

STUDIES ON INSECT PESTS OF SOYBEAN WITH
REFERENCE TO ITS VARIETAL SUSCEPTIBILITY
TO MAJOR PESTS AND THEIR CHEMICAL
CONTROL

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Dedicated
to my
Grand Father
SHRI G. G. KANGO

CERTIFICATE-I

This is to certify that the thesis entitled "STUDIES ON INSECT PESTS OF SOYBEAN, WITH REFERENCE TO ITS VARIETAL SUSCEPTIBILITY TO MAJOR PESTS, AND THEIR CHEMICAL CONTROL" submitted in partial fulfilment of the requirements for the degree of Master of Science in Agriculture of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bona fide research work carried out by Ku. NANDA KANGO under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

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

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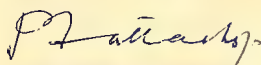
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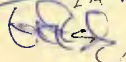
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CERTIFICATE-II

This is to certify that the thesis entitled "STUDIES ON INSECT PESTS OF SOYBEAN, WITH REFERENCE TO ITS VARIETAL SUSCEPTIBILITY TO MAJOR PESTS, AND THEIR CHEMICAL CONTROL" submitted by Ku. NANDA KANGO to the J.N. Krishi Vishwa Vidyalaya, Jabalpur in partial fulfilment of the requirements for the degree of M.Sc. (Ag.) in the Department of Entomology has been approved by the Student's Advisory Committee and External Examiner after an oral examination on the same.

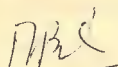

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(Ku. Manda Kango)

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CHAPTER-I

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INTRODUCTION

Soybean (Glycine max (L.) Merr.), one of the oldest leguminous crops of the world is a member of the pea family, it's very nutritious and almost as important as rest of pulses put together. This crop originated from North East China, Japan, Korea and the USA. [Scientific Crop Production 1970]

Soybean has been grown for centuries as a minor pulse crop in India, in hill region of Northern India and in southern Madhya Pradesh and adjoining areas of Maharashtra. Research work on this crop was initiated in 1965 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, by collection of exotic and indigenous germplasm. Thereafter, this work was augmented here with the help from USAID and University of Illinois. As a result of varietal experiments conducted, two varieties viz. Clark-63 and Bragg have been identified along with others for the state. These varieties were introduced for cultivation in Madhya Pradesh during 1967.

Madhya Pradesh is the largest soybean growing state of the country because of the popularity of this crop among cultivators which is evident from the fact that the crop acreage of the state at present is about 7 lakh ha, which is 80 per cent of total acreage of the country and the area under soybean during the end of 6th Five Year Plan is likely to reach

about 18 lakh ha. The total production of the state during the year 1977-78 was estimated to be 1.4 lakh tonnes, which has reached to 8 lakh tonnes during 1981-82. This was due to the evolution of new varieties like JS-2, Pb-1, Ankur, Bragg, JS 72-44 and JS 72-280. These varieties were found suitable under different agroclimatic zones of the state.

Soybean is ~~rich~~ rich in proteins, vitamins, minerals, salts and other food ingredients. It contains 49.4% proteins, 15.20% fat, 4.6% mineral matter, 3.7% fibre, 20.9% carbohydrates, 0.24% calcium, 0.96% phosphorus and 11.5% iron (Source: Wealth of India, 1956). It is the best of all vegetable proteins and hence regarded as very suitable for both diabetic and heart patients.

The new varieties recommended by the breeders are very responsive to fertiliser but at the same time they are susceptible to insect pests resulting in low productivity which is about 1.1 tonnes/ha.

The soybean embodies characteristics of pulses, oil-seeds and vegetables and therefore it is attacked by several insects, which find a tremendous amount of foliage, not only for hiding but also for food and nutrition.

The various pests attacking the crop at Jabalpur can be broadly classified according to their habits and habitats,

nature of damage and stage of the crop which are as follows:

Field pests

A. Soil pests, damaging seeds and seedlings

- (1) Seed corn maggot, Hylema (Delia) platura Meigen
- (2) Ground beetle, Genocephalus dorsograneosum Faber
- (3) Black cricket, Gryllus sp.
- (4) Cut worms, Agrotis ypsilon Rottenberg

B. Stem borers

- (1) Stem fly, Melanogromyza phaseoli (Tryon.)
- (2) Girdle beetle, Obareopsis (Oberia) brevis (Swdenbord)

C. Leaf defoliators and miners

- (1) Bihar hairy caterpillar, Picrisia obliqua Walker
- (2) Tobacco caterpillar, Spodoptera litura Fabricius
- (3) Linseed caterpillar, Spodoptera exigua Hubner
- (4) Green semilooper, Plusia orichalcea Fb.
- (5) Gram pod borer, Heliothis armigera Hubner
- (6) Brown semilooper, Mocis undata Fabricius
- (7) Brown caterpillar, Anarsia obhippias Meyerick
- (8) Leaf folder, Lamprosema indicata Fabricius
- (9) Leaf miner, Stomopteryx subocivella Zeller

D. Sucking pests

- (1) White fly, Bemisia tabaci (Gveunadius)
- (2) Jassids, Empoasca sp.
- (3) Southern green bug, Nazara viridula Linnaeus
- (4) Thrips, Caliothrips indicus Bagnel
- (5) Red spider mites, Tetranychus sp.
- (6) Aphids, Aphis craccivora Koch

Sufficient knowledge regarding the major insect pests like leaf minor, leaf folder, stemfly and girdle beetle damage has increased recently with the increasing acreage under this crop. The extent of damage by this insect is about 25-30 per cent more than any other pests so it is necessary either to identify resistant source of germplasm and to incorporate these genes into our existing variety or find out economic plant protection schedule to control the losses due to the major insect pests.

Third way of reducing losses by major insect pests is by way of manipulating the cultural practices like date of sowing, rotation of the crop etc.

The present field investigations were, therefore, carried out especially on major insect pests like girdle beetle, stemfly, leaf roller and leaf miner with the following objectives:-

- (1) To study the incidence of different insect pests of soybean crop.
- (2) To study the varietal susceptibility of soybean to its major pests viz. leaf miner, Stenopteryx subsecivella Zeller; leaf folder, Lamprosema indicata F.; girdle beetle, Oberia brevis Swed. and stemfly, Melanagromyza phaseoli (Tryon), so as to find out the most and least susceptible varieties.
- (3) To evaluate some modern insecticides against these pests.

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CHAPTER-II

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REVIEW OF LITERATURE

Soybean is an important leguminous crop which gets damaged by large number of insect pests during the growth period. The research work carried out at home and abroad regarding appearance of major pests, the damage caused by them to the different parts of the plants, varietal susceptibility and their chemical control has been reviewed here.

2.1. Incidence of insect pests

No systematic study on the arthropod pests of soybean has been made in India, except making a mere record of few pests like leaf miner Stomopteryx sp., stem borer beetle Oberia brevis Swed. and the leaf hopper Empoasca parathae (Dutt, 1915; Pruthi, 1940; Ayyar, 1940).

Fletcher (1914) noted the larvae of Lamprosema indicata F. through the plains of south India.

According to Fletcher (1920) the leaf miner Stomopteryx subsecivella Zeller is a specific pest of soybean, which appeared in epidemic form in Maharashtra.

Flint (1930) reported the soybean varieties, having smooth foliage and of glabrous type were severely damaged by jassids resulting in stunted growth and curled leaves with

yellow necrotic margin, while the rough hairy varieties were mostly free from infestation.

Isley (1936) reported about 91 per cent Heliothis larval intensity feeding on foliage during September at Arkansas.

Sonan (1937) reported the larvae of Prodenia litura F. feeding on 45 different plants.

Shchegolev (1939) observed from North Caucasus that 98 per cent leaves were found to be infested by Heliothis spp. during summer when the temperature was high.

Ayyar (1940) reported that the girdle beetle Oberon brevis Swed. is a serious pest of soybean. It bored into the stem of soybean in South India.

The leaf roller Lamprosema indicata F. was largely responsible for loss of 50% to 75% leaf area in fields of Seminole variety of soybean in 1944 in Puerto Rico (Plank, 1946).

Thirtynine species of Amposca were found to cause comparatively more damage to soybean out of the 84 species recorded in a survey at Minnesota (Kretzschmar, 1949).

The stemfly Melanagromyza phaseoli C&q. is an important pest causing serious damage to soybean crop. It attacks the pith portion due to which the top portion withers and

droops down. Its abundance in the soybean field may be attributed to the growing of sunhemp (Crotolaria juncea) crop which serves as an alternate host (Chewsebpong, 1949).

Khan and Rao (1950) reported two species of aphids namely Myzus persicae Sulz. and Aphis craccivora Koch. Both young and adult of these suck the cell sap from the cotyledonous leaves.

The injury caused by leaf miner Stenopteryx subcivellia Zeller was observed in different varieties of soybean in Java and Sumatra. Larvae feed on a short blister like mine in the leaf for about 18 days, after which it emerged and webbed several leaflets together forming a shelter in which it completed its development (Vander-Iaan, 1953).

According to survey conducted at different heights of Tarai area in India, the stemfly infestation varied from 60 to 100% in the field located at 2500 to 3500 ft above the mean sea level, with an exception of Jeolikote (Distt. Nainital) which is 3500 ft above mean sea level where the infestation was zero per cent probably due to its location in a valley (Singh, 1968).

Singh (1969) reported the tobacco caterpillar Spodoptera littoralis as a serious pest of soybean in the

Himalayan area. The larvae of this pest defoliate the crop in September.

Singh and Chibber (1969) reported that the semilooper Plusia orichalcea Fabr. is a polyphagous pest and devours voraciously the foliage and other soft vegetative parts. Besides soybean it causes extensive damage to cauliflower, cabbage and other crops. The pest is widely found in India.

Kapoor et al. (1970-71) reported that the girdle beetle Oberaea brevis Swed. is a stem borer of soybean. The beetle damaged 1 to 29.4 per cent plant stems, making it completely hollow from above the ground.

