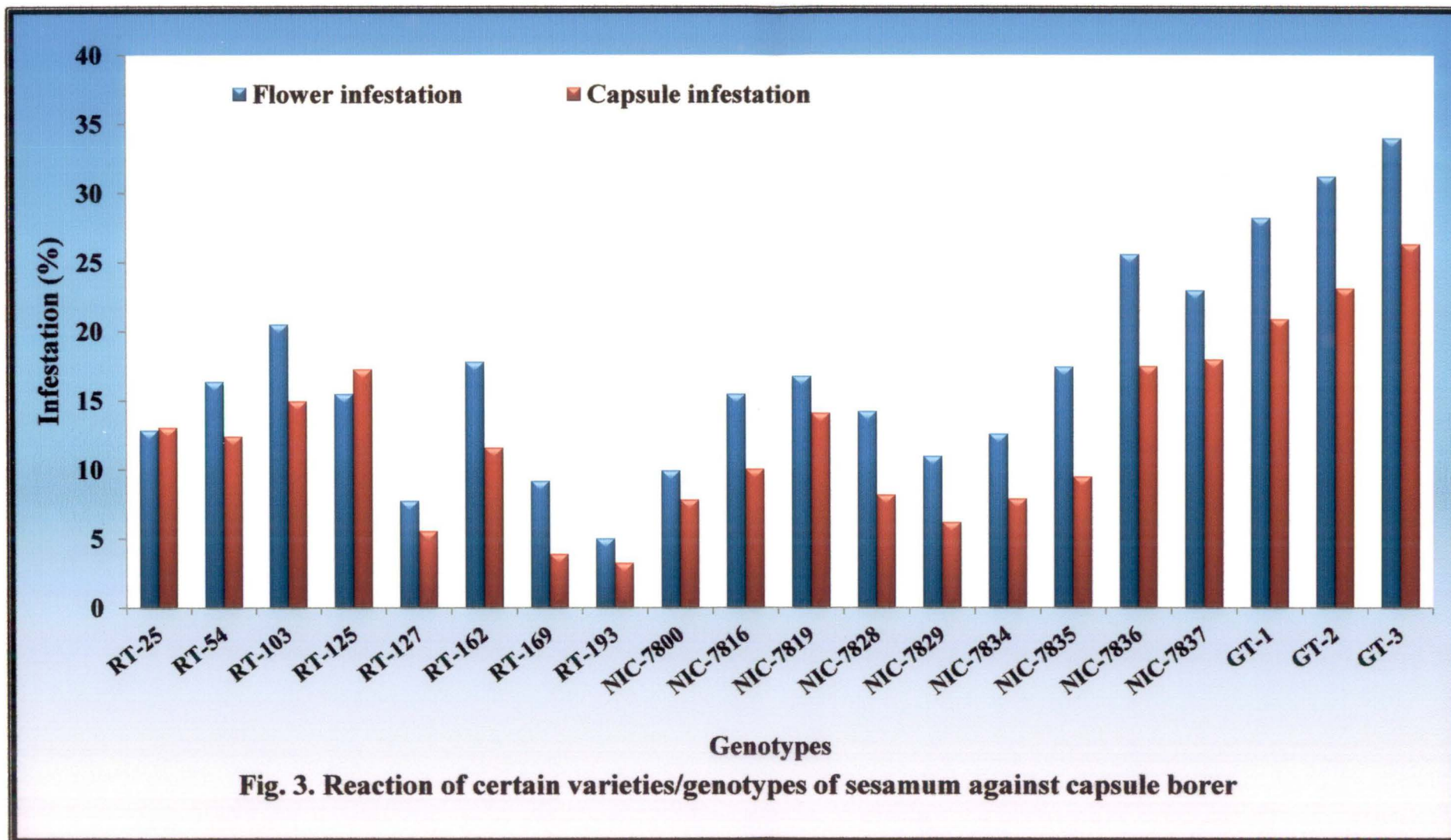
Infested Field

Plate V. Healthy and infested field of sesamum crop due to attack of *A. catalaunalis*

Table 7 : Reaction of certain varieties/genotypes of sesamum for their resistance to leaf webber

Genotypes tested	Flower damage (%)			Capsule damage (%)		
	2009	2010	Pooled mean	2009	2010	Pooled mean
RT-25	20.99* (13.23)	20.32 (12.48)	20.65 (12.86)	21.12 (13.37)	20.62 (12.72)	20.87 (13.05)
RT-54	23.46 (16.61)	21.67 (16.14)	22.81 (16.37)	20.06 (12.11)	20.54 (12.71)	20.30 (12.41)
RT-103	27.15 (20.97)	26.54 (20.07)	26.84 (20.52)	22.05 (14.55)	22.74 (15.37)	22.50 (14.96)
RT-125	23.19 (15.90)	22.61 (15.04)	22.90 (15.47)	19.09 (11.03)	23.53 (19.42)	19.25 (17.28)
RT-127	16.45 (8.08)	15.66 (7.42)	16.05 (7.75)	12.18 (4.63)	14.54 (6.46)	13.36 (5.55)
RT-162	24.81 (17.94)	24.60 (17.68)	24.70 (17.81)	19.10 (10.92)	20.54 (12.25)	19.72 (11.59)
RT-169	17.00 (9.30)	15.82 (9.05)	16.41 (9.18)	10.73 (3.90)	11.06 (3.87)	10.08 (3.88)
RT-193	12.95 (5.12)	12.56 (4.90)	12.75 (5.01)	8.78 (2.45)	11.38 (4.03)	10.89 (3.24)
NIC-7800	18.45 (10.08)	18.11 (9.77)	18.28 (9.93)	16.45 (8.61)	15.26 (7.01)	15.85 (7.81)
NIC-7816	23.16 (15.81)	22.59 (15.13)	22.87 (15.47)	17.69 (9.46)	18.83 (10.64)	18.26 (10.05)
NIC-7819	23.96 (17.27)	23.10 (16.25)	23.53 (16.76)	21.30 (13.40)	22.30 (14.80)	21.80 (14.10)
NIC-7828	21.86 (14.74)	21.12 (13.71)	21.49 (14.23)	15.90 (7.91)	16.77 (8.43)	16.33 (8.17)
NIC-7829	18.31 (10.66)	19.19 (11.30)	18.75 (10.98)	13.78 (5.80)	14.75 (6.58)	14.26 (6.19)
NIC-7834	20.33 (12.23)	21.00 (12.96)	20.66 (12.59)	15.90 (7.94)	16.16 (7.84)	16.03 (7.89)
NIC-7835	24.34 (17.14)	24.48 (17.77)	24.57 (17.45)	17.72 (9.66)	17.68 (9.33)	17.70 (9.49)
NIC-7836	30.37 (25.71)	30.25 (25.47)	30.31 (25.59)	24.73 (17.32)	24.68 (17.64)	24.55 (17.48)
NIC-7837	28.47 (23.10)	28.38 (22.86)	28.42 (22.98)	24.40 (17.31)	25.34 (18.83)	24.87 (17.97)
GT-1	31.89 (28.26)	31.90 (28.23)	31.89 (28.24)	26.58 (20.17)	27.57 (21.60)	27.07 (20.89)
GT-2	32.29 (30.17)	35.26 (36.29)	33.77 (31.23)	28.25 (22.55)	29.01 (23.69)	28.63 (23.12)
GT-3	36.34 (35.17)	34.95 (32.85)	35.64 (34.00)	29.71 (24.67)	31.88 (27.99)	30.79 (26.33)
C.D. at 5 %	6.05	6.55	5.90	4.88	7.42	5.36
S.Em.±	2.28	2.85	1.96	2.78	2.76	2.32
C.V. %.	14.74	17.83	14.64	11.47	13.40	15.64

*Figures outside parentheses are arc sin $\sqrt{\text{per cent} + 0.5}$ transformed values, while those in parentheses are retransformed values.



The highest flower damage was recorded in GT-2 (36.29%), however, it was at par with the GT-3 (32.85) and GT-1 (28.23%).

Based on pooled value, it is revealed that RT-193 variety recorded minimum flower infestation (5.01%) and differed significantly from the rest of the genotypes. It was at par with the RT-127 (7.75%), RT-169 (9.18%), NIC-7800 (9.93%) and NIC-7829 (10.98%). While, GT-3 recorded highest flower infestation (34.00%) and found highly susceptible and differed significantly from the other varieties. It was at par with GT-2 (31.23%) and GT-1(28.24%).

4.3.2 Susceptibility based on per cent capsule infestation

During 2009, RT-193 recorded minimum capsule infestation (2.45%) and found least susceptible and differed significantly from the rest of the genotype. It was at par with RT-169 (3.90%), RT-127 (4.63%), NIC-7829 (5.80%) and NIC-7828 (7.91%). The genotype GT-3 recorded maximum capsule damage (24.67%), hence found highly susceptible and differed significantly from other varieties. It was at par with the GT-2 (22.55%) and GT-1 (20.17). While during 2010, the lowest capsule damage was recorded in RT-169 (3.87%) and it was at par with RT-193 (4.03%), RT-127 (6.46%), NIC-7829 (6.58%) and NIC-7800 (7.01%). The highest capsule infestation was recorded in GT-3 (27.99%). However, it was at par with the GT-2 (23.69%) and GT-1(21.60%). Similar findings were also reported by Sengar (2003).

The pooled results revealed that RT-193 recorded minimum capsule damage (3.24%) and was least susceptible and differed significantly from the

rest of the genotypes. It was at par with the RT-169 (3.88%), RT-127 (5.55%), NIC-7829 (6.19%) and NIC-7800 (7.81%). GT-3 variety had highest capsule damage (26.33%) and was found highly susceptible and differed significantly from the other varieties. It was at par with GT-2 (23.12%).

Most of the varieties screened by various workers for their susceptibility against *A. catalaunalis* on sesamum differ from the varieties/genotypes screened under present experimentation as indicative from review of literature available on this aspect. Thus, because of uncommonness in the varieties screened at various places by various workers, it was difficult to compare the present results with the work done else where.

4.4 EFFECT OF DATE OF SOWING ON THE INCIDENCE OF *A. catalaunalis* IN SESAMUM

4.4.1 Leaf webber damage

The flower damage of leaf webber showed significant difference among different date of sowing during Summer-2010 and 2011. The flower damage was ranged from 2.50 to 14.12 per cent and 4.23 to 15.85 per cent during the year 2009-10 and 2010-11, respectively. The data summarized in Table 8 revealed that the flower damage was significantly lowest in crop sown on 22nd January (2.50%) and it was at par with the crop sown on 22nd February (3.86%) and 7th March (5.25%). Significantly higher flower damage was recorded in crop sown on 14th February (14.12%) and it was at par the 7th February (11.25 %) during the year 2009.

During the year 2010, result revealed that the flower damage was recorded significantly low as 4.23% when crop sown on 22nd January and

Table 8 : Effect of date of sowing on the incidence of *A. catalaunalis* and yield of sesamum crop (2009-10 and 2010-11)

Date of sowing	Flower damage (%)		Pooled damage (%)	Yield (kg/ha)		Pooled Yield (kg/ha)
	2009	2010		2009	2010	
D ₁ (22 th January)	9.96* (2.5)	12.42 (4.23)	11.19 (3.36)	583.75	578.00	580.87
D ₂ (7 th February)	19.18 (11.25)	21.59 (13.18)	20.70 (12.21)	580.00	516.25	456.87
D ₃ (14 th February)	22.04 (14.12)	23.56 (15.85)	22.80 (14.98)	466.25	480.25	428.50
D ₄ (22 th February)	11.98 (3.86)	13.90 (5.37)	12.94 (4.61)	580.00	552.50	566.25
D ₅ (7 th March)	14.42 (5.25)	15.99 (7.11)	15.20 (6.18)	376.75	519.25	492.75
S.Em.±	1.51	1.25	0.84	22.82	30.42	32.30
C.D at 5 %	4.65	3.84	2.63	70.31	90.45	91.03
C.V. %	19.27	14.24	16.69	9.49	11.49	10.65

*Figures outside parentheses are arc sin $\sqrt{\text{per cent} + 0.5}$ transformed values, while those in parentheses are retransformed values.

it was at par with the crop sown on 22nd February (5.37 %) and 7th March (7.11%). The flower damage was recorded significantly higher in crop sown on 14th February (15.85%) and it was at par with the crop sown on 7th February (13.18 %) (Fig. 4).

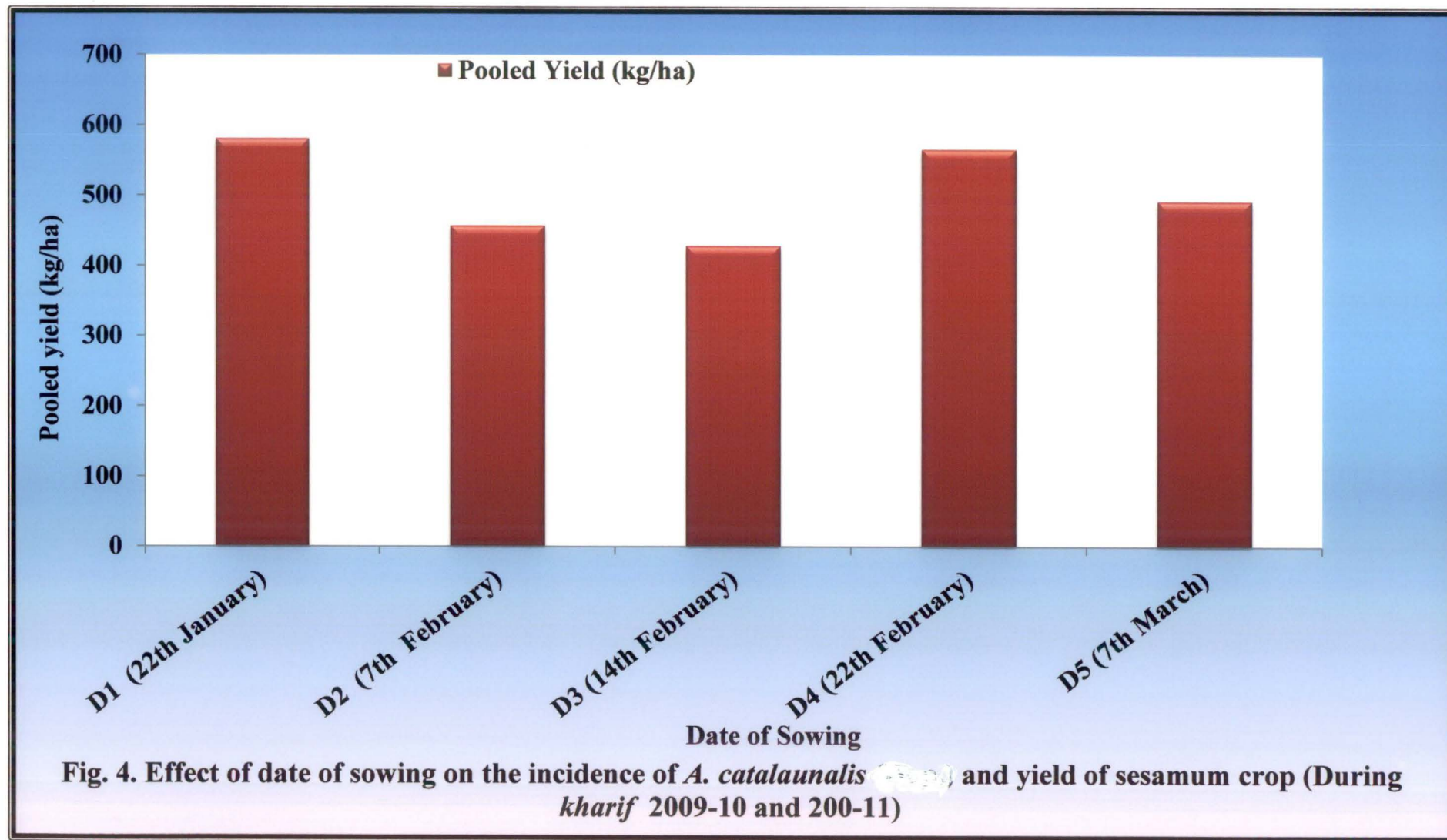
The pooled data summarised in Table 8 revealed that the flower damage was recorded significantly minimum in crop sown on 22nd January (3.36%) and it was at par with the crop sown on 22nd February (4.61%) and 7th March (6.18%). The flower damage was recorded significantly higher in crop sown on 14th February (14.98%) and it was at par with the crop sown on 7th February (12.21%).