Gangrade (1970-71) reported that the leaf folder Lamprosema indicata F. appeared in August and continued upto the end of September and also in November-February in case of humid winter. About 4-5 larvae per 100 plants in kharif season were reported. The larvae have the habit of folding the soybean leaves from the tip inwards or along with mid rib.

Gangrade (1971-72) reported that the leaf miner Stenopteryx subsecivella Zeller is a specific pest of soybean which appeared in epidemic form during 1971 in September at Jabalpur. The larvae of leaf miner mined the leaves under the epidermis resulting in scorched or crinkling symptoms.

Gangrade (1971-72) reported the gram pod borer Heliothis armigera Hb. as a sporadic pest of gram. It attacked soybean in an early phase of the growth and sometimes in the pod development phase when the developing grain was consumed by the larvae. The mean population of the larvae of Heliothis armigera Hb. ranged from 3.50 to 8.25 per 100 plants in kharif season were reported.

The stemfly Melanogramma phaseoli (Tryon) is a serious pest of soybean infesting over 95 per cent plants in kharif and upto 60 per cent plants in Rabi season. The fly attacked the plants from the unifoliate leaf stage when symptoms like withering and drooping of the leaves with dirty greenish colour of leaves in the early part were displayed, but later on the symptoms were masked under optimum moisture condition of the soil. The infested tunnel in the stem turned red and was packed with the excretory matter, larvae and pupae (Gangrade, 1972-73).

Todd et al. (1973) reported the damage by green stink bug Nazara viridula L. to the developing seed of soybean.

Bhattacharjee (1977) reported that two species of leaf roller Lamprosema indicata F. and Lamprosema dimenalis Gn. sporadically caused considerable damage to crop of soybean in India. It appears that the out break occurs only sporadically because the pests are held in check by natural enemies.

2.2. Varietal Susceptibility

Rawat et al. (1967-68) reported stemfly Melanagromyza phaseoli Tryon in 5 varieties of soybean namely Harosoy, Clark-63, Wayne, Shelly and local Seoni yellow. They reported maximum infestation (32.98%) in Harosoy, lowest infestation (2.97%) in local Seoni yellow, and moderate infestation (28.09%) in Wayne variety.

During 1968, they screened 13 varieties of soybean on the basis of population of larvae and pupae per 5 randomly selected plants. Out of these, 4 varieties namely Hampton, IC-130004, BC-14474 and Hardae were found to be less susceptible (0.75 to 1.75 larvae and pupae). Five varieties viz., Bragg, Tiachung, Wayne, Pb-1 and Seemans were intermediately susceptible (2.75 to 4.75 larvae and pupae), while 4 varieties viz., Clark-63, Dare, Imp-pelican, and Hill were most susceptible (7.75 to 13.25 larvae and pupae).

Gangrade (1970) reported susceptibility of 20 different varieties of soybean against the major pest including stemfly Melanagromyza phaseoli (Tryon). He reported 61.87 per cent to 100 per cent infestation in different varieties of soybean at harvest.

Gangrade (1970) reported the appearance of leaf folder on soybean in both kharif and rabi seasons. The number of

larvae per 100 plants ranged from 2.85 to 14.47 and per cent damaged plants varied from 1 to 10 among 20 different varieties tested.

Beohar et al. (1979-80) reported the variety JS 72-44 to harbour comparatively less pest population except that of stemfly whose infestation was lowest in Kalitur variety.

Jakhmola et al. (1980-81) reported susceptibility of different soybean varieties namely T-49, JS 72-148, JS 76-188, Pb-1, JS 72-44, EC-1116082, Kalitur, JS 75-1, JS-2, JS 72-280, JS 72-73, Ankur and Bragg. The variety JS-2 was found to be less infested by leaf miner (14.33 larvae/30 plants) followed by the varieties Pb-1, JS 72-73, JS 75-1 (15.16 to 16.49 larvae/30 plants).

Kawatheker (1981-82) reported the susceptibility of 18 different varieties of soybean against the leaf miner. He observed that JS 75-46 was the least susceptible variety while Bragg and JS 75-134 were found to be most susceptible varieties.

Bhattacharya (1982-83) reported the susceptibility of 18 soybean varieties against leaf miner Stomopteryx subsecivella Zellor. The variety JS 75-46 was found to be less infested by the pest followed by JS 72-44.

Bhattacharjee (1982-83) reported susceptibility of 12 varieties against leaf miner. Among the six varieties found least susceptible to the pest JS 72-44 was one, in which population was 1.06/plant. Among five varieties found moderately susceptible to pest were JS-2 and JS 76-259 in which population varied from 1.15 to 1.89 larvae/plant.

Thombre (1982-83) reported susceptibility of nine different varieties of soybean against the leaf miner. Out of 9 varieties, JS-2 was found to be least susceptible in which population was 1.91/plant while JS 72-44 was found most susceptible in which population was 2.44/plant.

Bichoo (1982-83) tested 12 varieties of soybean against girdle beetle. The variety JS 72-128 was found to be least susceptible while JS-2, JS 72-44, were found to be the three varieties among 6 varieties reported to be moderately susceptible.

2.3. Chemical Control

Shrivastav (1971) reported effect of insecticidal treatment on the yield of Bragg variety of soybean. In treated plot spraying was done with a mixture of dimethoate 0.03% and diazinon 0.03% in the ratio of 1:1. The treated crop gave an average increase of 42.06% yield over the check crop.

Kapoor et al. (1971) reported the effect of infestation by girdle beetle Oberes brevis Swed. on pod and yield of soybean, in Bragg variety. Crop was sprayed with endosulfan (Thiodan) 35% EC in the conc. of 0.05% at a regular interval of 15 days until the crop was harvested. Adjoining plot served as control. The average number of pods and grains from healthy plants were significantly more than those from beetle infested plants. The average yield per plant was 9.35.

Gangrade (1971) evaluated the effect of insecticidal spray on stemfly besides other insects of soybean. Among nine foliar insecticides the percentage plant infestation was significantly less in Nuvaeron (Monocrotophos) 0.04%.

Gangrade (1969-71) observed the effect of soil insecticides on arthropod pests of soybean and yield. Out of nine insecticides tested, phorate proved better as soil insecticide in respect of sucking insects, but EHC was better though not the best in respect of the stemfly. The length of stem damaged by the stemfly was lowest in phorate. No significant differences were found between the yield of insecticidal treatment and untreated check plot.

Gangrade (1972-73) evaluated the effect of granular and foliar insecticides against the stemfly and other insects. He observed significantly less plant infestation in phorate

(23.33%) followed by disyston (28.85%) and BHC (43.33%) which were significantly less infested in comparison to dimethoate 0.03% and control. The average length of damaged stem was highest in control plot (212.66%) as compared to insecticides among which phorate had lowest (44%) length of damaged stem. In dimethoate, the average length of damaged stem (126.33%) was observed.

Kapoor et al. (1973) carried out a trial on chemical control of stemfly Melanagromyza phaseoli Tryon both by foliar and soil insecticides. Among 6 foliar treatments, Monocrotophos 0.04%, dimethoate 0.03% and endosulfan 0.05% provided complete protection of crop against stemfly, whereas Monocrotophos and dimethoate gave the highest yield.

Gangrade (1973) observed that infestation of soybean by girdle beetle Oberea brovis Swed. was effectively checked by spray of endosulfan (35 EC) 0.05%, Methyldemeton (30 EC) 0.03% and dimethoate (35 EC) 0.05%. Endosulfan was significantly more effective than monocrotophos (40 EC) 0.04% and trichlorophos 0.03%.

Rawat et al. (1977-79) reported chemical control of leaf folder Lamprosema indicata F. by both, the foliar and soil insecticides. Among foliar treatments, Monocrotophos 0.04% provided complete protection to soybean crop against

the leaf folder. Among 6 soil insecticides parathion 2% was most effective even upto one week after the treatment.

Thombre (1982-83) reported relative efficacy of different insecticides against leaf folder Lamprosema indicata F. Out of 7 insecticides, the monocrotophos 0.05% was found to be highly effective even upto 7 days after the treatment. Cypermethrin 0.01% was also equally effective against the leaf folder.

2.4. Correlation Studies

Gangrade (1970-71) studied the correlation between the average tunnel length in 40 plants and yield of these plants. Negative correlations were obtained, however, the correlation was not significant between varieties.

Bhattacharya and Rathore (1979) reported at Pantnagar the correlation between tunnel length and various other characters including plant height, number of pods/plant, grain weight and weight/grain. It was concluded that tunnel length fails to show direct loss in the yield of soybean grain.

CHAPTER-III

MATERIALS AND METHODS

3.1. Study on the incidence of different insect pests appearing on soybean crop

A regular survey was carried out at 15 days interval to record the insect pests of soybean grown on research farm throughout the kharif season of 1982. The insect pests appearing on crop right from early stage upto harvest were recorded, and their status on the basis of their incidence and damage caused was determined.

For observations, 20 plants were randomly selected from the field and population of different insect pests was assessed and number of plant damage was also noted. The observations were taken on the basis of nature of damage exhibited by each pest species as detailed below:

3.1.1. Stem borers

3.1.1.1. Girdle beetle, *Oberoa brevis* Swed.

The beetle damage was identified by the presence of girdle in stem of soybean. Due to girdle formation the portion of the stem above the girdle became dry. The larvae of beetle subsequently made tunnel in stem and hollowed it upto the base of the plant.

FIG 2 A



Fig- STEM DAMAGE BY Metopnagromyza phaseoli Tryon

FIG 2 B



Fig. GIRDLES MADE BY A FEMALE GIRDLE BEETLE

3.1.1.2. Stemfly, Melanagromyza phaseoli Tryon

The fly is dark metallic green in colour. The larvae attack the stem of young soybean plants at a point in level with the surface of ground, causing the plants to wilt and the stem to decay. The symptoms of its were wilting and yellowing of the leaves.