4.4.2 Yield

During 2009, maximum yield of sesamum was obtained in crop sown on 22nd January i.e. 583.75 kg/ha. It was statistically at par with all the date of sowing except 7th March (376.75 kg/ha). Similarly next year, same date of sowing achieved maximum yield of sesamum (578.00 kg/ha). Significantly lowest yield was achieved from 7th March date of sowing (480.00 kg/ha).

Based on pooled value, significantly higher yield was obtained from 22nd January date of sowing (580.87 Kg/ha), however it was not differed from 22nd February (566.25 kg/ha). Significantly lowest yield was recorded from 14th February (428.50 kg/ha). It was at par with rest of treatments.

According to Abraham *et al.* (1977), the peak period of infestation was October to December. Rathod *et al.* (2011) found that *kharif* sesamum



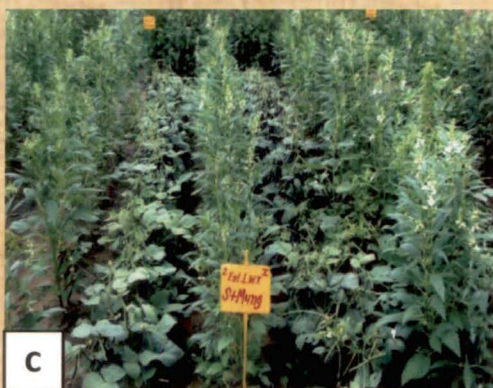
crop sown during 15th June to 5th July resulted in escaping the damage of capsule borer.

4.5 IMPACT OF INTERCROPPING ON THE INCIDENCE OF *A. catalaunalis* IN SESAMUM CROP

4.5.1 Flower damage (Plate VI)

During 2009, at 4 WAS, flower damage was recorded significantly lowest in sesamum + mungbean (1:1). *i.e.*, 4.30 per cent and was at par with sesamum + pearl millet (5.28%), sesamum + clusterbean (6.37%) and sesamum + urid (7.20%). It was significantly differed from other combinations. The higher flower damage was recorded in sesamum + groundnut (20.32%). While during 2010, lowest flower damage was recorded in sesamum + mungbean (7.32%). However, it was at par with sesamum + pearl millet (10.42%) and sesamum + clusterbean (13.22%) and recorded significantly higher damage in sesamum + groundnut (26.32%). Pooled results revealed that sesamum crop intercropped with mungbean registered significantly less flower infestation (5.81%) as compared to sole sesamum (12.75%), however, it was at par with pearl millet (7.85%) and clusterbean (9.79%) intercropping. Sesamum intercropped with groundnut registered significantly higher flower infestation (23.32%). (Tab. 9)

During 2009, at 5th WAS, significantly lowest flower infestation was recorded in sesamum + mungbean (4.43%) and was at par with sesamum + clusterbean (6.32%) and sesamum + pearl millet (9.32%). The significantly higher flower damage was recorded in sesamum + groundnut (17.18%).



A. Sesamum + clusterbean
B. Sesamum + groundnut
C. Sesamum + mungbean
D. Sesamum + pearl millet

E. Sesamum + cowpea
F. Sesamum + urid
G. Sole sesamum

Plate VI. Sesamum intercropped with different crops

Table 9 : Impact of intercropping system on the incidence of *A. catalaunalis* at flower stage in sesamum crop

Sr. No.	Treatments	Flower damage (%) at											
		4 WAS			5 WAS			6 WAS			7 WAS		
		2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
1.	Sesamum+ Groundnut (1:1)	26.84 (20.32)	31.07 (26.32)	28.96 (23.32)	24.83 (17.18)	23.11 (15.00)	23.97 (16.09)	23.19 (15.27)	26.88 (20.37)	25.04 (17.82)	24.57 (17.00)	22.67 (14.42)	23.62 (15.71)
2.	Sesamum + Cowpea (1:1)	18.02 (9.23)	25.18 (18.08)	21.60 (11.19)	20.91 (12.35)	19.16 (10.40)	20.03 (11.37)	20.07 (11.31)	23.08 (15.32)	21.58 (13.31)	19.76 (11.15)	20.97 (12.43)	20.36 (11.79)
3.	Sesamum + Urid (1:1)	15.44 (7.20)	23.14 (15.18)	19.29 (11.19)	19.13 (10.37)	14.65 (6.33)	16.89 (8.35)	17.23 (8.30)	23.00 (15.00)	20.11 (11.65)	17.06 (8.27)	18.19 (9.32)	17.62 (8.79)
4.	Sesamum + Pearlmillet (1:1)	13.87 (5.28)	19.09 (10.42)	16.48 (7.85)	17.68 (9.32)	11.11 (3.27)	14.40 (6.29)	13.85 (5.27)	17.59 (8.80)	15.72 (7.03)	14.92 (6.37)	15.93 (7.23)	15.42 (6.80)
5.	Sesamum + Cluster bean (1:1)	14.70 (6.37)	21.58 (13.22)	18.14 (9.79)	15.01 (6.32)	12.07 (4.23)	13.54 (5.27)	16.09 (7.22)	19.00 (10.25)	17.55 (8.73)	16.22 (7.40)	16.21 (7.48)	16.21 (7.44)
6.	Sesamum + Mungbean (1:1)	12.60 (4.30)	16.01 (7.32)	14.30 (5.81)	12.77 (4.43)	9.19 (2.12)	10.98 (3.27)	11.72 (3.65)	15.94 (7.40)	13.83 (5.52)	13.77 (5.28)	15.81 (7.07)	14.79 (6.17)
7.	Sole sesamum	16.97 (8.33)	24.79 (17.17)	20.88 (12.75)	20.07 (11.40)	17.04 (8.40)	18.55 (9.90)	18.73 (10.20)	22.30 (14.35)	20.51 (12.27)	18.74 (10.07)	19.62 (11.00)	19.18 (10.53)
S.Em. $\pm$		1.87	2.23	1.55	1.80	2.06	1.28	1.56	2.76	1.43	2.03	1.77	1.23
C.D at 5%		5.75	6.88	4.48	5.55	6.36	3.70	4.82	6.92	4.14	6.25	5.26	3.57
C.V. (%)		19.11	16.82	19.44	16.73	23.52	19.83	15.68	22.65	20.25	19.67	16.59	18.15

*Figures outside parentheses are $\arcsin \sqrt{\text{Per cent} + 0.5}$ transformed values, while those in parentheses are retransformed values.

WAS-Weeks after sowing.

However, it was at par with sesamum + cowpea (17.12%). Similar trend was also observed in year 2010. Pooled results indicated that sesamum crop intercropped with mungbean registered significantly lowest flower infestation (3.27%) and it was at par with intercropping with clusterbean (5.27%) and pearl millet (6.29%). Sesamum intercropped with groundnut registered significantly higher flower infestation (16.09%) as compared to sole crop of sesamum (9.90%).

During 2009, at 6 WAS, significantly lowest flower infestation recorded in sesamum + mungbean (3.65%) and it was at par with sesamum + pearl millet (4.27%) and sesamum + clusterbean (7.22%). While, in year 2010, minimum flower infestation was recorded in sesamum + mungbean (7.40%) and it was at par with sesamum + pearl millet (8.80%) and sesamum + clusterbean (10.25%). The significantly higher flower damage was recorded in sesamum intercropped with groundnut being 15.27 and 20.37 per cent during 2009 and 2010, respectively. Pooled value revealed that sesamum + pearl millet registered significantly lowest flower infestation (5.52%) as compared to sole crop of sesamum (22.11%). However, it was at par with sesamum + pearl millet (7.03%) and sesamum + clusterbean (8.73%) intercropping. Sesamum intercropped with groundnut registered significantly higher flower infestation (17.82%).

During both the year, significantly lowest flower damage was recorded in sesamum + mungbean and it was at par with sesamum + clusterbean and sesamum + pearl millet (Fig. 5). While, the highest flower damage was

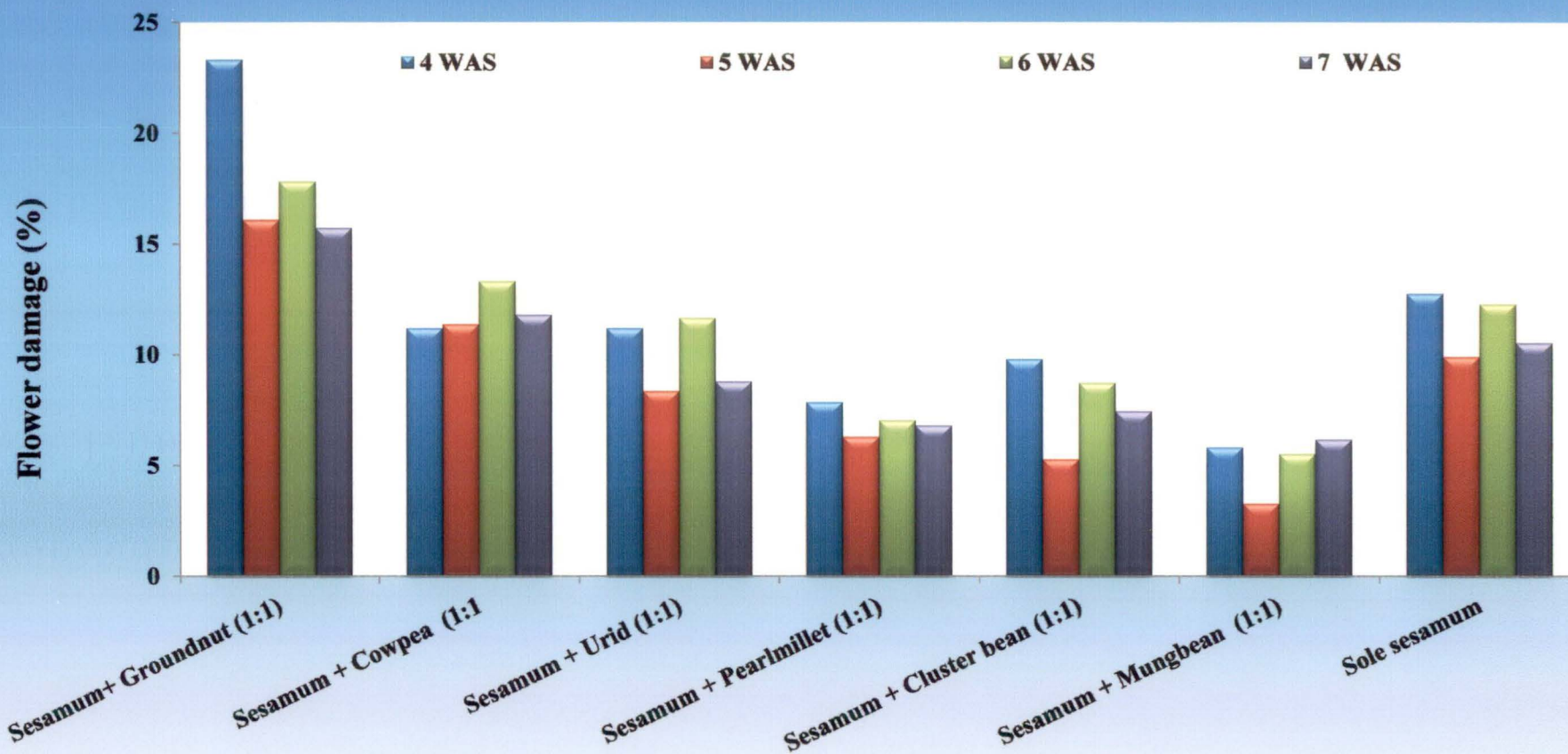


Fig. 5. Impact of intercropping system on the incidence of *A. catalaunalis* at flower stage in sesamum crop

recorded in sesamum crop intercropped with groundnut. During 7th WAS, sesamum crop intercropped with mungbean registered significantly lowest flower infestation (6.17%) and it was at par with pearl millet intercropping (6.80%). Sesamum intercropped with groundnut registered significantly higher flower infestation (15.71%) as compared to sesamum alone (10.53%).

4.5.2 Capsule damage

During 2009, At 4th WAS, capsule damage was recorded significantly lowest in sesamum + mungbean (1:1) *i.e.*, 3.27 per cent. It was significantly differed from other combinations. The higher capsule damage was recorded in sesamum + groundnut (15.37%). While, during 2010, lowest capsule damage was recorded in sesamum + pearl millet. However, it was at par with sesamum + clusterbean (5.52%) and recorded significantly higher damage in sesamum + groundnut (20.28%). Pooled result revealed that sesamum crop intercropped with mungbean registered significantly less capsule infestation (6.32%) as compared to sole crop (10.25%), however it was at par with pearl millet (6.40%) and clusterbean (7.51%) intercropping. Sesamum intercropped with groundnut registered significantly higher capsule infestation (17.82%) and it was at par with cowpea intercropping (12.37%) (Tab. 10).

During 2009, at 5th WAS, significantly lowest capsule infestation was recorded in sesamum + mungbean (6.28%) and was at par with sesamum + pearl millet (8.30%) and sesamum + clusterbean (9.28%). The significantly higher capsule damage was recorded in sesamum + groundnut (20.53%). However, it was at par with sesamum + cowpea (17.40) and sesamum + urid

Table 10 : Impact of intercropping system on the incidence of *A. catalaunalis* at capsule stage in sesamum crop

Sr. No.	Treatments	Capsule damage (%) at											
		4 WAS			5 WAS			6 WAS			7 WAS		
		2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
1.	Sesamum+ Groundnut (1:1)	23.40* (15.37)	26.82 (20.28)	25.11 (17.82)	27.12 (20.53)	34.83 (32.42)	30.98 (26.47)	33.68 (30.35)	29.93 (24.47)	31.81 (27.41)	28.44 (22.25)	33.73 (30.43)	31.08 (26.34)
2.	Sesamum + Cowpea (1:1)	20.80 (12.32)	21.04 (12.42)	20.92 (12.37)	24.87 (17.40)	28.10 (22.37)	26.49 (19.88)	28.47 (22.33)	22.29 (17.25)	25.38 (22.29)	18.62 (10.07)	28.43 (22.32)	23.52 (16.19)
3.	Sesamum + Urid (1:1)	14.99 (6.30)	20.07 (11.40)	17.53 (8.85)	23.31 (15.25)	25.21 (17.83)	24.26 (16.54)	26.81 (20.27)	20.94 (12.37)	23.88 (16.32)	20.87 (12.38)	24.79 (17.45)	22.83 (14.91)
4.	Sesamum + Pearl millet (1:1)	17.31 (8.53)	12.51 (4.28)	14.91 (6.40)	17.09 (8.30)	20.96 (12.38)	19.02 (10.34)	21.99 (13.63)	11.36 (3.43)	16.68 (8.53)	17.22 (8.37)	20.65 (12.07)	18.94 (10.22)
5.	Sesamum + Cluster bean (1:1)	18.36 (9.50)	14.06 (5.52)	16.21 (7.51)	18.06 (9.27)	23.34 (15.30)	20.70 (12.28)	24.80 (17.15)	20.09 (11.43)	22.45 (14.29)	19.99 (11.25)	21.68 (13.25)	20.83 (12.25)
6.	Sesamum + Mungbean (1:1)	11.12 (3.27)	18.17 (9.38)	14.64 (6.32)	14.97 (6.28)	18.36 (9.73)	16.66 (8.00)	17.02 (8.25)	18.11 (9.32)	17.56 (8.79)	15.95 (7.15)	16.97 (8.20)	16.46 (7.67)
7.	Sole sesamum	13.44 (5.20)	23.23 (15.30)	18.33 (10.25)	20.66 (12.15)	30.53 (25.44)	25.59 (18.79)	30.67 (22.79)	25.73 (19.43)	28.20 (21.11)	24.90 (17.37)	29.71 (24.25)	27.30 (20.81)
	S.Em. $\pm$	0.51	2.08	2.78	1.89	2.75	1.62	2.14	1.60	1.42	1.66	2.19	1.39
	C.D at 5%	1.56	6.42	4.42	5.81	8.49	4.68	6.61	4.93	4.12	5.13	6.76	4.01
	C.V. (%)	5.14	18.58	14.39	15.66	18.41	17.40	14.17	13.07	13.82	13.81	15.11	14.65

*Figures outside parentheses are arc sin $\sqrt{\text{Per cent} + 0.5}$ transformed values, while those in parentheses are retransformed values.