3.1.2. Defoliators

3.1.2.1. Tobacco caterpillar, Prodenia litura F.

The leaves of tobacco caterpillar were dark in colour, 25 to 30 mm in length, with conspicuous rows of yellow and black specks on dorsal lateral sides and black dots laterally, larvae fed on the epidermis leaving the main veins and thus skeletonizing the leaves.

3.1.2.2. Gram pod borer, Heliothis armigera Fb.

The larvae are usually light green with longitudinal strips of various colour like black pink brown, yellowish green etc. The larvae fed on leaves of soybean plants.

3.1.2.3. Leaf miner, Stomopteryx subsecivolla Zeller

The larvae of leaf miner were generally present in the epidermis of the leaves. The larvae are light green colour



Fig. 3 . Cup-shaped mine with a larvae
of the leaf-miner, *Stomopteryx*
subsecivella Zeller



Fig.4A. Lamprosema indicata F



Fig.4B. Injury by the larvae of Lamprosema indicata F

with black head. Larvae mined the leaf of soybean by making the elongate narrow tunnel. These tunnels indicated the larval presence. The damage of leaf miner could easily be identified by the presence of cup-shaped, structure of the leaf.

3.1.2.4. Leaf folder, Lamprosema indicata F.

The larvae of leaf folder were generally present on leaves. The larvae have the habits of feeding the leaves either from the tip inwards or along mid-rib and securing the fold with the help of a white resinous gum exuded.

3.1.2.5. Semilooper, Plusia orichalcea Fb.

The larvae are pale greenish white colour and feed singly on the soft tissue, leaving the veins.

3.1.3. Sucking insects

3.1.3.1. Green bug, Nazara viridula L.

Adults of bug are green in colour, both the adult and nymphs of which fed on green seeds by piercing the developing pods and seeds.

3.1.3.2. Jassids, Empoasca sp.

These are tiny green or dark green coloured, soft bodies insects. Both adult and nymphs sucked the cell-sap from the young cotyledonous leaves.

3.2. Varietal susceptibility of soybean to major insect pests

A field experiment was laid out on the Livestock Farm in the Soybean Project of Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, in Kharif 1982.

3.2.1. Number of treatments -- Twenty varieties

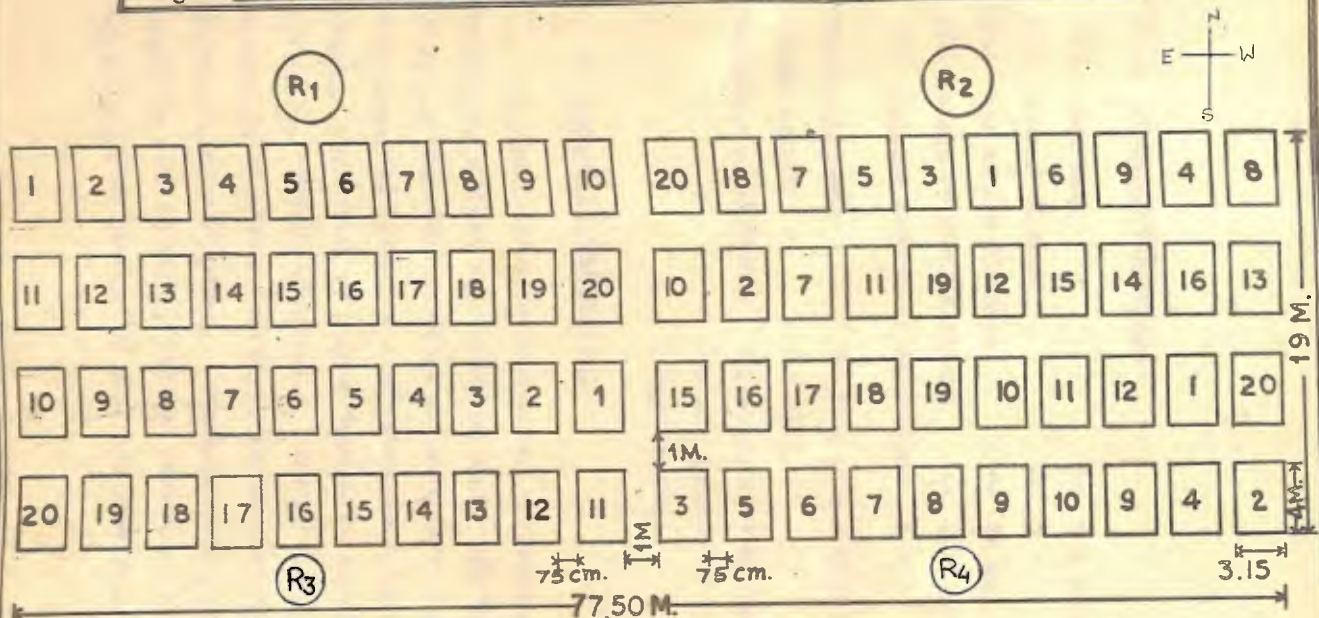
(1) JS 78-67	(11) JS 72-44
(2) JS 78-77	(12) Bragg
(3) JS 78-72	(13) JS 75-46
(4) JS 78-80	(14) JS 75-19
(5) JS 71-5	(15) Ankur
(6) JS-2	(16) JS 76-188
(7) Pb-1	(17) JS 76-205
(8) Cocker-stuart	(18) JS 76-259
(9) JS 72-185	(19) Kalitur
(10) JS 72-280	(20) T-49

3.2.2. Field specification and layout

Experimental design and layout was randomized block design with four replications. The details of layout and the randomized arrangement of treatment is shown in Fig. 5.

LAY OUT PLAN

Fig.5. VARIETAL SUSCEPTIBILITY OF SOYBEAN AGAINST MAJOR INSECT PEST



3.2.3. Plot specifications

- | | | |
|----------------------------------|----|------------|
| (i) Plot size | -- | 4 x 3.15 M |
| (ii) Number of rows | -- | 7 |
| (iii) Row to row distance | -- | 45 cm |
| (iv) Plant to plant distance | -- | 0.75 cm |
| (v) Spacing between replications | -- | 1 M |

Land requirement: 77.50 x 16 M = 1240 Sq. M.

Date of sowing: 7.7.1982

Fertilizer application: Superphosphate 40 kg/ha. Fertilizer was applied by broadcasting before sowing.

3.2.4. Method of observation

Observations were recorded at an interval of 15 days starting from first appearance of pest. For this purpose, 20 plants per plot were randomly selected from four places and total number of larvae of leaf miner and leaf folder were counted. The number of plants damaged by girdle beetle was also noted. The observations on stemfly were taken only at maturity on 10 plants randomly selected from each plot by splitting open each plant. Length of tunnel made by the stemfly in stem of each plant was also measured. Yield in g from 10 observed plants per plot was also recorded.

On the basis of larval counts and the damage observed, the varieties were categorised as:

- (i) Least susceptible
- (ii) Moderately susceptible
- (iii) Most susceptible

3.3. Chemical Control - Evaluation of some insecticides against the major pests of soybean

Seven insecticides as detailed below were tested in the field against major insect-pests of soybean. For this purpose, soybean variety JS 72-44 was sown on 7th July, 1982.

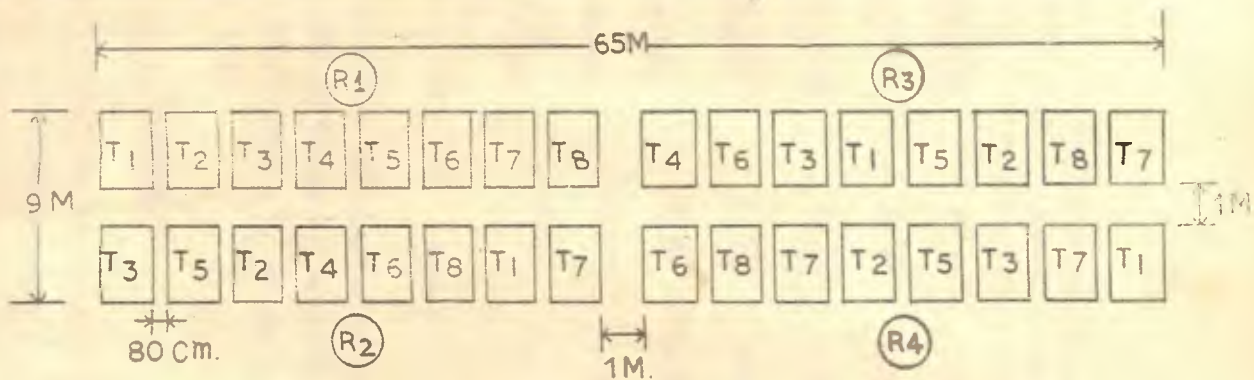
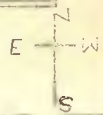
3.3.1. Field specifications and layout

Experimental design and layout was randomized block design. The details of layout and the randomized arrangement of treatments is shown in Fig. 6.

3.3.1.1. Plot specifications

(1) Plot size	---	3.2 x 4 M
(2) Number of rows per plot	---	8
(3) Row to row distance	---	40 cm
(4) Plant to plant distance	---	80 cm
(5) Plot to plot distance	---	80 cm
Land requirement	---	33.40 x 8 sq. M.

L A Y O U T P L A N →
 Fig.6. CHEMICAL CONTROL OF MAJOR INSECT PEST OF SOYBEAN CROP



S.No.	Treatments	Conc.	Spray	Quantity used/ litre
1.	Fenvalerate (Sumicidin)	20 EC	0.02%	1 ml
2.	Docamethin (Decis)	25 EC	0.004%	0.16 ml
3.	Cypermethrin (Cybus)	25 EC	0.009%	0.36 ml
4.	Monocrotophos (Nuvacron)	40 EC	0.04%	1 ml
5.	Thiodan (Endosulfan)	35 EC	0.07%	2 ml
6.	Rogor (Dimethoate)	30 EC	0.03%	1 ml
7.	Trizophos (Hostathion)	35 EC	0.07%	2 ml
8.	Control	-	-	-

The insecticides were applied in the field, with the appearance of pests on the crop. Observations were recorded 24 hours before and 24 hours, 72 hours, 7, 15 and 21 days after the treatments.