WAS-Weeks after sowing.

(15.25%). Similar trend was also observed in year 2010. Pooled results indicated that sesamum crop intercropped with mungbean registered significantly lowest capsule infestation (8.00%) and was at par with intercropping with pearl millet (10.34%) and clusterbean (12.28%). Sesamum intercropped with groundnut registered significantly higher capsule infestation (26.47%) as compared to sole crop of sesamum (18.79%).

During 2009, significantly lowest capsule infestation at 6th WAS was recorded in sesamum + mungbean (8.25%) and was at par with sesamum + pearl millet (13.63%). While, in 2010, minimum capsule infestation was recorded in sesamum + pearl millet (3.43%). It was significantly lowest than all the combinations. The significantly higher capsule damage was recorded in sesamum intercropped with groundnut being 30.35 and 24.41 per cent during year 2009 and 2010, respectively. At 6th WAS, sesamum + pearl millet registered significantly lowest capsule infestation (8.53%) as compared to sole crop of sesamum (22.11%), however, it was at par with sesamum + mungbean (8.79%) and sesamum + clusterbean (14.23%) intercropping. Sesamum intercropped with groundnut registered significantly higher capsule infestation (27.41%).

During both the year, significantly lowest capsule damage was recorded in sesamum + mungbean and it was at par with sesamum + clusterbean and sesamum + pearl millet. While, the highest capsule damage was recorded in sesamum crop intercropped with groundnut. At 7th WAS, sesamum crop intercropped with mungbean registered significantly lowest capsule infestation

(7.67%) (Fig. 6). It was at par with pearl millet (10.22%) intercropping. Sesamum intercropped with groundnut registered significantly higher capsule infestation (26.34%) as compared to sole crop of sesamum (20.81%).

4.5.3 Yield (Tab. 11)

During 2009, significantly higher yield of sesamum was achieved from the intercropping system of sesamum + mungbean (495.66 kg/ha). It was at par with sesamum + pearl millet (441.65 kg/ha). Significantly lowest yield was recorded in sesamum + groundnut (305.66 kg/ha) and sesamum + cowpea (350.00 kg/ha). Same trend of yield performance was also recorded in same intercropping combinations in year 2010.

Based on pooled value, significantly higher yield of sesamum was obtained from sesamum + mungbean (512.00 kg/ha). It was at par with sesamum + pearl millet (438.00 kg/ha). Significantly lowest yield of sesamum was recorded in sesamum + groundnut intercropping combination. The sesamum intercropped with cowpea could give 346.65 kg/ha which was lower than sole crop (363.40 kg/ha).

4.6 TESTING OF VARIOUS INSECTICIDAL MOLECULES FOR ITS EFFICACY AGAINST *A. catalaunalis*.

4.6.1 Flower damage (Tab. 12)

4.6.1.1 One day after spraying (Fig. 7)

The data on per cent flower damage before spray revealed that the infestation was uniformly distributed. All the treatments were significantly superior in minimizing flower infestation as compared to untreated plots of sesamum during both the year as well as in pooled results.

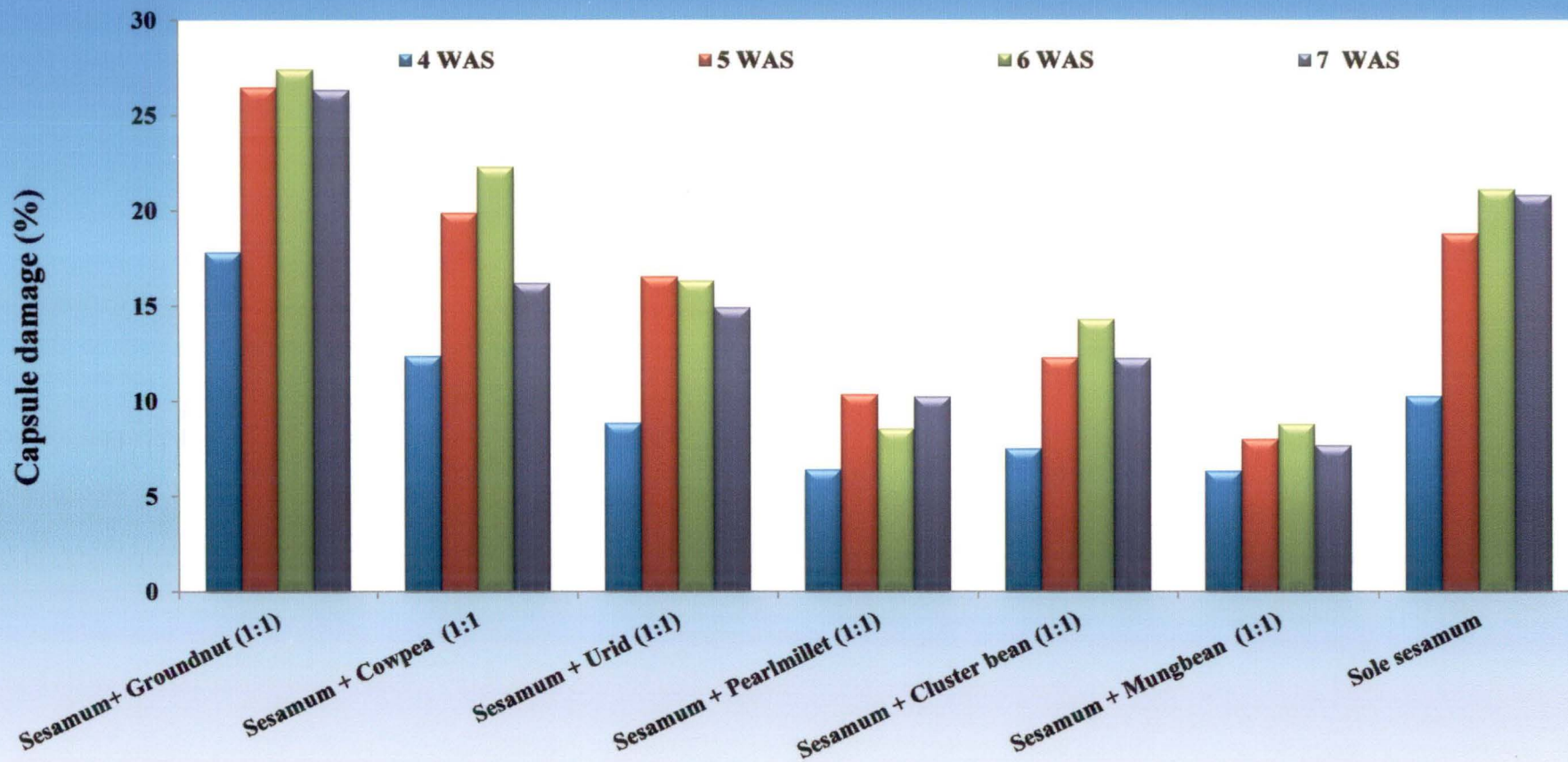


Fig. 6. Impact of intercropping system on the incidence of *A. catalaunalis* at capsule stage in sesamum crop

Table 11 : Impact of intercropping system on yield of sesamum crop

Sr. No.	Treatments	Yield (kg/ha)		Pooled mean (kg/ha)
		2009	2010	
1.	Sesamum + Groundnut (1:1)	305.66	295.00	300.33
2.	Sesamum + Cowpea (1:1)	350.00	343.33	346.65
3.	Sesamum + Urid (1:1)	390.45	381.50	386.05
4.	Sesamum + Pearlmillet (1:1)	441.65	434.35	438.00
5.	Sesamum + Clusterbean (1:1)	418.30	406.75	412.55
6.	Sesamum + Mungbean (1:1)	495.66	528.35	512.00
7.	Sole sesamum	375.75	351.45	363.40
S.Em.±		21.75	16.33	12.79
C.D at 5 %		67.02	50.31	36.55
C.V.%		9.49	7.22	8.45

The data presented in Table 12 indicated that after one day of spraying, all the treatments were significantly superior over the control in reducing the flower damage during *kharif* 2009. Significantly lowest flower damage (12.05%) was recorded in the treatment of emamectin benzoate 0.001 per cent and was at par with spark 0.036 per cent (15.75%) and polytrin 0.004 per cent (16.44%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective by registering 17.26, 22.07 and 23.43 per cent flower damage respectively, while, the rest of the treatments were least effective. The highest flower damage was recorded in control treatment *i.e.*, 48.07%.

During *kharif*, 2010, significantly lowest flower damage was recorded emamectin benzoate 0.001 per cent (11.53%) and was at par with spark 0.036 per cent (15.41%) and polytrin 0.004 per cent (16.13%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately by registering 16.75, 22.49 and 23.69 per cent flower damage respectively, while the rest of the treatment were least effective. In control plot, the damage was recorded as high as 49.88 per cent

The pooled results revealed that significantly lowest flower damage at one day after spraying recorded in the treatment of emamectin benzoate 0.001 per cent (11.79 %) but, it was at par with spark 0.036 (15.59%) and polytrin 0.004 per cent (16.28%). Thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective by registering

Table 12 : Testing of various insecticidal molecules for its efficacy against *A. catalaunalis* at flower stage in sesamum crop

Sr. No.	Treatments	Conc. (%)	Flower infestation (%)										
			Before sprays		1 DAS			3 DAS			7 DAS		
			2009	2010	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
1.	Emamectin benzoate 5 % SG	0.001	31.60* (27.50)	40.30 (41.55)	20.33 (12.05)	19.83 (11.53)	20.08 (11.79)	16.17 (7.36)	16.49 (7.84)	16.33 (7.60)	17.63 (8.92)	16.68 (8.03)	17.15 (8.47)
2.	Spark 36 EC	0.036	30.08 (24.70)	37.45 (38.40)	23.50 (15.78)	23.41 (15.41)	23.46 (15.59)	19.55 (10.74)	17.54 (8.70)	18.55 (9.72)	19.91 (11.07)	19.06 (10.58)	19.49 (10.82)
3.	Polytrin 44 EC	0.004	30.25 (25.55)	38.10 (38.70)	24.16 (16.44)	24.02 (16.13)	24.09 (16.28)	20.92 (12.22)	20.84 (12.20)	20.88 (12.21)	21.76 (13.30)	21.94 (13.33)	21.85 (13.31)
4.	Thiodicarb 75 % WP	0.15	29.85 (24.42)	35.15 (34.45)	24.89 (17.26)	24.37 (16.75)	24.63 (17.00)	25.79 (18.51)	21.00 (16.67)	23.39 (17.59)	27.49 (20.94)	26.45 (19.35)	26.97 (20.14)
5.	Fenvalerate 20 % EC	0.01	37.62 (22.56)	36.20 (36.22)	29.55 (22.07)	28.55 (22.49)	28.45 (22.28)	26.65 (19.73)	25.54 (18.00)	26.09 (18.86)	28.61 (22.28)	27.17 (19.61)	27.89 (20.94)
6.	Cartap hydrochloride 50 SP	0.1	28.45 (23.40)	35.55 (35.10)	30.65 (23.43)	29.21 (23.69)	29.38 (23.56)	29.21 (23.41)	27.03 (20.63)	28.12 (22.02)	31.95 (27.63)	30.70 (25.92)	31.32 (26.77)
7.	Profenofos 50 % EC	0.05	31.64 (27.60)	37.46 (37.20)	33.69 (25.65)	30.58 (25.71)	30.61 (25.68)	30.37 (25.06)	28.46 (22.22)	29.42 (23.64)	33.65 (30.25)	31.37 (26.93)	32.51 (28.59)
8.	Flubendiamide 480 SL	0.002	38.20 (36.22)	36.86 (35.75)	36.03 (30.67)	33.96 (30.72)	33.83 (30.69)	32.46 (28.62)	29.52 (22.86)	30.99 (25.74)	34.74 (32.34)	32.99 (29.03)	33.87 (30.68)
9.	Carbosulfan 25 % EC	0.05	40.15 (37.55)	39.40 (40.15)	50.05 (34.03)	36.15 (34.17)	36.09 (34.10)	33.57 (30.10)	31.47 (26.87)	32.54 (24.48)	35.68 (33.04)	33.87 (30.75)	34.77 (31.89)
10.	Control	-	34.75 (32.45)	38.10 (38.40)	36.40 (48.07)	44.93 (49.88)	47.49 (48.97)	51.68 (41.03)	43.64 (47.27)	47.66 (44.15)	41.48 (63.17)	44.81 (59.37)	43.14 (61.27)
S.Em.±			1.77	2.56	1.74	1.96	1.22	1.74	1.46	1.15	2.00	1.45	1.16
C.D. at 5%			NS	NS	4.45	4.95	3.50	4.48	4.05	3.28	5.15	3.70	3.32
C.V.%			12.64	11.60	9.98	11.53	10.77	10.49	9.69	10.15	11.83	8.86	10.49

*Figures outside parentheses are $\arcsin \sqrt{\text{Per cent} + 0.5}$ transformed values, while those in parentheses are retransformed values.