3.3.2. Method of observations

Observations were recorded on 25 plants per plot randomly selected from 5 different places on the number of larvae of leaf miner and leaf folder. Number of plants damaged by girdle beetle were also counted. At maturity the

observations on stemfly were taken on 10 plants randomly selected from each plot. Length of tunnel made in stem by the stemfly maggot in each plant was also measured after splitting open each plant. Yield of 10 observed plants were also recorded.

3.4. Statistical Analysis and Correlations

The data was subjected to statistically analysis after converting them in transformed values. The population data was transformed by $\sqrt{x + 0.5}$ value, while percentage data was transformed by angular transformation values. The data recorded in all the observations were pooled and analysed for knowing the significance of different treatments and observations. Following analysis of variance table was used:

S.No.	Source of variation	d.f.	S.S.	M.S.S.	FC	FR
1.	Block	(r-1)				
2.	Treatment	(t-1)				
3.	Error	(r-1)(t-1)				
	Total	rt-1				

Simple correlations were also worked out between tunnel length by stemfly Melanagromyza phaseoli Tryon. and yield, maturity days of varieties and population of leaf miner, leaf folder and per cent plant damage by girdle beetle and stemfly following the procedure suggested by Panse and Sukhatame (1957).

Following formula was used:-

$$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \frac{(\sum x)^2}{n} \right] \left[\sum y^2 - \frac{(\sum y)^2}{n} \right]}}$$

Linear relationship between y and x was also computed by following formulae:-

$$y = a + bx \dots\dots\dots (1)$$

RESULTS

4.1. Incidence of insect pests on soybean crop

The incidence of different insect pests on soybean was recorded at different stages of crop i.e. during vegetative stage, flowering and podding and at maturity.

The data on average population of different insect pests per 20 plants and per cent plant damage recorded at each stage of soybean crop are tabulated in table-1.

From table-1 it is evident that except leaf miner, leaf folder, girdle beetle and stemfly, the population of all other pests was very low during all stages of crop growth. The population of leaf miner and leaf folder was highest i.e. 10.93 larvae and 8.51 larvae/20 plants respectively during vegetative stage which subsequently decreased during flowering and podding stages of crop and was lowest during maturity (3.66 larvae and 1.75 larvae/20 plants). The average plant damage by both girdle beetle and stemfly was maximum during maturity stage of the crop (27.75 per cent and 25.52 per cent, respectively), while it was lowest during vegetative stage (11.43 per cent and 10.62 per cent respectively).

As regards other pests like tobacco caterpillar, green semilooper, gram pod borer, green pod bug, jassid and aphids,

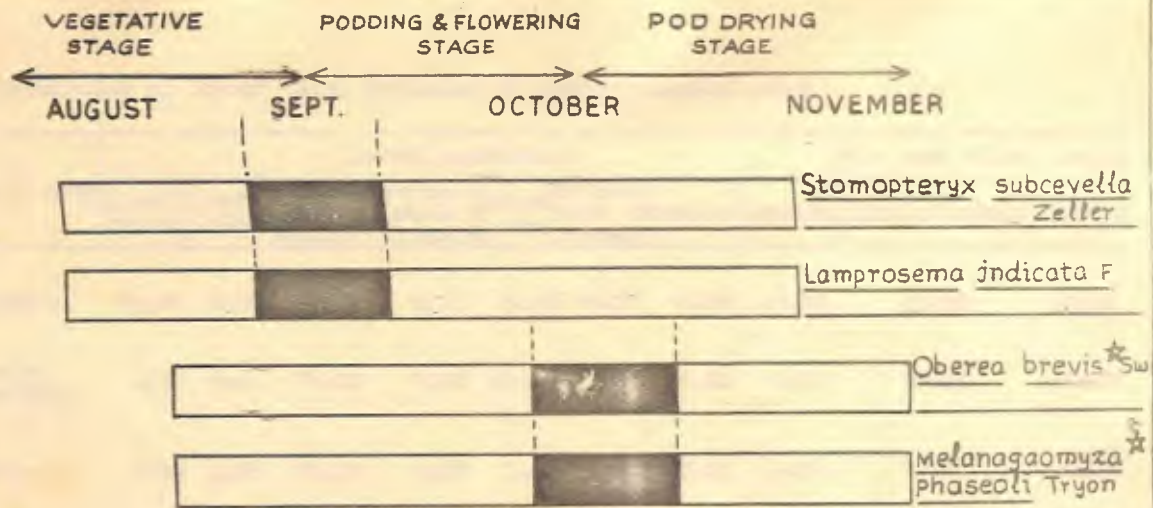


FIG. 7 . SCHEMATIC DIAGRAMME SHOWING APPEAREANCE OF INSECT PESTS ON SOYBEAN. CROP AND THE PERIOD OF THEIR ACTIVITY. SHADED AREA SHOWS THE PERIOD OF MAXIMUM ACTIVITY
★ MAJOR PESTS

Table-1: Population of insect pests appearing on soybean crop/20 plants.

S. No.	Stage of crop	Larval population							Per cent plant attack		
		Leaf miner	Leaf folder	Tobacco caterpillar	Green semi-looper	Green bug	Gram pod borer	Jassids	Aphids	Girdle beetle	Stemfly
1.	Vegetative	10.93	8.51	0.73	0.11	0.18	0.15	0.08	0.06	11.43	10.62
2.	Flowering and podding	7.37	5.41	0.11	0.08	10.50	0.06	0.03	0.05	20.66	15.62
3.	Maturity	3.66	1.75	0.29	0.02	1.00	0.03	0.01	0.03	27.75	25.52
Total		21.96	15.67	1.13	0.21	11.68	0.24	0.12	0.14	59.84	51.76
Mean		7.32	5.22	0.37	0.07	3.89	0.08	0.04	0.046	19.94	17.25

their population in general was very low. However, the population of these pests except that of green bug was relatively more during vegetative stage of the crop. The population of green bug was more during flowering and podding stages of the crop.

From the study on the incidence of different pests appearing during different stages of the crop growth, it appears that girdle beetle and the stemfly are the major pests on soybean crop at Jabalpur which may adversely affect the yield, while the leaf miner and leaf folder stand next inflicting losses to the crop by affecting the vitality of the plants during early stages of crop growth (Fig. 7).

4.2. Varietal susceptibility of soybean against major pests

Varietal susceptibility of 20 varieties of soybean was tested against major insect pests viz. leaf miner, leaf folder, girdle beetle and stemfly by taking three observations at an interval of 15 days.

4.2.1. Leaf miner, Stomopteryx subscivella Zeller.

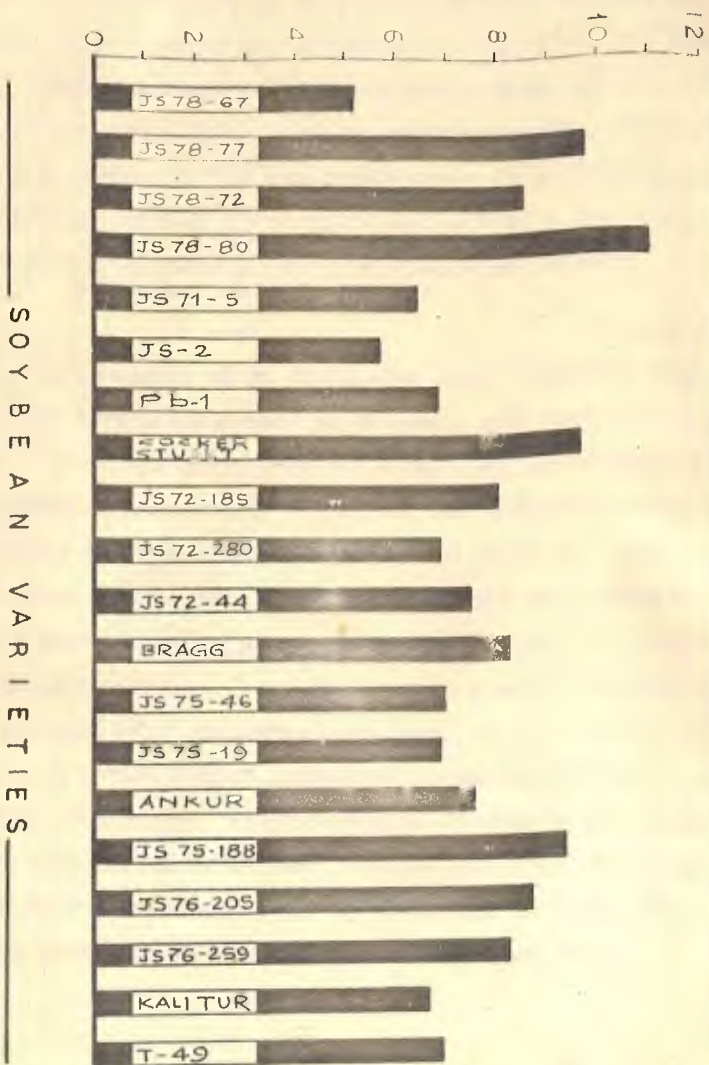
The data on average population of leaf miner/20 plants recorded in three observations are tabulated in table-2 (Fig. 6).

Table-2: Average population of leaf miner per 20 plants at 15 days interval (Average of 4 Replications).

S.No.	Name of varieties	1st observation	2nd observation	3rd observation	Total	Mean
1.	JS 75-67	7.50 (2.82)	5.00 (2.32)	3.00 (1.84)	15.50 (6.98)	5.15 (2.31)
2.	JS 78-77	13.50 (3.72)	8.00 (2.89)	7.75 (2.82)	29.25 (9.43)	9.75 (3.14)
3.	JS 78-72	15.25 (3.91)	7.50 (2.72)	3.00 (1.86)	25.75 (8.49)	8.58 (2.83)
4.	JS 78-80	18.75 (4.36)	10.20 (3.26)	4.25 (2.14)	33.20 (9.76)	11.06 (3.25)
5.	JS 71-5.	11.00 (3.38)	5.25 (2.34)	3.00 (1.81)	19.25 (7.54)	6.41 (2.51)
6.	JS-2	8.25 (2.94)	7.75 (2.81)	1.00 (1.18)	17.00 (6.93)	5.66 (2.31)
7.	Pb-1	10.75 (3.35)	7.75 (2.81)	2.00 (1.56)	20.50 (7.92)	6.83 (2.64)
8.	Cocker-stuart	15.00 (3.56)	11.25 (3.41)	2.75 (1.77)	29.03 (8.74)	9.67 (2.91)
9.	JS 72-185	13.50 (3.55)	7.75 (2.77)	3.00 (1.86)	24.50 (8.18)	8.08 (2.72)
10.	JS 72-280	10.75 (3.33)	8.25 (2.95)	1.75 (1.44)	20.78 (7.72)	6.91 (2.57)
11.	JS 72-44	7.25 (2.76)	10.75 (3.33)	4.25 (2.09)	22.20 (8.18)	7.40 (2.72)
12.	Bragg	12.50 (3.58)	9.50 (3.15)	2.75 (1.77)	24.75 (8.50)	8.25 (2.83)
13.	JS 75-46.	7.50 (2.78)	10.00 (3.22)	3.25 (1.89)	20.75 (7.89)	6.91 (2.63)
14.	JS 75-19	8.25 (2.93)	8.25 (2.92)	6.25 (2.32)	20.75 (8.17)	6.88 (2.72)
15.	Ankur	10.50 (3.39)	11.25 (3.40)	6.25 (2.54)	22.70 (8.11)	7.56 (2.72)
16.	JS 76-186	12.75 (3.43)	10.25 (3.25)	5.25 (2.37)	28.00 (9.23)	9.33 (3.07)
17.	JS 76-205	8.75 (3.02)	12.00 (3.51)	6.55 (2.43)	26.25 (8.75)	8.75 (3.00)
18.	JS 76-259	10.25 (3.24)	9.75 (3.09)	5.25 (2.33)	24.75 (8.66)	8.25 (2.89)
19.	Kalitur	9.00 (3.05)	10.25 (3.26)	3.25 (1.93)	20.00 (8.24)	6.66 (2.74)
20.	T-49	6.00 (2.51)	9.50 (3.13)	5.25 (2.37)	20.75 (8.21)	6.91 (2.67)
Mean		10.83 (3.27)	8.98 (3.02)	3.99 (2.01)		
Sig.		Sig.	Sig.	Sig.		
S.E.m ±		0.20	0.23	0.21		
C.D. at 5%		0.59	0.66	0.59		

Figures in parentheses are transformed $\sqrt{x + 0.5}$ values.

AVERAGE LARVAL POPULATION OF LEAF MINER



SOYBEAN VARIETIES

Fig. 8. AVERAGE POPULATION OF LEAF MINER ON DIFFERENT SOYBEAN VARIETIES

From the Table the differences in number of leaf miner, among different varieties in all three observations were significant. The population of leaf miner varied from time to time, and in between varieties also. During first observation the population of leaf miner varied from 6 in T-49 to 16.75 in JS 78-80. T-49 thus harboured significantly lowest population of leaf miner as compared to other varieties except JS 72-44, JS 75-46, JS 78-67, JS 75-19, JS-2, JS 76-205 and Kalitur in which population of leaf miner varied from 7.2 to 9.00. JS 78-80 on the other hand, harboured significantly maximum population of leaf miner as compared to other varieties except JS 78-72 in which population was 15.25. So these two varieties were found to be most susceptible. As regards other varieties, they were found to be intermediate in susceptibility.

During 2nd observation the population of leaf miner varied from 5 in JS 78-67 to 12 in JS 76-205. JS 78-67 thus, had significantly least population of leaf miner as compared to other varieties except JS 71-5, JS 78-72, JS 72-185, JS-2 and Pb-1 in which population of leaf minor was found to vary from 5.25 to 7.75. JS 76-205 on the other hand harboured significantly maximum population of leaf miner as compared to other varieties except JS 76-259, T-49, Bragg, JS 75-46, JS 76-188, Kalitur, JS 72-44, Ankur and Cocker-stuart in

which larval population varied from 9.50 to 11.25. As regards other three varieties, they were found to be intermediate in susceptibility.

During 3rd observation, the population of leaf miner varied from 1 in JS-2 to 7.7 in JS 78-77. JS-2 thus had significantly least population of leaf miner as compared to other varieties except in JS 72-280, Pb-1 and Cocker-stuart in which larval population varied from 1.75 to 2.75. JS 78-77 on the other hand harboured significantly maximum larval population of leaf miner as compared to other varieties except JS 75-19, JS 76-259, JS-188, T-49, JS 75-188, JS 76-205, Ankur in which larval population varied from 5.25 to 6.50. As regards remaining 9 varieties, they were found to be intermediate in susceptibility.

When the average larval population of all observations were taken into consideration, the variation in larval population of leaf miner due to time interval was found to be significant while that due to varieties and interaction between varieties and time interval was found to be nonsignificant. The average population of leaf miner was significantly more in 1st and 2nd observation (10.85 and 8.98 respectively) as compared to that in 3rd observation (3.99).

Taking into consideration the average larval population of leaf miner in all three observations taken together and

also that of each observation individually the varieties could be categorised as below:-

1. Least susceptible (Average population less than 7 larvae/20 plants):- JS-2, JS 78-67, Pb-1 and JS 71-5.
2. Most susceptible (Average population more than 9 larvae/20 plants):- JS 76-188, Cocker-stuart, JS 78-77 and JS 78-80.
3. Moderately susceptible (Remaining 12 varieties):- Kalitpur, JS 75-19, JS 72-280, JS 75-46, T-49, JS 72-44, Ankur, JS 72-185, Bragg, JS 76-259, JS 78-72 and JS 76-205.

4.2.2. Leaf folder, Lamprosema indicata F.

The data on average population of leaf folder/20 plants is presented in Table-3.

From the table the differences in number of leaf folder, among different varieties in all three observations except that in 2nd observation were significant.

During 1st observation the population of leaf folder varied from 5 in JS-2 to 18.25 in JS 78-80. JS-2 thus harboured significantly least population of leaf folder as compared to other varieties except Pb-1, JS 72-44, JS 75-46 in which population varied from 3.75 to 6. JS 78-80 thus harboured significantly maximum population of leaf folder as compared

Table-3: Average population of leaf folder per 20 plants at 15 days interval (Average of 4 Replications).

S.No.	Name of varieties	1st observation	2nd observation	3rd observation	Total	Mean
1.	JS 76-67	9.25 (2.89)	5.75 (2.44)	1.75 (1.56)	16.75 (6.89)	5.58 (2.39)
2.	JS 78-77	7.50 (2.69)	5.75 (2.48)	5.20 (2.34)	18.45 (7.51)	6.15 (2.50)
3.	JS 76-73	14.75 (3.88)	10.00 (3.19)	3.00 (1.80)	27.75 (8.87)	9.25 (2.95)
4.	JS 78-80	10.25 (4.30)	5.75 (2.47)	1.75 (1.47)	25.75 (8.24)	8.58 (2.74)
5.	JS 71-5	9.25 (3.11)	5.50 (2.35)	0.75 (1.05)	15.50 (6.51)	5.16 (2.17)
6.	JS-2	3.15 (1.88)	5.00 (2.52)	0.50 (0.96)	8.65 (5.09)	2.88 (1.69)
7.	Pb-1	3.75 (2.02)	6.50 (2.56)	1.25 (1.88)	11.50 (5.77)	3.83 (1.92)
8.	Cocker-stuart	9.50 (3.13)	6.25 (2.57)	1.50 (1.31)	17.50 (7.01)	5.75 (2.38)
9.	JS 72-185	11.00 (3.53)	6.50 (2.61)	2.25 (1.47)	19.75 (7.43)	6.58 (2.47)
10.	JS 72-280	10.00 (3.23)	6.75 (2.65)	2.25 (1.53)	19.00 (7.51)	6.33 (2.50)
11.	JS 72-44	5.00 (2.28)	7.29 (2.74)	3.20 (1.92)	15.40 (6.94)	5.13 (2.31)
12.	Bragg	8.25 (2.88)	7.25 (2.77)	1.25 (1.17)	16.75 (6.82)	5.58 (2.27)
13.	JS 75-46	6.00 (2.52)	7.25 (2.64)	0.25 (0.83)	13.50 (5.99)	4.50 (1.99)
14.	JS 75-19	8.00 (2.67)	6.75 (2.89)	0.75 (1.05)	15.50 (6.61)	5.16 (2.20)
15.	Ankur	10.75 (3.34)	9.75 (3.19)	1.75 (1.09)	21.25 (7.62)	7.08 (2.54)
16.	JS 76-188	11.00 (3.91)	7.50 (2.79)	1.50 (0.96)	20.00 (7.66)	6.66 (2.55)
17.	JS 76-205	11.25 (3.23)	8.75 (3.01)	1.80 (1.34)	21.50 (7.58)	7.16 (2.52)
18.	JS 76-259	11.50 (3.35)	8.00 (2.88)	1.70 (1.47)	21.20 (7.70)	7.06 (2.56)
19.	Kalitur	9.25 (3.09)	6.20 (3.12)	1.20 (1.25)	19.65 (7.46)	6.55 (2.48)
20.	T-49	9.75 (3.17)	8.00 (2.89)	0.50 (0.92)	18.25 (6.98)	6.08 (2.32)
Mean		9.36 (3.04)	7.17 (2.73)	3.28 (1.64)		
Sig.		Sig.	N. Sig.	Sig.		
S.E.m ±		0.21	-	0.18		
C.D. at 5%		0.61	-	0.52		

Figures in parentheses are transformed $\sqrt{x + 0.5}$ values.