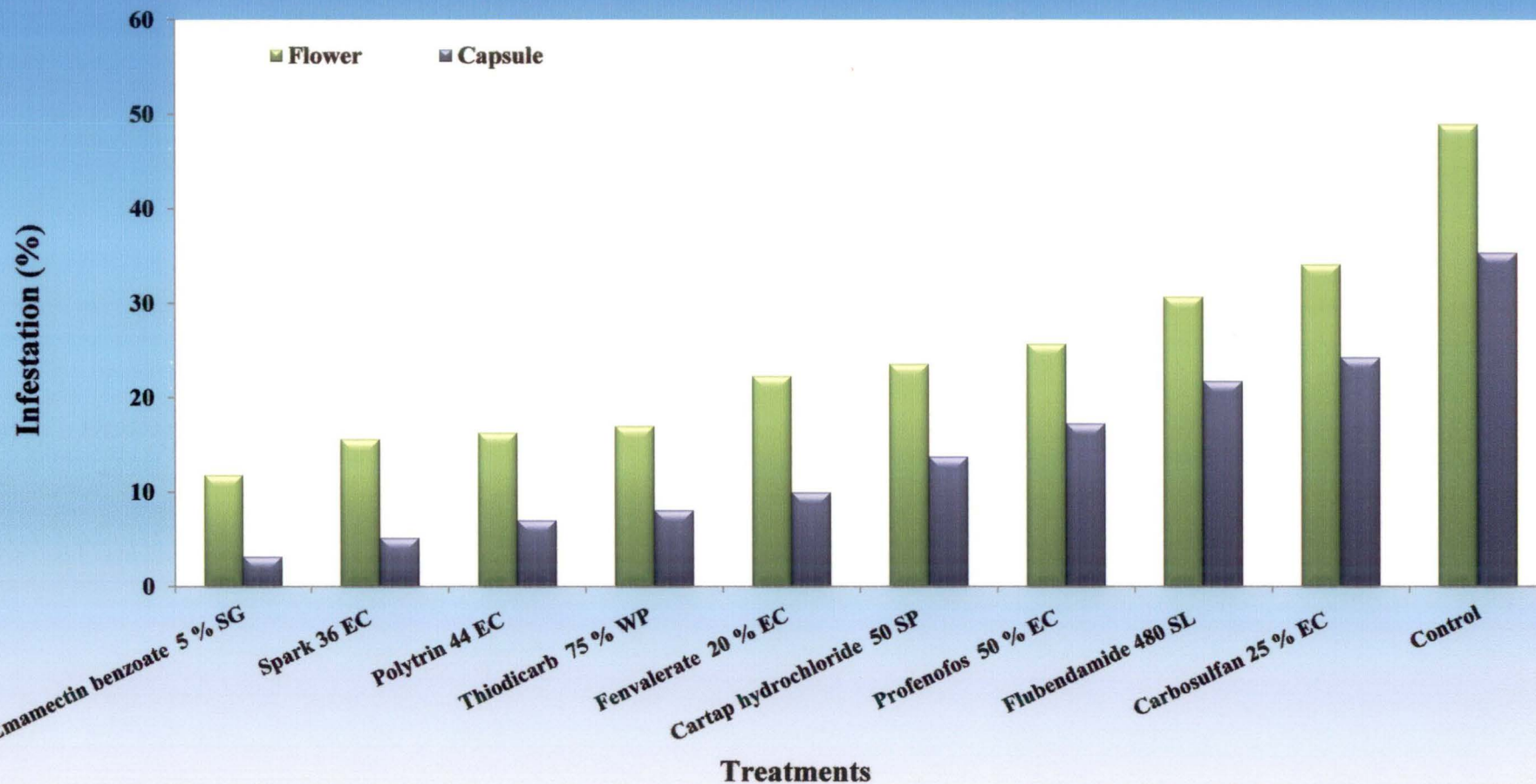


Fig. 7. Testing of various insecticidal molecules for its efficacy against *A. catalaunalis* after one day of spray in sesamum crop

17.00, 22.28 and 23.56 per cent, while, the rest of the treatments were least effective. In control plot, the damage was recorded as high as 48.97 per cent.

4.6.1.2 Three day after spraying (Fig. 8)

The flower damage was significantly low in all the treatments as compared to control during *kharif*, 2009. Among the treatments, significantly minimum flower damage was observed in Emamectin benzoate 0.001 per cent (7.36%) and was at par with spark 0.036 per cent (10.74%) and polytrin 0.004 per cent (12.22%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective by registering 18.51, 19.73 and 23.41 per cent damage respectively, while, the rest of the treatment were least effective. In control plot, the maximum damage was recorded (41.03%) maximum flower damage.

Similarly, during *kharif* 2010, the flower damage was observed significantly lowest in emamectin benzoate 0.001% per cent (7.84%) and it was at par with spark 0.036 per cent (8.70%) and polytrin 0.004 per cent (12.20%). While, thiodicarb 0.15 per cent (16.67%), fenvalerate 0.01 per cent, (18.00%) and cartap hydrochloride 0.1 per cent (20.63%) were moderately effective, while rest of the treatments were least effective. In control plot, the damage was recorded as high as 47.27 per cent.

The pooled results of two years showed that significantly lowest flower damage was recorded in emamectin benzoate 0.001 per cent (7.60 %) but, it was at par with spark 0.036% (9.72%) and polytrin 0.004% (12.21%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride

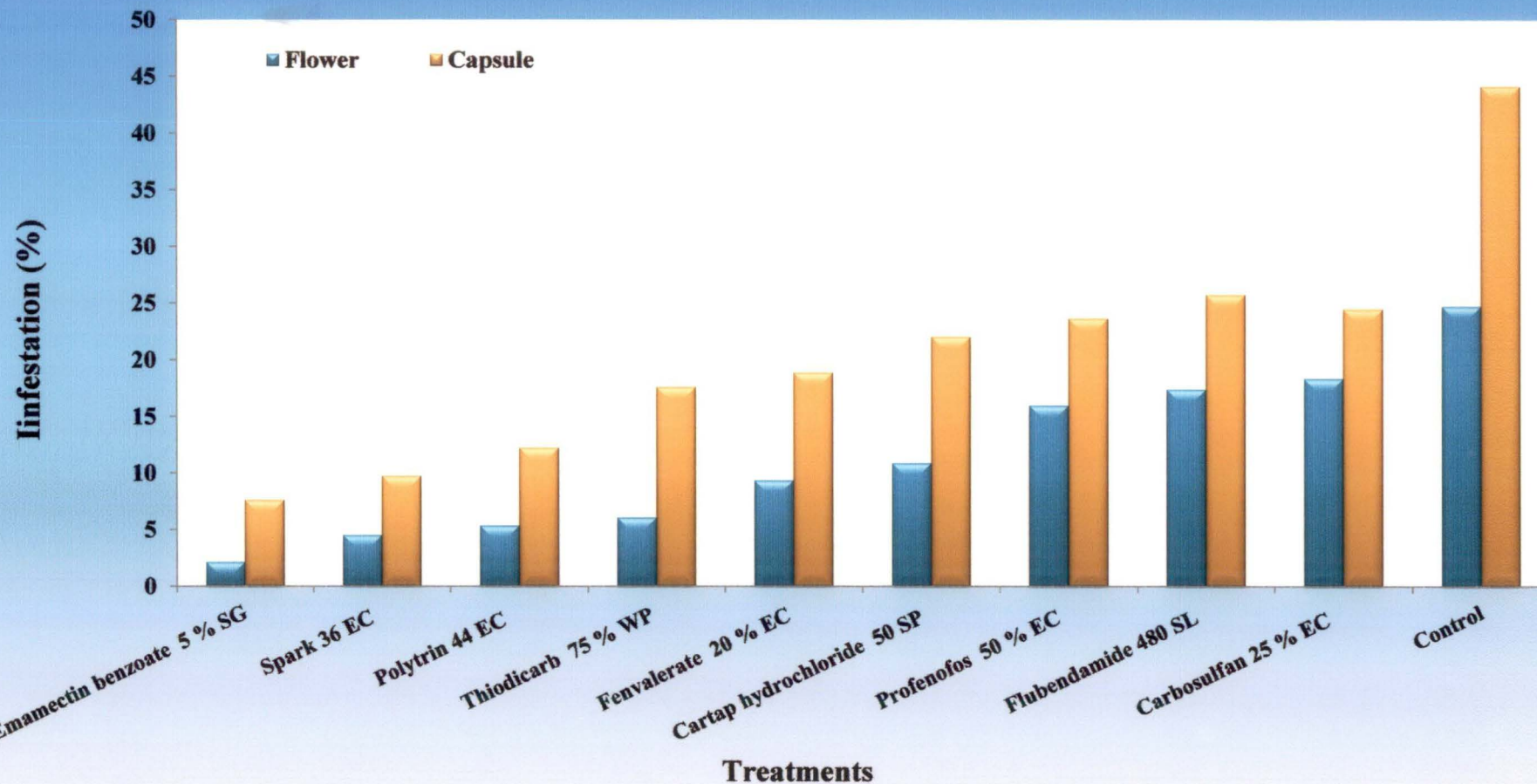


Fig. 8. Testing of various insecticidal molecules for its efficacy against *A. catalaunalis* after three day of spray in sesamum crop

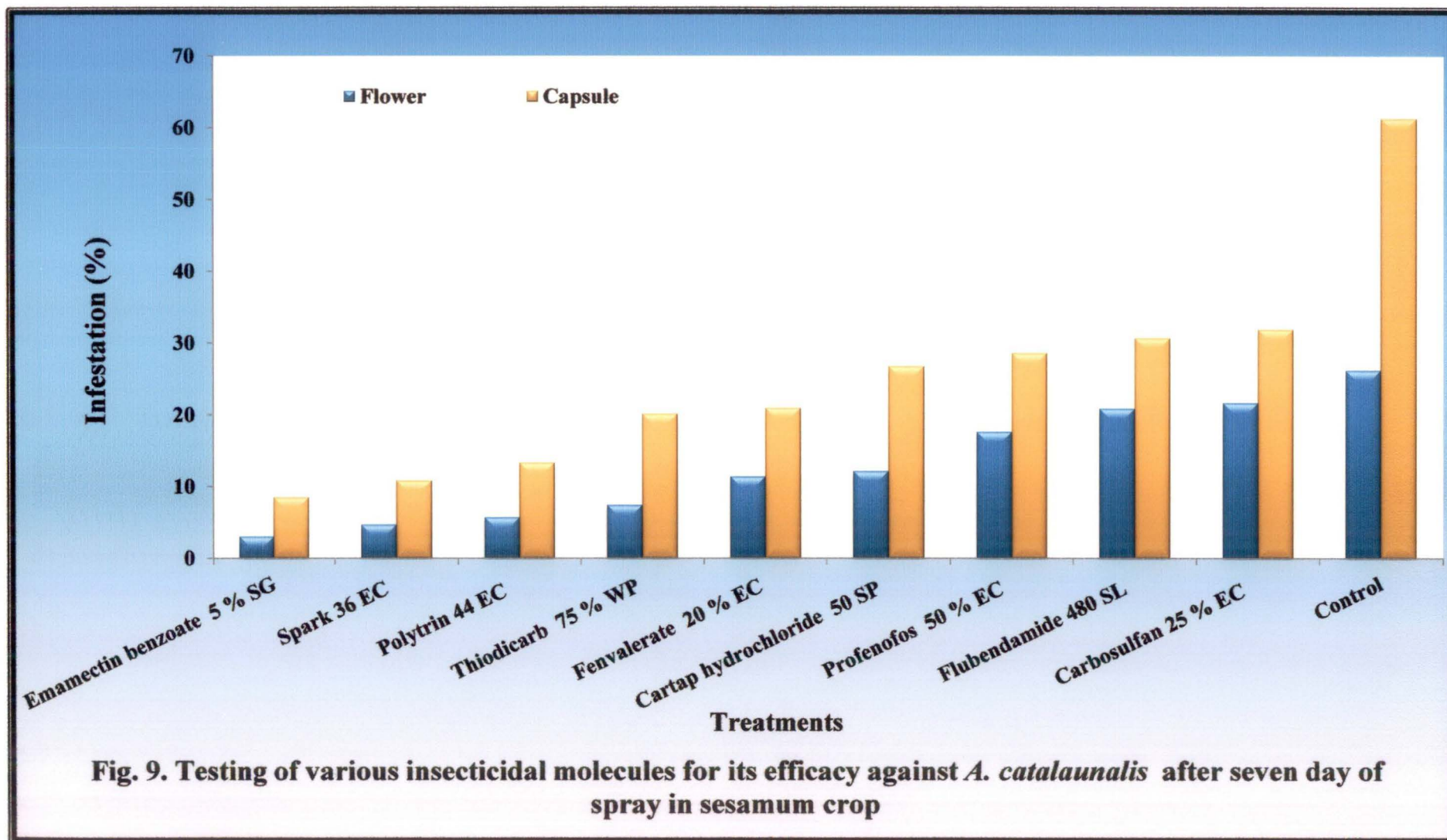
0.1 per cent were moderately effective by registering 17.59, 18.86 and 22.02 per cent flower damage, respectively, while the rest of the treatments were least effective. In control plot, flower damage was recorded as high as 44.15 per cent.

4.6.1.3 Seven day after spraying (Fig. 9)

The flower damage was significantly low in all the treatments as compared to control during *kharif*, 2009. Among the treatments, significantly lowest flower damage was recorded in emamectin benzoate 0.001 per cent (8.92%), but, it was at par with spark 0.036% (11.07%) and polytrin 0.004 per cent (13.30%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective by registering 20.94, 22.28 and 27.63 per cent damage, respectively, while the rest of the treatment were least effective. In control plot, the damage was recorded as high as 63.17 per cent.

Similarly, during *kharif* 2010, the lowest flower damage was observed in emamectin benzoate 0.001 per cent (8.03%) and was at par with spark 0.036 per cent (10.58%) and polytrin 0.004 per cent (13.33%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective by registering 19.35, 19.61 and 25.92 per cent damage respectively, while the rest of the treatment were least effective. In control plot, the damage was recorded as high as 59.37 per cent.

The pooled results of 7 DAS revealed that significantly lowest flower damage was emamectin benzoate 0.001 per cent (8.47%) but, it was at par with



spark 0.036 per cent (10.82%) and polytrin 0.004 per cent (13.31%) flower damage. While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective by registering 20.14, 20.94 and 26.77 per cent damage respectively, while the rest of the treatments were least effective. In control plot, the damage was recorded as high as 61.27 per cent.

4.6.2 Capsule damage (Tab.13)

4.6.2.1 One day after spraying (Fig. 7)

The data on per cent capsule infestation among various treatments during *kharif* 2009 and 2010 are presented in Table 14. Before spray, all the treatments were non-significant with respect to capsule damage.

The capsule damage recorded after first day of treatment showed significant differences among treatments as compared to control. Among the treatments, emamectin benzoate 0.001 per cent was significantly superior in reducing capsule damage (3.20%). However, it was at par with spark 0.036 per cent and polytrin 0.004 per cent, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, recording 5.00, 7.20, 8.80 and 10.50 per cent capsule damage, while, cartap hydrochloride 0.1 per cent (13.97%) and profenofos 0.05 per cent (18.27%) were moderately effective in reducing capsule damage, while, the rest of the treatments were least effective. The highest capsule damage was recorded in control treatment (35.40%).