AVERAGE POPULATION OF LEAF FOLDER

SOYBEAN VARIETIES

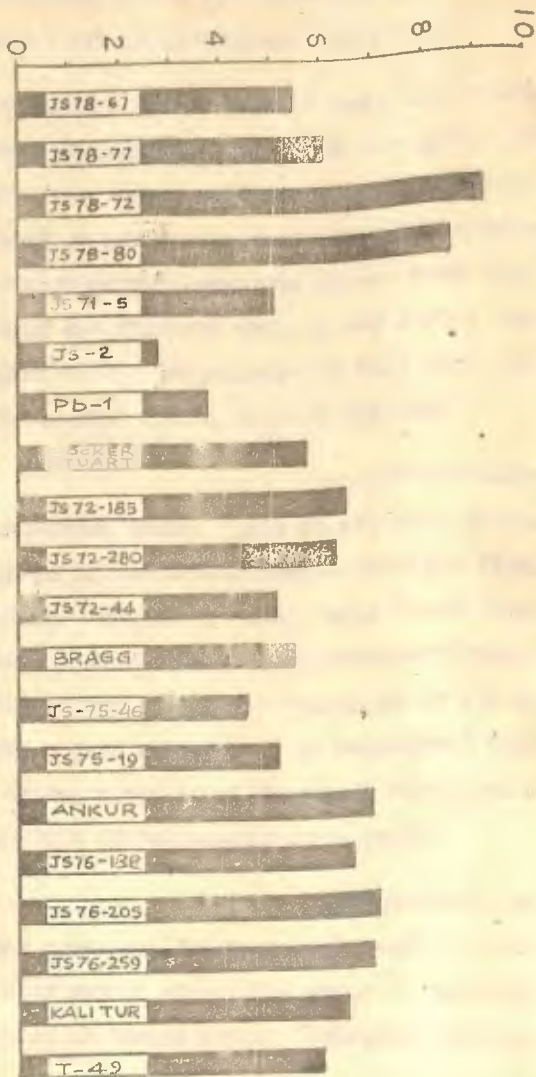


Fig. 9
AVERAGE POPULATION OF LEAF FOLDER ON DIFFERENT SOYBEAN VARIETIES

to other varieties except Ankur, JS 72-185, JS 76-259 and JS 78-72 in which population varied from 10.75 to 14.75. As regards other 12 varieties, they were found to be intermediate in susceptibility.

During 2nd observation the population of leaf folder varied from 5 in JS-2 to 10 in JS 78-72. During 3rd observation population of leaf folder varied from 0.25 in JS 75-46 to 5.2 in JS 78-77. JS 75-46 thus harboured significantly least population of leaf folder as compared to other varieties except T-49, JS-2, JS 76-188, JS 71-5, Ankur, Bragg, Fb-1, Kalitur, Cocker-stuart and JS 76-205 in which population varied from 0.5 to 1.50. Other varieties were found to be most susceptible.

When the average larval population of all observations was taken into consideration, the variation in population of leaf folder due to time interval was found to be significant while that due to varieties and interaction between time interval and varieties were found to be nonsignificant. The average population of leaf folder was significantly more in 1st (9.36) and 2nd (7.17) observation which was significantly more as compared to that in 3rd observation (3.28).

Taking into consideration the average larval population of leaf folder of all three observations taken together

and also that of each observation individually, the varieties could be categorised as below:-

1. Least susceptible (Average population less than 6 larvae/ 20 plants):- JS-2, Pb-1 and JS 75-46.
2. Most susceptible (Average population more than 7 larvae/ 20 plants):- JS 76-259, JS 78-80 and JS 78-72.
3. Moderately susceptible (Remaining 14 varieties):- JS 72-44, JS 71-5, JS 78-67, Bragg, JS 75-19, Cocker-stuart, T-49, JS 78-77, JS 72-280, Kalitur, JS 72-185, JS 76-188, Ankur and JS 76-205.

4.2.3. Girdle beetle, Oberia brevis Swed.

The data on average percentage plant damage by girdle beetle are given in table-4.

From the table it is clear that the differences in plant damage among different varieties in all three observations were significant.

During 1st observation the plant damage by girdle beetle varied from 3.75 per cent in T-49 to 35 per cent in JS 78-72. T-49 thus had least plant infestation as compared to three varieties viz. Cocker-stuart, JS 78-77 and JS 78-72, in which plant infestation varied from 17.50 per cent to 35

Table-4: Average per cent plant attack by girdle beetle/20 plants at 15 days interval (Average of 4 Replications).

S.No.	Name of varieties	1st observation	2nd observation	3rd observation	Total	Mean
1.	JS 78-67	12.50 (20.17)	21.25 (27.05)	40.00 (38.70)	73.75 (85.92)	24.58 (28.64)
2.	JS 78-77	22.50 (24.67)	36.25 (36.74)	51.25 (45.74)	110.00(107.15)	36.66 (35.71)
3.	JS 78-72	35.00 (35.92)	42.50 (40.50)	51.25 (45.72)	128.75(122.14)	42.91 (40.71)
4.	JS 78-80	10.00 (18.14)	25.00 (29.14)	38.75 (37.98)	73.75 (85.26)	24.58 (28.42)
5.	JS 71-5	16.25 (22.73)	37.50 (37.46)	41.25 (40.92)	95.00(101.11)	31.66 (33.70)
6.	JS-2	5.00 (12.92)	12.50 (18.14)	28.75 (32.25)	46.25 (63.31)	15.41 (21.10)
7.	Pb-1	5.00 (12.92)	12.50 (20.61)	23.75 (29.08)	41.25 (62.61)	13.75 (20.87)
8.	Cocker-stuart	17.50 (24.44)	21.25 (27.33)	80.00 (33.15)	68.75 (84.92)	22.91 (28.30)
9.	JS 72-185	10.00 (13.28)	31.25 (33.27)	36.25 (36.76)	77.50 (83.31)	25.83 (27.77)
10.	JS 72-280	9.00 (10.57)	12.50 (20.47)	21.25 (27.33)	37.75 (56.37)	12.58 (19.48)
11.	JS 72-44	8.75 (16.16)	17.50 (24.44)	25.00 (29.76)	51.25 (70.96)	17.08 (23.55)
12.	Bragg	5.25 (12.15)	27.50 (31.51)	32.50 (34.60)	65.25 (78.26)	21.75 (26.08)
13.	JS 75-46	5.25 (14.30)	33.75 (39.94)	48.75 (44.20)	87.75 (98.44)	29.25 (32.81)
14.	JS 75-19	8.75 (17.06)	27.50 (31.37)	35.00 (28.60)	71.25 (77.93)	23.75 (25.67)
15.	Ankur	9.75 (11.53)	25.00 (29.28)	32.50 (35.20)	66.25 (76.01)	20.08 (25.33)
16.	JS 76-188	11.25 (16.94)	16.25 (23.58)	26.25 (30.74)	53.75 (71.26)	17.91 (23.75)
17.	JS 76-205	8.75 (14.48)	20.00 (26.33)	30.00 (33.07)	58.75 (73.88)	19.58 (24.70)
18.	JS 76-259	8.75 (14.48)	40.00 (39.23)	36.25 (42.83)	85.00 (96.54)	28.33 (32.18)
19.	Kalitur	6.25 (12.45)	22.50 (26.46)	31.25 (33.27)	60.00 (72.18)	20.00 (24.06)
20.	T-49	3.75 (7.84)	12.50 (19.95)	23.75 (28.90)	40.00 (56.69)	13.33 (18.89)
Mean		10.66 (16.68)	24.75 (29.14)	34.16 (35.44)		
Dig.		Sig.	Sig.	Sig.		
S.E.m ±		4.30	3.41	3.25		
C.D. at 5%		12.28	9.71	9.18		

Figures in parentheses are Angular transformed values.

per cent. JS 78-12 thus had maximum plant infestation as compared to other varieties except Cocker-stuart and JS 78-77.

During 2nd observation plant infestation varied from 12.50 per cent in JS-2 to 42.50 per cent in JS 78-72. JS-2, thus had least plant infestation as compared to other varieties except T-49, JS 72-280, Pb-1, JS 76-188, JS 72-44, JS 76-205, Kalitur, JS 78-67 and Cocker-stuart in which plant infestation varied from 12.50 per cent to 21.25 per cent. JS 78-72 thus had maximum plant infestation as compared to other varieties except JS 75-19, Bragg, JS 72-185, JS 78-77, JS 71-5, JS 76-259 and JS 75-46, in which plant infestation varied from 27.50 per cent to 40.7 per cent. Remaining two varieties viz. JS 78-80 and Ankur were found to be intermediate in susceptibility.

During 3rd observation, plant infestation varied from 27.33 per cent in JS 72-280 to 51.25 per cent in both JS 78-77 and JS 78-72. JS 72-280, thus had least plant infestation as compared to other varieties except JS 75-19, T-49, Pb-1, JS 72-44, JS 76-188, JS-2, JS 76-205, Cocker-stuart, Kalitur, Bragg and Ankur in which plant infestation varied from 28.60 per cent to 32.50 per cent. JS 78-77 thus had maximum plant infestation as compared to other varieties except JS 78-80, JS 78-67, JS 71-5, JS 76-259, JS 75-46 and JS 78-72 in which plant infestation varied from 38.75 per cent to 51.25 per

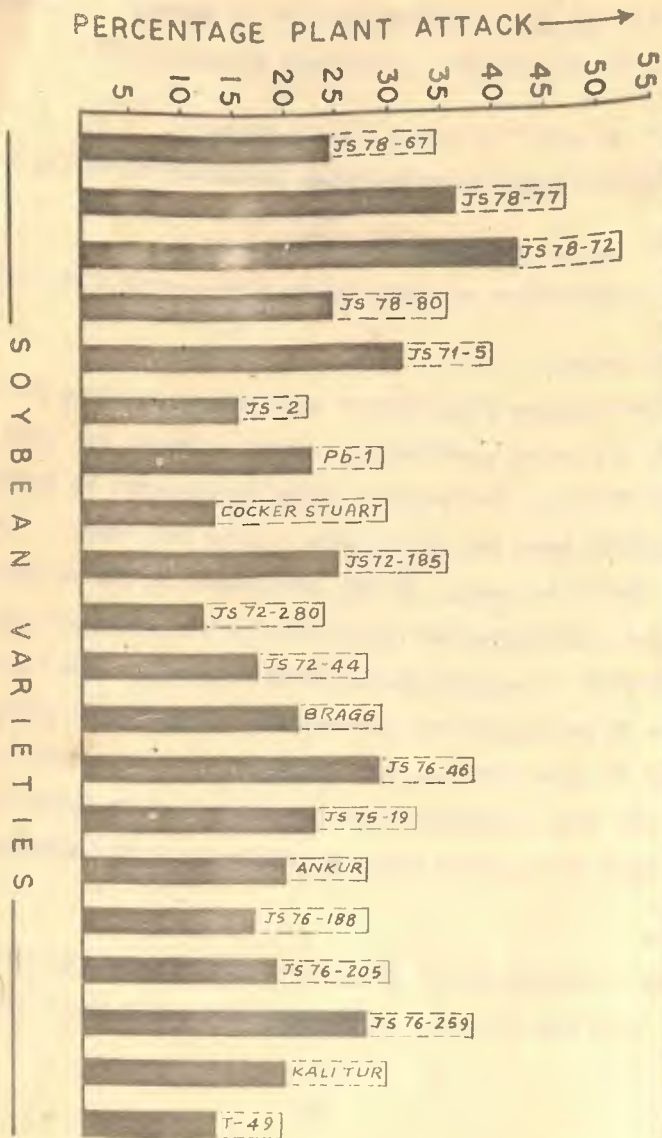


FIG. 10. PERCENTAGE PLANT ATTACK BY GIRDLE BEETLE

cent. Only one variety, JS 72-185, was found to be intermediate in susceptibility, in which plant infestation was 26.25 per cent.

When the average plant infestation of all observations were taken into consideration, the variation in plant infestation due to time interval was found to be significant while that due to varieties and interaction between time interval and varieties were found to be nonsignificant. The percentage plant infestation by girdle beetle was significantly highest (34.18 per cent) in 3rd observation which significantly differed from 1st observation (10.66 per cent). Taking into consideration the average plant infestation by girdle beetle of all three observations taken together and also that of each observation individually the varieties could be categorised as below:

1. Least susceptible (Average plant infestation less than 16%):- JS 72-80, T-49, Pb-1 and JS-2.
2. Most susceptible (Average plant infestation more than 30%):- JS 71-5, JS 78-77 and JS 78-72.
3. Moderately susceptible (Remaining 13 varieties):- JS 78-67, JS 78-80, Cocker-stuart, JS 72-185, JS 72-44, Bragg, JS 75-46, JS 75-19, Ankur, JS 76-188, JS 76-205, JS 76-259 and Kalitur.

4.2.4. Stemfly, Melanagromyza phaseoli Tryon.

The data on average plant infestation, the per cent length tunnelled by pest recorded per 10 plants in each variety along with the yield are tabulated in table-5.

From the table it is clear that the differences in per cent plant damage among different varieties were significant. The plant damage by stemfly varied from 7.5 per cent in Kalitur to 30.00 per cent in JS 75-46. The variety Kalitur had least plant infestation by stemfly as compared to 5 varieties viz. JS 78-80, Bragg, JS 72-44, Pb-1 and JS 75-19 in which the plant infestation varied from 25 per cent to 27.5 per cent. JS 75-46 had maximum plant infestation as compared to Kalitur.

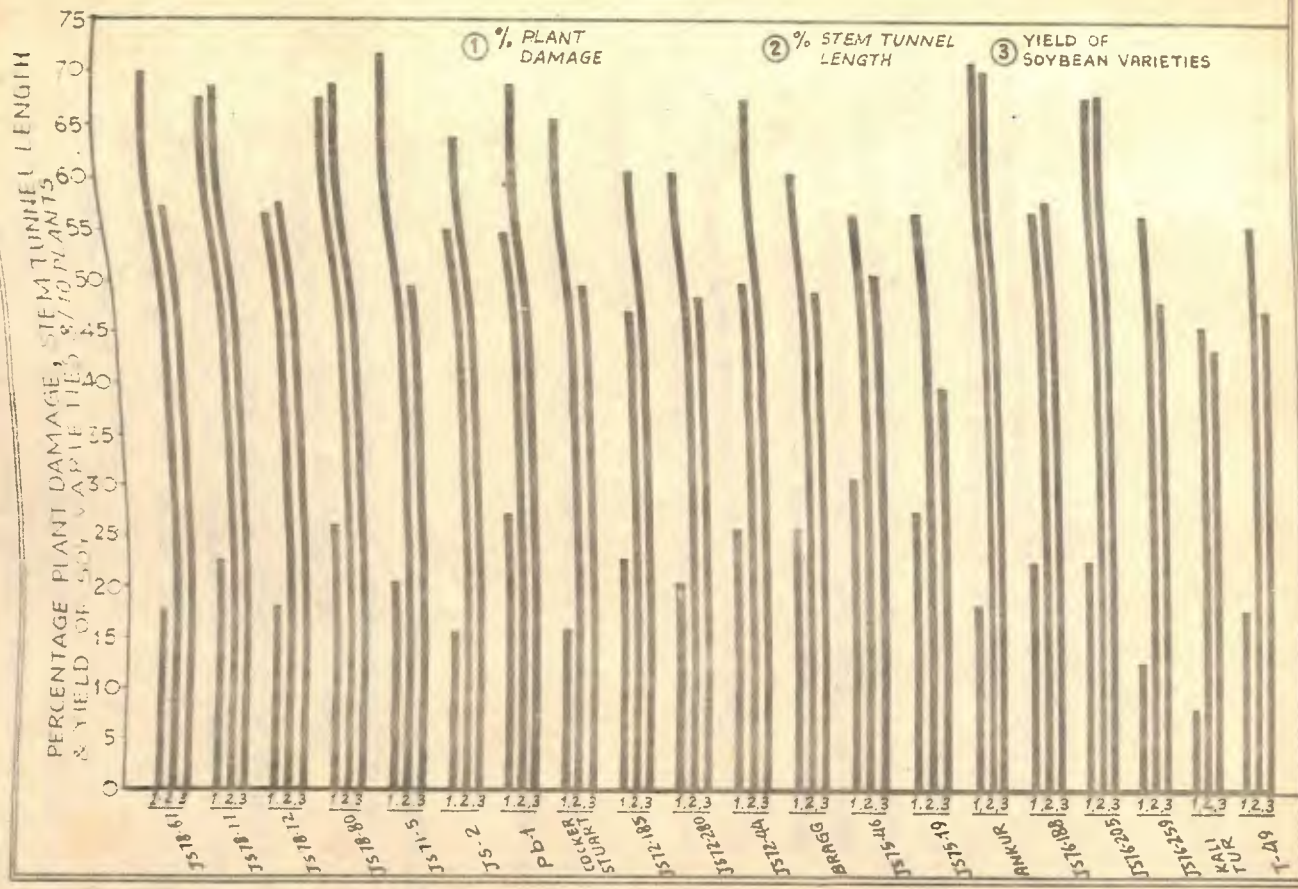
The differences in percentage stem tunnelled among different varieties were significant. The tunnel length by stemfly varied from 45.7 per cent in Kalitur to 69.77 per cent in JS 78-67. Kalitur, thus had significantly least per cent stem tunnelled as compared to other varieties except JS 72-185, JS 72-44, T-49, JS 75-19, JS 78-72, JS 76-188, JS-2 and Pb-1. The last one, however, was at par with 78-67 which had significantly maximum stem length tunnelled (69.77 per cent). The differences in yield of 10 plants among different varieties were significant. The yield per 10 plants

Table-5: Average per cent plant infestation, the per cent length tunnelled and yield of soybean varieties in g/10 plants (Average of 4 Replications).

S. No.	Name of varieties	Percentage plant damaged by stemfly	Percentage of stem tunnel length	Yield in g/10 plants
1.	JS 78-67	17.50 (21.05) *	69.77 (59.07) *	51.27
2.	JS 78-77	22.50 (27.69)	67.80 (53.85)	68.95
3.	JS 78-72	17.50 (21.05)	56.92 (49.01)	57.90
4.	JS 78-80	25.00 (29.36)	67.82 (55.51)	68.35
5.	JS 71-5	20.00 (23.20)	71.10 (57.64)	49.67
6.	JS-2	15.00 (19.55)	57.25 (49.25)	68.65
7.	Pb-1	27.50 (30.80)	59.12 (50.31)	68.96
8.	Cocker-stuart	15.00 (22.50)	65.92 (51.42)	49.65
9.	JS 72-185	22.50 (27.33)	46.90 (43.20)	60.32
10.	JS 72-280	20.50 (21.05)	60.85 (51.36)	48.72
11.	JS 72-44	25.00 (29.72)	49.67 (44.80)	67.10
12.	Bragg	25.00 (29.36)	60.90 (51.34)	48.23
13.	JS 75-46	30.00 (32.52)	66.15 (54.54)	50.75
14.	JS 75-19	27.50 (31.02)	56.51 (48.75)	39.25
15.	Ankur	17.50 (21.05)	70.40 (57.14)	69.40
16.	JS 76-188	22.50 (27.69)	56.90 (49.04)	57.12
17.	JS 76-205	17.50 (21.05)	67.81 (55.51)	67.27
18.	JS 76-259	12.50 (17.89)	56.92 (49.08)	48.35
19.	Kalitur	7.50 (11.25)	48.70 (42.22)	43.00
20.	T-49	17.50 (24.96)	54.54 (48.22)	47.75
Sig		Sig	Sig	Sig
S.E.m \pm		6.19	2.98	5.69
C.D. at 5%		17.65	8.46	16.79

* Angular transformed value

FIG. 11. PERCENTAGE PLANT DAMAGE PERCENTAGE STEM TUNNEL LENGTH CAUSED BY STEM FLY & YIELD OF SOYBEAN VARIETIES. 9/10 PLANTS



varied from 39.25 g in JS 75-19 to 69.40 g in Ankur. The variety Ankur recorded higher grain yield/10 plants as compared to other varieties except JS 78-72, JS 76-188, JS 72-185, JS 72-44, JS 76-205, JS 78-80, JS-2, Pb-1 and JS 78-77 in which yield varied from 57.90 g to 68.95 g. JS 75-19, on the other hand, recorded significantly lowest yield as compared to other varieties except Kalitur, T-49, Bragg, JS 76-259, JS 72-280, Cocker-stuart, JS 71-5, JS 75-46 and JS 78-67.