During *kharif* 2010, significantly lowest capsule damage was recorded in emamectin benzoate 0.001 per cent (3.10%) and was at par with spark 0.036

Table 13 : Testing of various insecticidal molecules for its efficacy against *A. catalaunalis* at capsule stage in sesamum crop

Sr. No.	Treatments	Conc. (%)	Before sprays		Capsule infestation (%)								
					1 DAS			3 DAS			7 DAS		
			2009	2010	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
1.	Emamectin benzoate 5 % SG	0.001	27.26 (21.00)	29.24 (23.85)	10.85* (3.20)	10.75 (3.10)	10.80 (3.15)	9.41 (2.23)	9.21 (2.07)	9.31 (2.15)	10.54 (2.97)	10.87 (3.12)	10.71 (3.04)
2.	Spark 36 EC	0.036	27.86 (21.85)	27.02 (20.64)	14.57 (5.00)	13.75 (5.28)	14.16 (5.14)	13.56 (4.80)	12.48 (4.22)	13.02 (4.51)	13.61 (5.17)	12.53 (4.22)	13.07 (4.69)
3.	Polytrin 44 EC	0.004	28.17 (22.30)	27.56 (21.46)	15.76 (7.20)	15.16 (6.80)	15.46 (7.00)	13.77 (5.30)	14.00 (5.40)	13.89 (5.35)	14.25 (6.00)	14.04 (5.40)	14.14 (5.70)
4.	Thiodicarb 75 % WP	0.15	27.56 (21.43)	30.22 (24.82)	17.73 (8.80)	16.17 (7.33)	16.95 (8.06)	14.55 (6.03)	14.81 (6.07)	14.68 (6.05)	16.08 (7.27)	16.36 (7.57)	16.22 (7.42)
5.	Fenvalerate 20 % EC	0.01	27.96 (22.00)	28.89 (23.75)	19.02 (10.50)	18.22 (9.43)	18.62 (9.96)	17.83 (9.35)	18.22 (9.33)	18.02 (9.34)	20.13 (11.37)	19.73 (11.38)	19.93 (11.37)
6.	Cartap hydrochloride 50 SP	0.1	29.02 (22.66)	33.17 (28.35)	22.23 (13.93)	21.98 (13.56)	22.10 (13.74)	19.91 (11.23)	19.29 (10.47)	19.60 (10.85)	20.87 (12.25)	20.19 (12.00)	20.53 (12.12)
7.	Profenofos 50 % EC	0.05	28.21 (24.84)	33.78 (30.92)	25.64 (18.27)	24.11 (16.23)	24.87 (17.25)	24.21 (16.37)	23.56 (15.53)	23.88 (15.95)	24.82 (17.17)	25.51 (18.10)	25.16 (17.63)
8.	Flubendiamide 480 SL	0.002	37.82 (35.40)	39.15 (36.80)	28.05 (22.20)	27.76 (21.32)	27.91 (21.76)	25.65 (18.38)	24.14 (16.38)	24.90 (17.38)	27.19 (20.42)	27.69 (21.33)	27.44 (20.87)
9.	Carbosulfan 25 % EC	0.05	38.25 (38.34)	34.95 (32.75)	30.52 (25.30)	29.19 (23.25)	29.85 (24.27)	27.21 (20.45)	24.12 (16.25)	25.67 (18.35)	27.92 (21.25)	28.35 (22.10)	28.14 (21.67)
10.	Control	-	36.20 (34.50)	29.80 (24.65)	36.77 (35.40)	38.40 (35.29)	36.59 (35.34)	31.54 (24.29)	29.65 (25.15)	30.60 (24.72)	31.74 (27.30)	29.65 (25.10)	30.70 (26.20)
S.Em.±			2.65	1.58	2.25	2.12	1.12	1.68	2.18	1.23	1.49	2.48	1.30
C.D. at 5%			NS	NS	6.68	6.29	3.47	4.98	6.48	3.58	4.43	7.36	3.72
C.V.%			15.45	13.81	17.60	17.18	17.40	19.76	19.95	17.40	12.45	20.94	17.18

*Figures outside parentheses are $\arcsin \sqrt{\text{Per cent} + 0.5}$ transformed values, while those in parentheses are retransformed values.

per cent (5.28%) and polytrin 0.004 per cent (6.80%), thiodicarb 0.15 per cent (7.33%) and fenvalerate 0.01 per cent (9.43%) damage. While, cartap hydrochloride 0.1 per cent and profenofos 0.05 per cent were moderately effective after first day of spray registering 13.56 and 16.23 per cent capsule damage respectively, while, the rest of the treatment were least effective. Untreated plot recorded maximum capsule damage was (35.29%).

The pooled results revealed that significantly lowest capsule damage was noticed in the treatment of emamectin benzoate 0.001 per cent (3.15 %) and was at par with spark 0.036 per cent and polytrin 0.004 per cent, thiodicarb 0.15 per cent and fenvalerate 0.01 per cent, with 5.14, 7.00, 8.06 and 9.96 per cent capsule damage. While, cartap hydrochloride 0.1 per cent (13.74%) and profenofos 0.05 per cent (17.25%) were moderately effective, while, rest of the treatments were least effective. The highest capsule damage was recorded in control treatment (35.34%).

4.6.2.2 Three day after spraying (Fig. 8)

The third day after application, more or less similar trend was observed the treatments were found superior in reducing the capsule damage and significantly superior over control during 2009. Among the different treatments, emamectin benzoate 0.001 per cent was most effective treatment and was at par with spark 0.036 per cent and polytrin 0.004 per cent and thiodicarb 0.15 per cent with 4.80, 5.30 and 6.03 per cent capsule damage. While, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective after first day of spray by registering 11.23 and 16.37

per cent capsule damage, respectively, while the rest of the treatments were least effective. The highest capsule damage was recorded in control treatment (24.29%).

Similarly, during *kharif*, 2010, emamectin benzoate 0.001 per cent found most promising in minimizing capsule damage (2.07%). It was at par with spark 0.036 per cent (4.22%) and polytrin 0.004 per cent (5.40%) and thiodicarb 0.15 per cent (6.07%). While, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent and profenofos 0.05 per cent were moderately effective after first day of spray by registering 9.33, 10.47 and 15.53 per cent capsule damage respectively, while the rest of the treatments were least effective. The highest capsule damage was recorded in control treatment (25.15%)

The pooled results revealed that significantly lowest capsule damage was noticed in emamectin benzoate 0.001 per cent (2.15 %) but, it was at par with spark 0.036 per cent and polytrin 0.004 per cent, thiodicarb 0.15 per cent with 4.51, 5.35 and 6.05 per cent capsule damage. While, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent and profenofos 0.05 per cent were moderately effective after first day of spray by registering 9.34, 10.85 and 15.95 per cent capsule damage respectively, while, the rest of the treatment were least effective. The highest capsule damage was recorded in control treatment (24.72%).

4.6.2.3 Seven day after spraying (Fig. 9)

Significantly lowest capsule damage was recorded in emamectin benzoate 0.01 per cent (2.97%) and was at par with spark 0.036 per cent (5.17%) and polytrin 0.004 per cent (6.00%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective after first day of spray by registering 7.27, 11.37 and 12.25 per cent capsule damage, respectively, while the rest of the treatment were least effective. The highest capsule damage was recorded in control treatment (48.07%).

During *kharif*, 2010, significantly lowest capsule damage was recorded in the emamectin benzoate 0.001 per cent (3.12%) and was at par with spark 0.036 per cent (4.22 %) and polytrin 0.004 per cent (5.40%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent were moderately effective after first day of spray by registering 7.57, 11.38 and 12.00 per cent capsule damage respectively, while, the rest of the treatment were least effective. In control plot, the capsule damage was recorded as high as 25.10 per cent

The pooled results revealed that significantly lowest capsule damage was noticed in emamectin benzoate (3.04%) but, it was at par with spark (4.69%) and polytrin (5.70%) capsule damage. While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective by registering 7.42, 11.37 and 12.12 per cent capsule

damage respectively, while, the rest of the treatment were least effective. In control plot, the capsule damage was recorded as high as 26.20 per cent.

4.6.3 Yield avoidable losses and economics (Fig. 10)

The main goal of pest management is to suppress the target pest using different components and its ultimate effect on yield and economics. Therefore, to determine the effect of various insecticidal treatments, the yield data were recorded. On the basis of yield, increased the yield over control and avoidable losses were calculated, whereas, by using cost of treatments net incremental cost benefit ratio (NCIBR) was calculated. The results on yield, avoidable losses and economics are presented in Table 14.

4.6.3.1 Yield

Highest grain yield was achieved in treatment of emamectin benzoate 0.001 per cent (473 kg/ha). It was statistically at par with spinosad 0.036 per cent (391 kg/ha). Among different insecticidal treatments significantly lowest yield was obtained from carbosulfan 0.05 per cent which was not differed from the flubendamide 0.002 per cent. Polytrin 0.004 per cent, thiodicarb 0.15 per cent and fenvalerate 0.01 per cent could remain next effective treatments by giving 451, 432 and 425 kg/ha yield, respectively. In case of untreated pooled yield was 236 kg/ha (Tab. 14).

4.6.3.2 Avoidable losses

Increase in yield over control ranged from 13.77 to 44.00 per cent due to application of insecticides against leaf webber. Maximum yield was increased in plot treated with emamectin benzoate 0.001 per cent (44.00%) followed by

Table 14 : Efficacy of various insecticidal molecules on yield of sesamum crop

Sr. No.	Treatments	Conc. (%)	Yield (kg/ha)		Pooled mean (kg/ha)	Increase in yield over control (%)	Avoidable Loss (%)
			2009	2010			
1.	Emamectin benzoate 5% SG	0.001	463.33	483.35	473.35	44.00	0.00
2.	Spark 36 EC	0.036	436.66	465.60	451.16	41.67	4.68
3.	Polytrin 44 EC	0.004	411.65	453.35	432.50	39.50	9.05
4.	Thiodicarb 75 % WP	0.15	418.32	433.45	425.85	38.27	5.85
5.	Fenvalerate 20 % EC	0.01	391.65	420.55	406.15	35.21	6.18
6.	Cartap hydrochloride 50 SP	0.1	368.34	383.42	375.85	29.98	12.31
7.	Profenofos 50 % EC	0.05	346.45	366.75	356.65	26.21	13.17
8.	Flubendiamide 480 SL	0.002	326.25	343.25	335.00	21.44	10.98
9.	Carbosulfan 25 % EC	0.05	303.35	306.35	305.05	13.77	15.34
10.	Control	-	282.45	244.00	263.16	0.00	23.49
C.D. at 5 %			17.23	15.43	11.40	-	-
S.Em. ±			51.18	45.85	32.42	-	-
C.V. %.			7.96	6.85	7.41	-	-

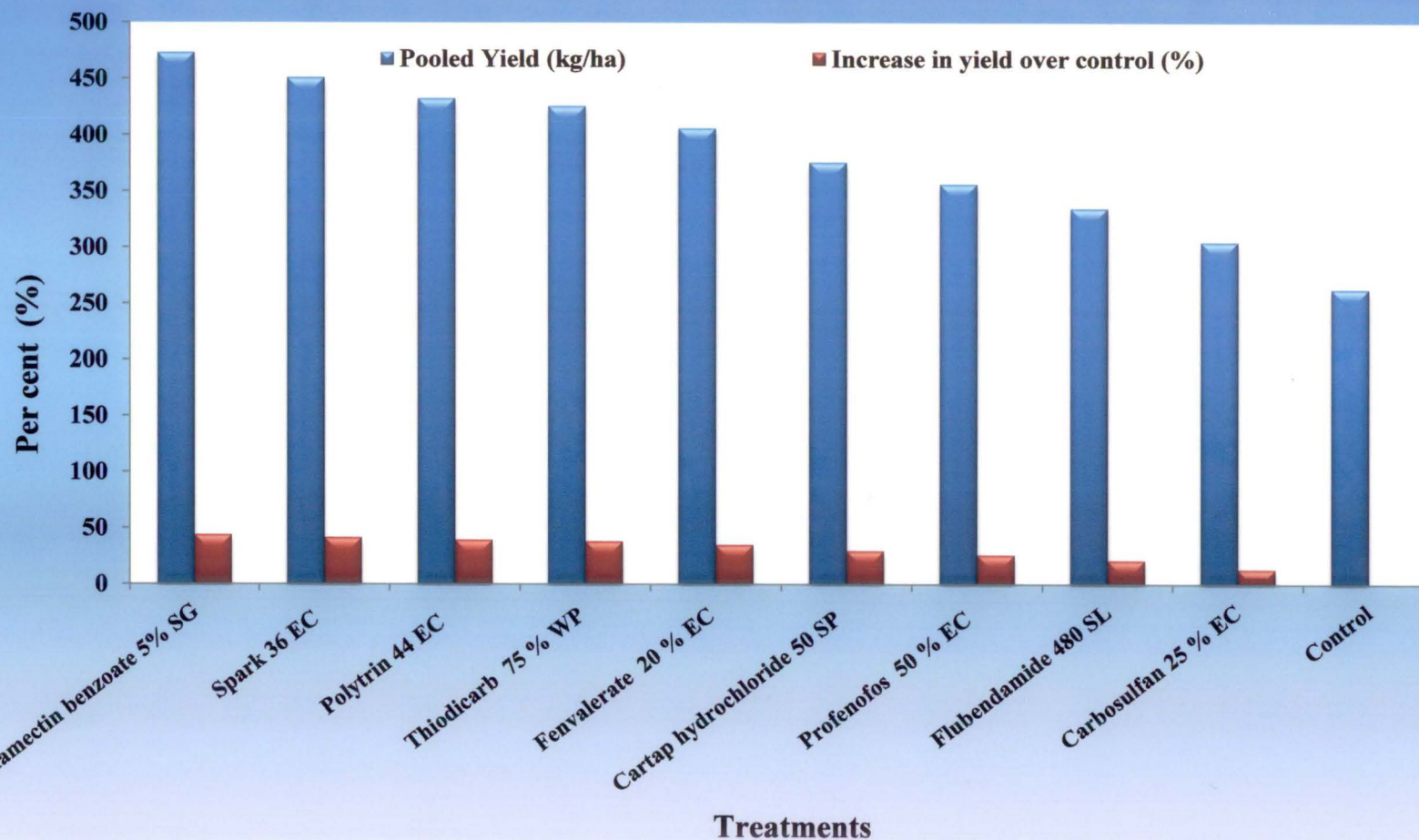


Fig. 10 Efficacy of various insecticidal molecules on yield of sesame crop during *kharif* 2009-10

the spark 0.036 per cent (41.67%). Avoidable loss in yield due to infestation of leaf webber was varied from 4.68 to 23.49 per cent in different treatments. It was lowest in (4.68%) in spark 0.036 per cent followed by thiodicarb 0.15 per cent (5.85%) and fenvalerate 0.01 per cent (6.18%). Maximum avoidable loss was recorded in untreated *i.e.*, 23.49 per cent.

4.6.3.2 Economics

Economics of various application of insecticides evaluated against leaf webber indicated that maximum realization was obtained in plot treated with emamectin benzoate 0.001 per cent (₹ 12600) followed by spark 0.036 per cent (₹ 11280) and polytrin 0.004 per cent (₹ 10140). Minimum net realization was recorded in carbosulfan 0.05 per cent (₹ 2520) followed by flubendamide 0.0042 per cent (₹ 4320) and profenofos 0.04 per cent (₹ 5580) (Table 15). Highest NCIBR was obtained in spark 0.036 per cent (1:4.48) which was followed by emamectin benzoate 0.001 per cent (1:3.14). The efficacy of spark 0.036 per cent and polytrin 0.004 per cent were also reported by Sengar (2003). So, far the effectiveness of other insecticides is concerned, efficacy of chlorpyrifos (Patel and Bhalani, 1986), cypermethrin (Singh *et al.* 1991, Kumar and Goel 1994 and Kumar and Goel 1995), endosulfan (Yadav *et al.* 1985; Vagela, 1988; Srivastava *et al.* 1989, Murlibaskaran *et al.* 1993; Gorpade and Thakur, 1995; Paul and Shantanu, 1997) and profenofos (Vagela, 1988) against *A. catalaunalis* have been reported by various workers.



Table 15 : Economics of different insecticidal treatments used for the management of *A. catalaunalis* in sesamum crop

Sr. No.	Treatments	Conc. (%)	Quantity of insecticide (l/ha) or (kg/ha)	Cost of treatment (₹/ha)	Yield (kg/ha)	Gross realization (₹/ha)	Net realization over control	Net gain	ICBR	NICBR
1.	Eamectin benzoate 5 % SG	0.001	0.1	2450	473	28380	12600	10150	1: 4.14	1: 3.14
2.	Spark 36 EC	0.036	0.5	1740	451	27060	11280	9540	1: 5.48	1: 4.48
3.	Polytrin 44 EC	0.004	0.5	2200	432	25920	10140	7940	1: 3.60	1: 2.60
4.	Thiodicarb 75 % WP	0.15	1.0	3600	425	25500	9720	6120	1: 1.70	1: 0.70
5.	Fenvalerate 20 % EC	0.01	0.25	2575	406	24360	8580	6005	1: 2.33	1: 1.33
6.	Cartap hydrochloride 50 SP	0.1	1.0	3300	375	22500	6720	3420	1: 1.05	1: 0.05
7.	Profenofos 50 % EC	0.05	0.5	2210	356	21360	5580	3370	1: 1.52	1: 0.52
8.	Flubendiamide 480 SL	0.002	0.021	2400	335	20100	4320	1920	1: 0.80	1: -0.20
9.	Carbosulfan 25 % EC	0.05	0.5	2150	305	18300	2520	370	1: 0.17	1: -0.83
10.	Control	-	-	-	263	15780	-	-	-	-

Labour charge : 120 ₹; Market price = 60 ₹/kg sesamum seed and Quantity of water-500 l/ha.

SUMMARY AND CONCLUSION

V. SUMMARY AND CONCLUSION

Antigastra catalaunalis (Duponchel) is an important pest of sesamum causing severe damage. Investigations on seasonal abundance and Integrated management of leaf webber, *A. catalaunalis* (Duponchel) in sesamum crop, experiments were conducted at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Talod during the year 2009 to 2011. The important conclusions accrued from the research studies are summarized in this chapter.

5.1 NATURE AND EXTENT OF DAMAGE

The data on extent of damage caused by *A. catalaunalis* on leaves, flowers and capsules. It is cleared from the data that in the early stage of the crop, the percentage of damaged leaves ranged from 2.66 to 4.02 and 3.2 to 6.19 during the year 2009 to 2010, respectively. At flowering stage of the crop, the percentage of damaged flower ranged from 20.52 to 47.52 and 26.78 to 40.00 during 2009 to 2010, respectively. While, percentage of damaged capsule ranged from 6.25 to 20.25 and 5.26 to 28.02 during the year 2009 and 2010, respectively.

5.2 SEASONAL ABUNDANCE AND CORRELATION

The observation on egg population indicated that the egg population started after 2nd week of sowing (28th standard week) increased gradually and reached to its peak (1.60 eggs/plant) in 11th and 12th week after sowing (37th and 38th standard week) in the year 2009 and 4.90 eggs/plant in the 12th week after sowing (38th standard week) in the year 2010 than declined

suddenly. Thus, egg population was recorded maximum during September in both the years.

The data on larval population also indicated more or less similar trend of population fluctuation. The larval population appeared in 2nd week of sowing (28th standard week) increased gradually and reached to its peak (1.33 larva/plant) in 11th and 12th week after sowing (37th and 38th standard week) in the year 2009 and 4.33 larvae/plant in the 11th week after sowing (37th standard week) in the year 2010 than declined suddenly. Thus, higher larval population was also found higher during September in both the years.

Studies on effect of various weather parameters on the incidence of leaf webber and capsule borer were carried out. The correlation coefficient values indicated that the egg population of leaf webber exhibited significant and negative correlation with minimum temperature ($r = -0.6354$), average temperature ($r = -0.1328$), relative humidity (-0.6055) and Rain fall ($r = -0.3333$). While, positive correlation was observed with maximum temperature ($r = 0.3274$). The correlation coefficient values indicated that the larval population of leaf webber exhibited significant and negative correlation with minimum temperature ($r = -0.6487$), average temperature ($r = -0.1667$), relative humidity ($r = -0.5837$) and rain fall ($r = -0.3396$). While, positive correlation was observed with maximum temperature ($r = 0.2770$). The peak larval population was recorded during the 3rd week of September (4.33 larvae/plant in 39th standard week), when maximum temperature was 37.8°C, minimum temperature was 22.3°C, relative humidity was 82.0 per cent

and rainfall was 0.00 mm. The leaf webber infestation was started from the 2nd week of July (0.25 larvae/plant in 29th standard week), when maximum temperature was 39.5°C, minimum temperature was 24.5°C, relative humidity was 72.0 per cent and rainfall was 0.00 mm. The pest population was gradually increased with increase relative humidity. The rainfall had negative effect on pest population. If, number of rainy days were more in the week, the pest population was reduced (*i.e.*, 1.20 larvae/plant) in the fourth week of August.

Thus minimum temperature, relative humidity and rainfall adversely affected on the abundance of leaf webber but maximum temperature favoured the development of leaf webber population on sesamum crop during *kharif* 2009 and 2010.

5.3 REACTION OF CERTAIN VARIETIES/GENOTYPES OF SESAMUM TO *A. catalaunalis*

Twenty genotypes/varieties of sesamum were evaluated for their susceptibility against *A. catalaunalis* during *kharif* season of 2009 and 2010. These genotypes/varieties have been evaluated based on flower and capsule infestation.

5.3.1 Susceptibility based on per cent flower infestation

RT-193 variety recorded minimum flower infestation (5.01%) and differed significantly from the rest of the genotypes. It was at par with the RT-127 (7.75%), RT-169 (9.18%), NIC-7800 (9.93%) and NIC-7829 (10.98%). While, GT-3 recorded highest flower infestation (34.00%) and found

highly susceptible and differed significantly from the other varieties. It was at par with GT-2 (31.23%) and GT-1 (28.24%).

5.3.2 Susceptibility based on capsule infestation

RT-193 recorded minimum flower infestation (3.24%) and was least susceptible and differed significantly from the rest of the genotypes. It was at par with the RT-169 (3.88%), RT-127(5.55%), NIC-7829 (6.19%) and NIC-7800 (7.81%). While, the genotype GT-3 recorded highest flower infestation (26.33%) and was found highly susceptible and differed significantly from the other varieties. It was at par with the treatment of GT-2 (23.12%).

5.4 EFFECT OF DATE OF SOWING ON THE INCIDENCE OF *A. catalaunalis* IN SESAMUM

The flower damage of leaf webber was recorded significantly minimum in crop sown on 22nd January (3.36%) and it was at par with the crop sown on 22nd February (4.61%) and 7th March (6.18%). The flower damage was recorded significantly higher in crop sown on 14th February (14.98%) and it was at par with the crop sown on 7th February (12.21%).

Based on pooled value, significantly higher yield was obtained from 22nd January (580.87 Kg/ha). It was at par with 22nd February (566.25 kg/ha). Significantly lowest yield was recorded from 14th February (428.50 kg/ha).

5.5 IMPACT OF INTERCROPPING ON THE INCIDENCE OF *A. catalaunalis* IN SESAMUM CROP

5.5.1 Flower damage

The significantly lowest flower damage was recorded in sesamum + mungbean and it was at par with sesamum + clusterbean and sesamum + pearl millet. While, the highest flower damage was recorded in sesamum crop intercropped with groundnut. During 7th WAS, sesamum crop intercropped with mungbean registered significantly lowest flower infestation (6.17%) and it was at par with pearl millet intercropping (6.80%). Sesamum intercropped with groundnut registered significantly higher flower infestation (15.71%) as compared to sesamum alone (10.53%).

5.5.2 Capsule damage

The significantly lowest capsule damage was recorded in sesamum + mungbean and it was at par with sesamum + clusterbean and sesamum + pearl millet. While, the highest capsule damage was recorded in sesamum crop intercropped with groundnut. At 7th WAS, sesamum crop intercropped with mungbean registered significantly lowest capsule infestation (7.67%) and it was at par with pearl millet (10.22%) intercropping. Sesamum intercropped with groundnut registered significantly higher capsule infestation (26.34%) as compared to sole crop of sesamum (20.81%).

5.5.3 Yield

Based on pooled value, higher yield of sesamum was obtained from sesamum + mungbean (512.00 kg/ha). It was at par with sesamum + pearl millet

(438.00 kg/ha). Significantly lowest yield was recorded in sesamum + groundnut intercropping combination. The sesamum intercropped with cowpea could give 346.65 kg/ha which was lower than sole crop (363.40 kg/ha).

5.6 TESTING OF VARIOUS INSECTICIDAL MOLECULES FOR ITS EFFICACY AGAINST *A. catalaunalis* IN SESAMUM

5.6.1 Flower damage

5.6.1.1 One day after spraying

The significantly lowest flower damage was noticed in the treatment of emamectin benzoate (11.79%) but it was at par with spark (15.59%) and polytrin (16.28%) flower damage. While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective by registering 17.00, 22.28 and 23.56 per cent, while the rest of the treatments were least effective. In control plot, the damage was recorded as high as 48.97 per cent.

5.6.1.2 Three day after spraying

The significantly lowest flower damage was noticed in emamectin benzoate 0.001 per cent (7.60%) but, it was at par with spark 0.036 per cent (9.72%) and polytrin 0.004 per cent (12.21%). While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective by registering 17.59, 18.86 and 22.02 per cent flower damage respectively, while, the rest of the treatments were least effective. In control plot, flower damage was recorded as high as 44.15 per cent.

5.6.1.3 Seven day after spraying

The significantly lowest flower damage was noticed in the treatment of emamectin benzoate 0.001 per cent (8.47%), but it was at par with spark 0.036 per cent (10.82%) and polytrin 0.004 per cent (13.31%) flower damage. While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective by registering 20.14, 20.94 and 26.77 per cent damage respectively, while, the rest of the treatments were least effective. In control plot, the damage was recorded as high as 61.27 per cent.

5.6.2 Capsule damage

5.6.2.1 One day after spraying

The significantly lowest capsule damage was noticed in the treatment of emamectin benzoate 0.001 per cent (3.15%) and was at par with spark 0.036 per cent and polytrin 0.004 per cent, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent, with 5.14, 7.00, 8.06 and 9.96 per cent capsule damage. While, cartap hydrochloride 0.1 per cent (13.74%) and profenofos 0.05 per cent (17.25%) were moderately effective, while rest of the treatments were least effective. The highest capsule damage was recorded in control treatment (35.34%).

5.6.2.2 Three day after spraying

The significantly lowest capsule damage was noticed in emamectin benzoate 0.001 per cent (2.15%) but, it was at par with spark 0.036 per cent and polytrin 0.004 per cent, thiodicarb 0.15 per cent with 4.51, 5.35 and 6.05 per cent capsule damage. While, fenvalerate 0.01 per cent, cartap hydrochloride 0.1 per cent and profenofos 0.05 per cent were moderately

effective after first day of spray by registering 9.34, 10.85 and 15.95 per cent capsule damage respectively, while, the rest of the treatment were least effective. The highest capsule damage was recorded in control treatment (24.72%).

5.6.2.3 Seven day after spraying

The significantly lowest capsule damage was noticed in emamectin benzoate (3.04%) but, it was at par with spark (4.69%) and polytrin (5.70%) capsule damage. While, thiodicarb 0.15 per cent, fenvalerate 0.01 per cent and cartap hydrochloride 0.1 per cent were moderately effective by registering 7.42, 11.37 and 12.12 per cent capsule damage respectively, while, the rest of the treatment were least effective. In control plot, the capsule damage was recorded as high as 26.20 per cent.

5.6.2.4 Yield

Highest grain yield was achieved in treatment of emamectin benzoate 0.001 per cent *i.e.* 473.00 kg/ha. It was at par with spark 0.036 per cent (391 kg/ha). Significantly lowest yield was obtained from carbosulfan 0.05 per cent which was not differed from flubendiamide 0.002 per cent.

5.6.2.5 Avoidable losses

Increase in yield over control ranged from 13.77 to 44.00 per cent due to application of insecticides against leaf webber. Maximum yield was increased in plot treated with emamectin benzoate 0.001 per cent (44.00%) followed by the spark 0.036 per cent (41.67%). Avoidable loss in yield due to infestation of leaf webber was varied from 4.68 to 23.49 per cent in different treatments.

It was lowest in (4.68%) in spark 0.036 per cent followed by thiodicarb 0.15 per cent (5.85%) and fenvalerate 0.01 per cent (6.18%). Maximum avoidable loss was recorded in untreated *i.e.*, 23.49 per cent.

5.6.2.6 Economics

Economics of various application of insecticides evaluated against leaf webber indicated that maximum realization was obtained in plot treated with emamectin benzoate 0.001 per cent (₹ 12600) followed by spark 0.036 per cent (₹ 11280) and polytrin 0.004 per cent (₹ 10140). Minimum net realization was recorded in carbosulfan 0.05 per cent (₹ 2520) followed by flubendiamide 0.0042 per cent (₹ 4320) and profenofos 0.04 per cent (₹ 5580). Highest NCIBR was obtained in spark 0.036 per cent (1:4.48) which was followed by emamectin benzoate 0.001 per cent (1:3.14).



REFERENCES

REFERENCES

- Abraham, E.V.; Natarajan, K. Murugesan, M. (1977). Damage by pests and phyllody to *Sesamum indicum* in relation to the time of sowing. *Madras Agric. J.* **64** (5): 298-301.
- Ahuja, D.B. (2005). Evaluation of Integrated pest management modules in sesame. *Indian J. Ent.* 67(3):231-233.
- Ahuja, D.B. and Bakhetia, D. R. C. (1995). Bio-ecology and management of insect pests of sesame – a review. *J. insect Sci.*, **8** (1) : 1-19.
- Anand, G.V. and Selvenarayanan, V. (2005). Reaction of sesamum germplasm against shoot webber *Antigastra catalaunalis* Duponchel. *Indian J. Pl. Protect.*, **33** (1) : 35-38.
- Anonymous (1926). A caterpillar pest of sesame. *Farming in S. Africa*, 1(7): p.223. [Fide: *RAE* (A), 15(1):19].
- Anonymous (2001). District wise area, Production and yield per hectare of important food and non- food crops in Gujarat state. Directorate of Agriculture, Gujarat state, Krishi Bhavan, Gandhinagar, p. 42
- Anonymous (2010). Crop wise area production and productivity of Gujarat Sate. Directorate of Economics and Statistics, Department of Agriculture and Co-operation. pp. 28-29.
- Bhaduria, N.K.S.; Bhaduria, N.S and Dwivedi, U.S. (2000). Pest complex of sesamum and their status under Gwalior condition (M.P.).*Agric. Sci. Digest*, **20**(2):108-09.
- Bhaskaran,R.K.M.; Mahadevan, N.R. and Thangavela, S. (1981). Influence of intercropping on the infestation of shoot webber in sesame. *Indian.J.agri.Sci.* **64** (6):440-442.

- Bhattacharjee, N and Lal, R. (1962). Studies on the varietal susceptibility of 'til' to the attack of *Antigastra catalaunalis* (Duponchel). *Indian J. Ent.*, **24** (1): 58-63.
- Bhattacharjee, N.S. Lal, R. (1960). Studies on the 'til' leaf roller, *Antigastra catalaunalis* (Duponchel), external anatomy of various stages *J.Anim.Morph.Physiol.*, **7** (2) :103-124.
- Cheema, J. S. and Singh, G. (1987). Biology of sesame leaf webber and capsule borer *Antigastra catalaunalis* (Duponchel) [Pyrilladae: Lepidoptera] in Punjab. *J. Res.*, (PAU) **19** (2):170-171.
- Desai, M. T. and Patel, R. M. (1965). Studies on sesamum leaf roller [*Antigastra catalaunalis* (Duponchel)] in Gujarat. *Indian oilseed.J.* **9**(2):428-34.
- Deshpande, R.R. and Singh, Z. (1969) Assessment of damage to *til* (*Sesamum orientale* L.)[indicum]by the leaf and pod caterpillar, *Antigastra catalaunalis* (Duponchel)] in Madhya Pradesh. *JNKVV Res J.*, **3**(1): 57.
- Ghorpade, S.A. and Thakur, S.G.(1995). Management of major insect pests of sesamum in India. *J.Insect.Sci.* **8**(1):43-47.
- Ghosh, C.C. (1923). *Reports by entomologist Mandalay for years ended 30th June 1922 and 1923*, Rangoon, pp.1-9. [Fide: *RAE* (A), 12:550].
- Gupta, M.P.; Rai, H.S. and Chausaria, S.K. (2002). Incidence and avoidable loss due to leaf roller/capsule borer, *Antigastra catalaunalis* Dup. in same. *Ann. Pl. Prot. Sci.*, **10** (2) : 202-206.
- Gurs, S. D. and Hussain, T. (1998) Evaluation of sesame germplasm against the incidence of *Antigastra catalaunalis* (Duponchel) [Lepidoptera: Pyrallidae]. *Shashpva.* **5**(1):69-72.

- Hargreaves, H. (1927) *Annual report of govt. Entomologist*. Sci. Rep. Dept. Agric. Uganda, p.11. [Fide: *RAE* (A), 16:314].
- Hegde, D. M. and Sudhakar Babu, S.N. (2002). *Sesame*. In Prasad, R.(Ed.) Textbook of Field crops production, ICAR, New Delhi.pp.549-51.
- Jagtap, A. B.; Ghule, B. D. and Deokar, A. B. (1986). Comparatively efficacy of some insecticides against capsule borer on sesamum . *J.MAU*, 11(3): 360-61.
- Jakhmola, S. S Kumar, S. and Goel, S. C. (1995). Population dynamics of pyralid, *Antigastra catalaunalis* (Duponchel) on sesamum in relation to abiotic factors. *J. Ent. Res.*, **18**(1):61-64.
- Jakhmola, S. S. and Yadav, H.S. (1990). Evaluation of some insecticide and number of applications against *Antigastra catalaunalis* (Duponchel). *Indian J. Pl. Prot.*, **52** (2) : 335-338.
- Jakhmola, S.S. and Yadav, H.S. (1975). Some observation on *Mermis* sp. as a parasite of 'Til' leaf roller, [*Antigastra catalaunalis* (Duponchel)], *Indian. J. Ento.*, **35**(2):170-72.
- Kapadia, M.N. (1996). Estimation of losses due to pod borers in oilseed crops. *J. Oilseeds Res.*, **13** (1) : 139-140.
- Karuppaiah, V; Nadarajan, L.; Kumar, K.; (2009). Mechanism of resistance in sesame genotype to *Antigastra catalaunalis* (Duponchel) *Annal.Pl. prot. Sci.*, **17**(2):337-340.
- Kumar, R.; Ali, S. and Chandra, U. (2009) Seasonal incidence of insect pests of *sesamum indicum* . *Annal.Pl.Pro.Sci.*, **17** (2) : 487-488.

- Kumar, S. and Goel, S.C. (1994a). Population dynamics of a pyralid, *Antigastra catalaunalis* (Duponchel) on sesamum in relation to abiotic factor. *J. Ent. Res.*, **18**(1):61-64.
- Kumar, S. and Goel, S.C. (1994b). Residual toxicity of synthetic pyrethroids against *Antigastra catalaunalis* (Duponchel) in sesamum *Indian J. Ent.*, **56** (2):156-63.
- Kumar, S. and Goel, S.C. (1995). Efficacy of synthetic pyrethroids and quinalphos against *Antigastra catalaunalis* (Duponchel) infesting sesamum. *J. Ent., Res.*, **19**(1):39-42.
- Kumar, S.; Rohilla, H.R. and Singh, H. (1990). Evaluation of sesamum genotype against the incidence of shoot webber cum pod borer *antigastra catalaunalis* (Duponchel) *J. Res. (PAU)*., **20**(4):291-94.
- Lefroy, H.M. and Howlett, F.M. (1909). *Indian Insect Life Thacker Spink and Co.*, Culcutta, 186pp.
- Mahadevan, N. R.; Ganesh, S.K.; Kandasamy, G. and Sivaraman, M.R. (1989). Evaluation of sesamum entries for resistance to leaf webber, *Antigastra catalaunalis* (Duponchel). *Madras Agric. J.*, **76** (5) : 300.
- Mahadevan, N.R. (1988). Screening of sesamum entries for resistance to leaf webber, *Antigastra catalaunalis* (Duponchel). *Madras Agric. J.*, **75**(5):224.
- Manimegalai, N. and Mahalingam, C.A. (1997). Screening of sesamum entries against shoot webber and capsule borer. *Madras Agric. J.*, **84** (2): 103.
- Mathur, Y.K.; Verma, J.P. and Singh, B. (1971). Insecticide control of til leaf and pod caterpillar, *Antigastra catalaunalis* (Duponchel) [Lepidoptera: Pyralidae]. *Pesticides.*, **5**(9):18-19.

- Menon, M.G.R.; Lal, R. and Bhattacharjee, N. S. (1960). Studies on *Antigastra catalaunalis* (Duponchel), the til leaf roller., *Indian J. Ent.*, **22**(1):1-6
- Mishra, H.P. and Patnaik, N.C. (1994). Comparative efficacy of some insecticides against the sesamum leaf webber and pod borer, *Antigastra catalaunalis* (Duponchel) [Lepidoptera:Pyrallidae]. *J. Ent. Res.*, 18 (2): 177-79.
- Muralibaskaran, R.K.; Mahadevan, N.R. and Thangavelu, S.(1993). Evaluation of Plant products against the sesamum shoots webber and pod borer, *Antigastra catalaunalis* (Duponchel). *Indian J. Ent.* **55**(4):385-89.
- Muralibaskaran, R.K.; Ganesh,S.K. and Thangavelu, S.(1994). Germplasm screening against sesame leaf roller and pod borer, *Antigastra catalaunalis* (Duponchel). *Madras. Agric.J.*, **81**(11):618-21.
- Narayanan,E.S.(1961). *Insect pest of sesamum and method of their control*. ICAR, New Delhi, p.87.
- Nath,P.; Bhushan, S. Singh, A.K. (2003). Effect of intercropping on the population of insect pests of sesamum *J. Appl. Zool. Res* **14**(1):76-79.
- Patel, A.A. and Bhalani, P.A. (1986). Chemical control on sesamum leaf roller, *Antigastra catalaunalis* (Duponchel) [Lepidoptera:Pyrallidae]. *Pesticides*, **20**(4):23-26.
- Patel, P.G. (1978). *Biology and chemical control of leaf webber and capsule borer, Antigastra catalaunalis* (Duponchel) (Pyrallidae: Lepidoptera) on Sesamum. M.Sc.(agri.) Thesis submit to the Gujarat Agriculture University, S. K. Nagar.

- Patel, V. B. (1973). Some studies on bionomics and control of sesamum leaf roller [*Antigastra catalaunalis* Duponchel] under Junagadh condition. M.Sc.(Agri.) Thesis submit to the Gujarat Agri. University, S.K. Nagar.
- Patel, V.N., Saradava, D.A.; Kabaria, B.B. and Talpada, M.. (2009). Estimation of yield losses in rainfed sesamum due to leaf webber *Antigastra catalaunalis* Duponchel. In : National Symposium on IPM Strategies to Combat Emerging Pests in sesamum.
- Paul, S.K. and Shantanu, J. (1997). Effects of time of sowing and insecticidal treatments on incidence of *Antigastra catalaunalis* (Duponchel), Yield attribute characters and seed yield of sesamum. *Environment and Ecology.*, 15(2):225-27.
- Pillai, R.M. (1921). Short notes on the insects pests of crops in Travancore. Travancore Dept.Agric.pp:53.
- Prasad, S.K. (1970). Varietal difference in the incidence of *Antigastra catalaunalis* (Duponchel) on sesame (*Sesamum indicum* L.). *Indian J. Ent.*, 32(3):279-82
- Poul, M.D. (1976). Studies of chemical control of mustard pests. *Indian J.Pl. Prot.*, 14(1) : 9-14.
- Rai, H. S.; Gupta, M.P.; Shrivastava, R. L. (1999). Effect of date of sowing on shoot webber and pod borer incidence and yield of sesame. *Agri. sci. digest.*, 19 (2) : 81-83.
- Rai,H.S.; Verma M.L.; Gupta,M.P. (2002). Effect of date of sowing on shoot webber and pod borer incidence and yield of sesame. *Annl. pl. prot. sci.*, 10 (1) : 150-151.

- Rath, L. K.; Mishra, A and Mukherjee, S.K.(1997). Varietal reaction in sesamum to leaf webber and capsule borer *Antigastra catalaunalis* (Duponchel), *Insect environment.*, **3**(2):50-51.
- Rohilla, H.R. and Singh, R. (1992). Evaluation of spray schedule and assessment of yield losses in sesamum leaf roller, *Antigastra catalaunalis* (Duponchel), [Pyrallidae: Lepidoptera] *Indian. J. Ent.*, **54**(1):48-53.
- Saxena, A.A. and Jakhmola, S.S. (1983). Effect of spray time and number on sesame leaf webber and capsule borer, *Antigastra catalaunalis* (Duponchel). *Agric. Sci. Digest*, **13**(3):131-33.
- Selvenarayan, V. and Baskaran, P. (1966). Efficacy of non-conventional insecticides against the sesame shoot webber and capsule borer, *Antigastra catalaunalis* (Duponchel). *Agric. Sci. Dig.*, **13**(3) :131-133.
- Sengar, S (2003). Biology, Population dynamics, Varietal susceptibility and chemical control of leaf webber and capsule borer, *Antigastra catalaunalis* (Duponchel) (Pyrallidae: Lepidoptera) on sesamum. M.Sc. (Agri.) thesis submitted to Gujarat Agri. University, S. K. Nagar.
- Shrivastava, S.S.; Shrivastava, N and Das, S.B. (1989). Comparatively efficacy and economics of some (Lepidoptera Pyralidae) in sesamum. *Pestology.*, **13**(6):15-17.
- Singh, G. P.; Sinha, R.P.; Singh, S.P., Hameed, S.F. (1992). Population dynamics and biology of sesamum shoot and leaf webber, *Antigastra catalaunalis* (Duponchel) [Lepidoptera:Pyralidae]. *J. Insect Sci.*, **16**(4):305-10.

- Singh, G.P. and Grewal, G.S.(1989). Efficacy of new insecticides against sesamum leaf webber and capsule borer, *Antigastra catalaunalis* (Duponchel) in Punjab. *J. insect Sci.*, **2**(2):146-51.
- Singh, G.; Grewal, G. S. and Prihar, R.S. (1991). Chemical control of sesamum leaf webber and capsule borer, *Antigastra catalaunalis* (Duponchel) on sesame. *J. Insect Sci.*, **3**(2):174-76.
- Singh, H. ; Jaglan, R.S and Kharub, S.S. (1990). Antibiosis in some sesame genotypes against shoot webber and pod borer, *Antigastra catalaunalis* (Duponchel), *J. Insect Sci.*, **3**(2): 174-76.
- Singh, O.P. and Jakhmola, S.S. (1984). Efficacy of new insecticides in the control of sesamum leaf webber and capsule borer. *Indian J. Agric. Sci.* **54**(6):509-11.
- Sinha, R.P. and Prasad, R.P. (1992). Population dynamics of sesame shoot and leaf webber (*Antigastra catalaunalis* Dup.) in relation to abiotic factors. *J. Appl. Biol.*, **2**(1): 76-78.
- Sood, N.K. and Sidhu, A. (1984). Chemical control of leaf roller and capsule borer *Antigastra catalaunalis* (Lepidoptera:Pyraidae). *Pesticides.*, **18**(8): 36 -37.
- Srivastava, N.; Duhoon, S.S. and Rahuwanshi, K.M.S.(2002). Testing of different germplasm lines of sesame against leaf roller and capsule borer, *Antigastra catalaunalis*, *Sesame and safflower newsletter*, **17**:69-70.
- Talpur, M.A ; Khuhbro, R.D.; Rustamani, M.A.; Nizamani, I. A. (2002). Insect pests associated with sesame at Tandojam. *Pak. J. appl. Sci.* **2** (7):723-726.

- Talpur, M.A ; Khuhbro, R.D.; Rustamani, M.A.; Nizamani, I. A. (2002). Insect pests associated with sesame at Tandojam. *Pak. J. appl. Sci.* **2** (7):723-726.
- Thakor, K.C. (2006). Biology, Seasonal abundance in relation to weather parameters and integrated management of sesamum leaf webber, *Antigastra catalaunalis* (Duponchel). M.Sc.(Agri.) thesis submitted to Sardarkrushinagar Dantiwada Agri. University, S. K. Nagar.
- Tripathi, J.K.; Srivastava, J.P. and Tripathi, A. (2007). Efficacy of different insecticides against *Antigastra catalaunalis* Duponchel. Infesting Sesamum. *J. Pl. Protect. and Environ.*, **4** (2) : 81-84.
- Vagela, N. M. (1988). Studies on biology and chemical control of sesamum leaf roller, *Antigastra catalaunalis* (Duponchel). M.sc. (Agri.) Thesis, G.A.U, Junagadh.
- Viroja, M.K.(2011). Seasonal incidence and bio-efficacy of neem products against leaf webber, *A. catalaunalis* (Duponchel). Infesting sesamum. M.Sc.(Agri.) thesis submitted to Junagadh Agri. University,
- Vora , V.J.; Bharodia, R.K. and Kapadia, M.N. (1984) Pests of oilseed crops and their control-sesamum. *Pesticides*, **18**(3):11-12.
- Yadav, G.S.; Kathpal, T.S.; and Singh, H. (1985) Efficacy of monocrotophos, carbaryl and endosulfan against *Antigastra catalaunalis* (Duponchel) and their persistence in soil and Sesamum seeds. *Indian. J. Agric. sci.*, **55**(6):438-42.

Zumreoglu, S. (1982) Investigation on the sesame moth, *Antigastra catalaunalis* (Duponchel) [Lepidoptera:Pyrilladae], which cause considerable damage on sesame growing areas of the Aegian region. *Turkiya Bitki koruma Dergisi*. **6**(4) :227-32.



APPENDICES

Appendix I: Weekly observations on per cent flower infestation by *A. catalaunalis* in various genotypes of sesamum 2009

S.N	Genotype	Per cent flower infestation at indicated week after sowing				
		W-6	W-7	W-8	W-9	W-10
1	RT-25	19.12 (10.37)	18.03 (9.21)	16.01 (7.20)	28.47 (22.27)	24.75 (17.12)
2	RT-54	20.87 (12.30)	25.58 (18.68)	22.88 (14.24)	26.77 (20.45)	24.94 (17.36)
3	RT-103	24.99 (17.40)	23.87 (15.97)	29.59 (24.37)	31.27 (26.47)	26.93 (20.66)
4	RT-125	25.54 (18.17)	16.30 (7.48)	21.24 (13.18)	25.89 (18.65)	25.91 (22.02)
5	RT-127	16.35 (7.60)	19.43 (10.71)	16.04 (7.32)	17.35 (8.47)	14.60 (6.32)
6	RT-162	24.97 (20.25)	19.12 (12.87)	19.31 (10.62)	28.30 (22.85)	29.04 (23.14)
7	RT-169	14.71 (6.18)	21.88 (22.47)	14.98 (6.30)	14.56 (6.25)	13.76 (5.29)
8	RT-193	13.83 (5.33)	28.24 (7.62)	13.60 (5.15)	10.95 (3.17)	12.47 (4.33)
9	NIC-7800	18.97 (10.30)	16.39 (12.37)	16.61 (7.70)	19.30 (10.65)	18.28 (9.37)
10	NIC-7816	23.46 (15.32)	20.92 (17.61)	18.04 (9.10)	21.14 (12.57)	29.84 (24.45)
11	NIC-7819	28.52 (22.35)	25.12 (8.77)	16.44 (7.52)	30.52 (25.42)	28.06 (22.31)
12	NIC-7828	20.13 (11.47)	17.42 (5.48)	19.24 (10.36)	25.02 (17.43)	32.85 (28.96)
13	NIC-7829	17.10 (8.30)	16.85 (13.88)	16.15 (7.38)	21.95 (13.53)	15.92 (7.22)
14	NIC-7834	19.90 (11.43)	26.95 (10.45)	16.89 (8.25)	23.42 (15.53)	23.38 (15.47)
15	NIC-7835	22.09 (13.70)	19.26 (20.77)	25.78 (18.45)	27.06 (20.38)	20.94 (12.38)
16	NIC-7836	10.53 (25.43)	27.29 (19.43)	32.63 (28.83)	32.34 (28.37)	31.26 (26.51)
17	NIC-7837	32.31 (28.33)	26.47 (13.52)	31.23 (26.54)	24.36 (16.77)	33.53 (30.36)
18	GT-1	33.84 (30.83)	21.89 (14.64)	33.72 (30.42)	33.74 (30.68)	36.28 (34.75)
19	GT-2	34.83 (32.53)	22.85 (27.73)	34.96 (32.38)	34.74 (32.40)	39.21 (25.82)
20	GT-3	35.91 (33.95)	31.95 (30.70)	37.82 (37.40)	36.69 (35.29)	39.78 (38.38)
S.em..±		1.79	2.08	2.17	2.47	2.37
C.D.at 5%		5.13	5.97	6.22	7.09	6.80
C.V. %		12.92	15.80	16.82	16.68	15.76

Appendix II: Weekly observations on per cent capsule infestation by *A. catalaunalis* in various genotypes of sesamum 2009

S.N	Genotype	Per cent capsule infestation at indicated week after sowing				
		W-6	W-7	W-8	W-9	W-10
1	RT-25	28.50 (22.32)	16.62 (8.00)	18.99 (10.63)	23.53 (15.53)	19.11 (10.37)
2	RT-54	26.72 (20.15)	15.55 (7.05)	18.38 (10.20)	22.05 (13.70)	18.14 (9.47)
3	RT-103	29.20 (23.37)	15.22 (7.00)	21.04 (12.50)	24.61 (17.53)	20.94 (12.33)
4	RT-125	25.11 (18.00)	14.98 (6.28)	18.12 (9.20)	21.78 (13.37)	17.09 (8.30)
5	RT-127	15.94 (7.23)	9.15 (2.30)	12.61 (4.30)	14.82 (6.10)	10.83 (3.23)
6	RT-162	14.79 (6.23)	18.18 (9.27)	20.16 (11.40)	24.08 (16.30)	20.16 (11.40)
7	RT-169	7.08 (1.019)	9.08 (2.07)	9.55 (2.33)	12.45 (4.47)	9.70 (2.40)
8	RT-193	17.96 (9.25)	7.50 (1.23)	11.67 (3.70)	11.36 (3.43)	8.69 (1.87)
9	NIC-7800	20.53 (12.00)	11.39 (3.50)	23.34 (15.40)	17.06 (8.13)	12.19 (4.00)
10	NIC-7816	21.74 (13.33)	14.16 (5.50)	17.90 (9.03)	20.95 (12.40)	15.84 (7.03)
11	NIC-7819	25.44 (18.00)	18.22 (9.33)	20.65 (12.00)	24.92 (17.30)	19.11 (10.37)
12	NIC-7828	21.46 (13.00)	10.66 (3.13)	16.52 (8.00)	18.84 (10.28)	13.68 (5.13)
13	NIC-7829	16.86 (8.00)	12.51 (4.23)	14.90 (6.28)	15.79 (7.00)	11.47 (3.50)
14	NIC-7834	22.99 (15.00)	11.90 (4.10)	15.75 (7.00)	17.98 (9.30)	12.61 (4.30)
15	NIC-7835	24.42 (17.00)	13.19 (5.00)	17.35 (8.57)	19.89 (11.30)	14.96 (6.43)
16	NIC-7836	29.80 (24.30)	20.61 (12.50)	22.45 (14.17)	27.08 (20.40)	23.01 (15.23)
17	NIC-7837	29.63 (24.13)	20.03 (11.37)	21.81 (13.37)	26.22 (19.10)	25.67 (18.57)
18	GT-1	31.30 (26.63)	23.25 (15.30)	24.85 (17.25)	28.65 (22.53)	26.13 (19.12)
19	GT-2	33.10 (29.37)	24.74 (17.83)	25.52 (18.20)	30.24 (25.00)	28.54 (22.37)
20	GT-3	33.78 (30.48)	25.77 (18.97)	28.41 (22.33)	30.67 (27.00)	29.98 (24.57)
S. Em.±		1.81	2.17	1.80	1.72	1.69
C.D.at 5%		5.06	5.20	5.05	4.93	4.85
C.V .%		13.14	14.35	16.40	13.77	16.39

Appendix III: Weekly observations on per cent flower infestation by *A. catalaunalis* in various genotypes of sesamum 2010

S.N	Genotype	Per cent flower infestation at indicated week after sowing				
		W-6	W-7	W-8	W-9	W-10
1	RT-25	18.76 (10.00)	19.02 (10.23)	27.01 (20.25)	23.67 (15.72)	14.88 (6.20)
2	RT-54	22.42 (14.10)	26.37 (19.72)	25.29 (18.53)	23.25 (5.17)	21.39 (13.20)
3	RT-103	24.79 (17.13)	24.63 (16.95)	29.89 (24.36)	25.34 (18.58)	28.84 (23.32)
4	RT-125	25.34 (17.90)	17.43 (8.57)	24.38 (16.57)	26.92 (20.08)	20.26 (12.10)
5	RT-127	16.72 (7.43)	20.33 (11.70)	15.04 (6.33)	13.38 (5.42)	14.78 (6.22)
6	RT-162	26.84 (20.07)	22.15 (13.90)	26.78 (20.82)	29.71 (24.13)	18.24 (9.50)
7	RT-169	15.40 (6.65)	18.27 (23.50)	4.58 (12.44)	13.7 (15.25)	13.72 (5.28)
8	RT-193	12.87 (4.72)	17.47 (8.67)	10.20 (2.77)	12.33 (4.23)	12.18 (4.10)
9	NIC-7800	18.69 (10.03)	21.85 (13.47)	18.28 (9.60)	17.98 (9.05)	15.54 (6.72)
10	NIC-7816	23.08 (14.97)	25.91 (18.67)	20.19 (11.53)	28.40 (22.33)	17.06 (8.13)
11	NIC-7819	28.39 (22.15)	17.48 (8.83)	29.80 (24.35)	26.44 (20.13)	14.51 (5.80)
12	NIC-7828	19.95 (11.27)	15.12 (6.50)	23.49 (15.43)	31.56 (26.93)	17.35 (8.42)
13	NIC-7829	16.58 (7.08)	27.77 (21.47)	21.11 (12.52)	17.07 (8.28)	15.05 (6.43)
14	NIC-7834	19.43 (10.93)	21.88 (13.57)	22.64 (14.53)	24.16 (16.46)	18.00 (9.30)
15	NIC-7835	21.73 (13.27)	27.92 (21.65)	27.41 (21.04)	21.89 (13.40)	26.51 (19.47)
16	NIC-7836	28.51 (22.43)	27.22 (20.48)	31.72 (27.37)	31.91 (27.52)	33.08 (29.53)
17	NIC-7837	30.83 (26.13)	22.76 (14.53)	24.93 (17.77)	32.23 (28.35)	31.87 (27.53)
18	GT-1	34.27 (31.53)	23.72 (15.73)	33.02 (29.55)	35.11 (32.86)	34.38 (31.45)
19	GT-2	35.20 (33.13)	28.71 (22.75)	57.04 (43.15)	36.55 (35.02)	35.72 (33.48)
20	GT-3	36.20 (34.43)	32.02 (28.08)	46.15 (33.26)	37.58 (36.83)	33.09 (31.70)
S.em. $\pm$		1.82	1.87	2.62	2.45	2.34
C.D.at 5%		5.22	5.36	6.12	7.01	6.10
C.V. %		13.28	14.16	17.72	16.65	15.30

Appendix IV: Weekly observations on per cent capsule infestation by *A. catalaunalis* in various genotypes of sesamum 2010

S.N	Genotype	Per cent capsule infestation at indicated week after sowing				
		W-6	W-7	W-8	W-9	W-10
1	RT-25	22.53 (15.00)	20.31 (11.77)	17.16 (8.23)	26.44 (20.00)	17.39 (8.60)
2	RT-54	22.07 (14.00)	19.53 (11.27)	16.86 (8.00)	27.91 (22.00)	16.77 (8.30)
3	RT-103	24.84 (17.33)	24.57 (17.00)	21.53 (13.00)	26.53 (19.50)	18.77 (10.00)
4	RT-125	21.44 (12.33)	19.15 (10.50)	16.34 (7.50)	25.67 (18.33)	16.77 (8.00)
5	RT-127	15.74 (7.22)	15.01 (6.32)	17.52 (9.00)	15.39 (6.60)	10.96 (3.17)
6	RT-162	21.48 (13.17)	22.31 (14.27)	17.29 (8.50)	26.87 (16.33)	17.88 (9.00)
7	RT-169	14.49 (6.00)	13.40 (5.00)	12.48 (4.50)	9.45 (2.27)	12.86 (2.40)
8	RT-193	13.76 (5.20)	12.62 (4.41)	10.94 (3.30)	13.81 (5.23)	1.221 (7.16)
9	NIC-7800	17.83 (9.33)	8.00 (16.77)	5.53 (14.07)	15.79 (7.00)	14.05 (5.20)
10	NIC-7816	12.50 (21.020)	10.00 (18.87)	7.20 (16.09)	23.72 (16.00)	16.39 (7.50)
11	NIC-7819	24.66 (17.00)	23.14 (15.00)	17.52 (9.00)	29.29 (23.50)	18.41 (9.50)
12	NIC-7828	19.95 (11.37)	17.52 (9.00)	14.92 (6.23)	17.88 (9.00)	15.34 (6.53)
13	NIC-7829	16.62 (8.00)	15.77 (7.07)	13.19 (5.00)	17.25 (8.47)	12.69 (4.37)
14	NIC-7834	19.17 (11.00)	16.98 (8.50)	14.25 (6.00)	16.37 (7.53)	14.91 (6.17)
15	NIC-7835	20.30 (12.00)	18.12 (9.60)	15.49 (7.00)	19.62 (11.00)	15.87 (7.03)
16	NIC-7836	23.39 (15.50)	26.39 (19.70)	24.66 (17.00)	29.93 (24.50)	20.23 (11.50)
17	NIC-7837	25.38 (18.00)	28.62 (23.00)	23.06 (15.00)	30.87 (26.00)	19.84 (11.17)
18	GT-1	26.84 (20.00)	30.07 (25.00)	26.89 (20.00)	32.11 (28.02)	22.99 (15.00)
19	GT-2	27.82 (22.00)	32.18 (28.10)	25.40 (21.33)	33.38 (30.00)	24.42 (17.00)
20	GT-3	30.01 (25.00)	34.59 (32.00)	32.10 (28.00)	34.79 (32.27)	28.72 (22.67)
S. Em. $\pm$		2.81	1.65	1.91	2.17	1.27
C.D.at 5%		5.06	4.70	5.44	6.22	3.63
C.V. %		15.70	13.33	17.45	15.90	12.46

**Appendix VII : Weekly meteorological data recorded at observatory of
Agricultural Research Station, S. D. Agricultural University,
Talod from July to October, 2009 and 2010**

Month and Year	Standard week	Temperature (°C)		Relative humidity (%)	Rain fall (mm)
		Max.	Min.		
July, 2009	28	29.9	15.0	78.5	0.0
	29	27.8	17.5	80.5	0.0
	30	28.5	16.5	72.5	0.0
	31	29.0	17.0	76.0	0.0
August, 2009	32	32.5	15.0	77.0	0.0
	33	33.0	14.0	84.5	5.00
	34	30.5	13.0	85.0	0.0
	35	28.0	13.5	75.0	2.00
September, 2009	36	27.5	12.5	77.0	0.0
	37	27.0	16.5	67.5	0.0
	38	28.5	18.0	70.5	4.00
	39	33.0	15.5	71.5	0.00
October, 2009	40	35.0	14.0	75.5	2.00
July, 2010	28	28.4	14.0	77.2	0.0
	29	29.1	13.7	68.1	0.0
	30	25.3	12.5	74.9	0.0
	31	27.7	16.5	76.0	4.0
August, 2010	32	30.7	14.9	78.6	0.0
	33	32.1	16.9	78.1	0.0
	34	31.6	16.2	67.3	0.0
	35	31.8	8.0	78.8	0.0
September, 2010	36	32.5	11.3	75.6	0.0
	37	31.4	9.1	74.3	0.0
	38	31.8	12.7	72.6	0.0
	39	32.3	17.1	71.9	0.0
October, 2010	40	33.9	18.8	72.3	0.0

Appendix V: Effect of sowing date on the incidence of *A. Catalaunalis* in sesamum during year 2009

Treatment	Flower damage/ plants at different weeks after sowing								
	4	5	6	7	8	9	10	11	12
January 22 D ₁	4.25 (0.89)	6.42 (1.41)	6.94 (1.85)	9.67 (2.10)	10.91 (2.56)	12.34 (3.35)	15.52 (4.64)	12.07 (3.22)	9.22 (2.56)
February 7 D ₂	12.34 (3.46)	15.31 (5.64)	18.36 (9.94)	19.37 (10.45)	21.00 (11.56)	23.88 (16.40)	25.12 (18.05)	20.06 (14.46)	17.91 (11.25)
February 14 D ₃	15.31 (6.14)	17.36 (7.34)	20.09 (11.82)	21.76 (13.77)	24.14 (16.73)	25.79 (17.26)	28.14 (20.34)	27.37 (19.34)	21.76 (14.75)
February 22 D ₄	7.69 (1.35)	9.43 (2.15)	10.43 (3.30)	11.55 (4.05)	13.60 (5.18)	13.43 (5.48)	14.96 (6.16)	12.25 (4.26)	9.24 (2.84)
March 7 D ₅	8.15 (1.84)	8.96 (2.43)	10.74 (3.48)	12.10 (4.42)	14.27 (6.14)	15.68 (7.45)	17.37 (8.26)	15.63 (6.44)	13.49 (5.52)
S.Em	1.20	0.89	1.25	1.34	1.56	1.34	1.16	1.34	1.09
C.D	2.35	1.75	2.70	2.78	3.15	2.70	2.30	2.16	2.15
C.V %	10.34	7.45	11.34	12.34	13.34	14.25	12.45	14.30	14.26

Appendix VI: Effect of sowing date on the incidence of *A. Catalaunalis* in sesamum during year 2010

Treatment	Flower damage/ plants at different week after sowing								
	4	5	6	7	8	9	10	11	12
January 22 D ₁	7.42 (1.68)	8.94 (2.42)	10.08 (3.07)	10.93 (4.26)	12.83 (5.24)	13.51 (6.34)	13.33 (6.92)	11.68 (5.29)	9.52 (2.86)
February 7 D ₂	13.77 (5.77)	15.71 (7.41)	17.88 (9.50)	20.00 (11.47)	22.11 (14.62)	25.04 (17.46)	26.17 (19.76)	29.79 (20.23)	20.58 (12.26)
February 14 D ₃	16.31 (8.12)	17.88 (9.50)	19.74 (11.47)	22.20 (14.34)	24.76 (17.59)	26.34 (19.72)	30.96 (25.34)	29.21 (20.34)	24.02 (16.28)
February 22 D ₄	8.39 (2.13)	9.75 (3.21)	11.16 (4.26)	12.95 (5.15)	14.96 (6.25)	15.69 (7.56)	17.94 (9.46)	14.86 (6.04)	11.65 (4.26)
March 7 D ₅	9.39 (2.67)	11.94 (4.23)	14.30 (5.26)	16.82 (6.76)	19.51 (9.34)	19.94 (10.26)	20.64 (11.26)	16.65 (8.27)	15.04 (5.83)
S.Em	0.80	0.72	0.86	0.94	1.05	1.30	1.06	1.74	1.10
C.D	1.40	1.35	1.84	1.48	2.45	2.25	2.04	2.03	2.06
C.V %	8.37	6.77	6.70	7.60	8.20	8.34	9.26	11.42	9.35

CERTIFICATE

This is to certify that, I have no objection for supplying to any scientist only one copy or any part of this thesis at a time through reprographic process, if necessary for rendering reference service in a library or documentation center.

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[VARMA H. S.]