Taking into consideration the plant damage and per cent stem length tunnelled by stemfly, the varieties could be categorised as below:

1. Least susceptible (less than 10 per cent plant infestation and less than 46 per cent stem length tunnelled):-
Kalitur.
2. Most susceptible (more than 34 per cent plant infestation and more than 55 per cent stem length tunnelled):-
JS 75-19, Pb-1, Bragg, JS 75-46, and JS 78-80.
3. Intermediate in susceptibility (Remaining 14 varieties):-
JS-2, JS 78-67, JS 78-72, Cocker-stuart, Ankur, JS 76-259, T-49, JS 76-205, JS 71-5, JS 78-77, JS 72-185, JS 72-280, JS 76-188 and JS 72-44.

However, taking the overall picture of pest incidence in different varieties and their yield record, JS-2 and Pb-1 seemed to be most promising varieties.

4.3. Chemical control of major pests

The data on the average population of leaf miner, leaf folder and per cent plant damage by girdle beetle recorded in each treatment before ~~and~~ ^{after} insecticide application and at definite intervals after treatment are tabulated in tables 6, 7 and 8. The data on average plant damage and average per cent stem length ^{percent} tunnelled observed at harvest along with yield of grain recorded from 10 plants per treatment, are tabulated in table-9.

4.3.1. Leaf miner, Stomopteryx subscivella (Zeller)

The data on the average larval population of leaf miner are tabulated in table-6.

From the table it is clear that the differences in the number of leaf miner larvae among different treatments were not significant at 24 hours before and 21 days after the treatment. But the differences in population were significant in the post treatment observations taken at 72 hours, 7 and 15 days.

In pre-treatment observations, the pest population was equally distributed in the crop as is evident from its non-significance. Similarly, the insecticidal treatment did not appear to show their effects till 24 hours after treatment.

Table-6: Average population of leaf miner/25 plants (Average of 4 Replications).

S. No.	Treatment	72 hours	7 days	15 days	Total	Mean
1.	Fenvalerate	8.25 (2.91) *	7.20 (2.76) *	3.00 (1.84) *	18.45 (7.51)	6.15 (2.50)
2.	Decamethrin	7.25 (2.77)	7.00 (2.71)	3.25 (1.88)	17.50 (7.36)	5.83 (2.45)
3.	Cypermethrin	7.00 (2.80)	4.25 (2.16)	2.25 (1.65)	13.50 (6.61)	4.50 (2.20)
4.	Monocrotophos	7.00 (2.71)	5.20 (2.37)	2.25 (1.63)	14.45 (6.71)	4.81 (2.23)
5.	Thiodan	6.00 (2.49)	4.75 (2.20)	2.25 (1.65)	13.00 (6.34)	4.33 (2.11)
6.	Dimethoate	5.25 (2.34)	4.25 (2.16)	2.00 (1.56)	11.50 (6.06)	3.83 (2.02)
7.	Hostathion	4.00 (2.09)	4.00 (2.11)	1.50 (1.40)	9.50 (5.60)	3.16 (1.86)
8.	Control	10.25 (3.27)	10.00 (3.29)	8.75 (3.00)	29.00 (9.55)	9.66 (3.18)
Average		6.87 (2.67)	5.83 (2.48)	3.15 (1.82)		
S.Em ±		0.22	0.19	0.14		
C.D. at 5%		0.66	0.54	0.42		

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* Figures in parentheses are transformed $\sqrt{x + 0.25}$ values.



It also seems that different insecticides lost toxicity after 20 days.

72 hours after the treatment trizophos 0.07% was significantly most effective in reducing leaf miner population (4.00 larvae/25 plants) as compared to decomethrin 0.004%, Cypermethrin 0.009%, fenvalerate 0.02% and Control (7.25 to 10.25 larvae/25 plants). Next treatments in order of merit were dimethoate 0.03% and endosulfan 0.07% which showed their superiority over control.

7 days after treatment, trizophos 0.07% followed by dimethoate 0.03%, Cypermethrin 0.009%, endosulfan 0.07% and monocrotophos 0.04% were significantly most effective in reducing leaf miner population (4.00 to 5.20 larvae/25 plants) as compared to decamethrin, fenvalerate and Control (7.00 to 10 larvae/25 plants). The fenvalerate 0.02% was at par with control and was the least effective.

15 days after treatment, trizophos 0.07% again proved most effective in reducing the leaf miner population (1.50 larvae/25 plants) as compared to fenvalerate, decamethrin and Control (3.00 to 8.75). Next treatments in order of effectiveness were dimethoate, monocrotophis, Cypermethrin and endosulfan which did not differ significantly among themselves but were significantly superior to Control.

Taking into consideration the average larval population in different treatments and at different time interval, it was seen that differences in average larval population among different treatments and that of time interval were significant.

All insecticidal treatments except fenvalerate 0.02% proved to be significantly superior to control in reducing the larval population. Trizophos 0.07% followed by dimethoate 0.03% were the most effective treatments. The average larval population was significantly highest at 72 hours after treatment (6.87 larvae/25 plants) as compared to that at 15 days after treatment (3.15 larvae/25 plants). The differences in larval population between time interval of 72 hours and 7 days were not significant. It shows that larval population gradually declined till it was very low at 15 days after treatments.

4.3.2. Leaf folder, Lamprosema indicata F.

The data on average population of leaf folder in different treatments are tabulated in table-7.

From the table it is clear that the differences in the population of leaf folder among different treatments were not significant at 24 hours before and 21 days after the treatment. But the differences in population were significant

Table-7: Average population of leaf folder/25 plants (Average of 4 replications).

S.No.	Treatment	After treatment					Total	Mean
		24 hours	72 hours	7 days	15 days			
1.	Fen-valerate	3.75 (2.05)*	3.00 (1.84)*	2.25 (1.65)*	1.2* (1.38)*	10.25 (6.92)	2.56 (1.73)	
2.	Decamethrin	4.25 (2.16)	3.25 (1.93)	3.00 (1.84)	1.60 (1.47)	12.10 (7.53)	3.02 (1.88)	
3.	Cypermethrin	3.25 (1.93)	2.27 (1.78)	2.00 (1.56)	1.00 (1.18)	8.52 (6.45)	2.13 (1.61)	
4.	Monocrotophos	2.75 (1.75)	2.50 (1.69)	1.50 (1.40)	0.75 (1.09)	7.50 (5.59)	1.87 (1.39)	
5.	Thiodan	4.50 (2.21)	3.25 (1.93)	2.25 (1.63)	1.50 (1.40)	11.50 (7.17)	2.87 (1.79)	
6.	Dimethoate	4.00 (2.11)	3.00 (1.86)	2.00 (1.56)	1.00 (1.18)	10.00 (6.71)	2.50 (1.67)	
7.	Hostathion	5.00 (2.32)	3.00 (1.75)	2.25 (1.65)	1.50 (1.40)	11.75 (7.12)	2.93 (1.78)	
8.	Control	6.25 (2.50)	4.75 (2.22)	5.75 (3.00)	3.25 (1.79)	20.00 (9.65)	5.75 (2.41)	
Average		4.21 (2.13)	3.18 (1.88)	3.50 (1.78)	1.48 (1.36)			
Sig.	Sig.	Sig.	Sig.	Sig.				
S.E.m	0.12	0.11	0.14	0.13				
C.D. at 5%	0.36	0.32	0.41	0.38				

* Figures in parentheses are transformed $\sqrt{x + 0.5}$ values

in the post treatment observations taken at 72 hours, 7 and 15 days.

In pre-treatment observation, the population was equally distributed in the crop as is evident from its nonsignificance. The insecticidal treatments seemed to be effective till 15 days after treatment.

24 hours after treatment all insecticidal treatments except trizophos 0.07% proved significantly effective in reducing leaf folder population as compared to Control. Monocrotophos 0.04% followed by Cypemethrin 0.009%, fenvalerate 0.02% and dimethoate 0.03% were the most effective treatments. Trizophos 0.07% was at par with Control.

72 hours after the treatments, monocrotophos 0.04% followed by other insecticides again proved significantly most effective in reducing the population of leaf folder (2.50 larvae/25 plants) as compared to decamethrin 0.004% and Control (3.25 larvae to 4.75 larvae/25 plants).

7 days after the treatment monocrotophos followed by other insecticides again proved most effective in reducing the population of leaf folder as compared to decamethrin 0.004% and Control (8.75 larvae/25 plants).

15 days after the treatments the monocrotophos 0.04% followed by other insecticides except decamethrin 0.04% were

significantly most effective (0.75 larvae to 1.50 larvae/25 plants) as compared to Control (3.25 larvae/25 plants). Decamethrin was at par with Control.

Taking into consideration the average larval population in different treatments and different time intervals it was seen that differences in average larval population among different treatments and that of time interval were significant. All insecticidal treatments proved to be significantly superior to control in reducing the larval population. Monocrotophos 0.04% followed by Cypermethrin 0.009% were the most effective treatments. The average larval population was significantly highest at 24 hours after the treatments (4.21 larvae/25 plants) as compared to that at 15 days after treatments (1.48 larvae/25 plants). The population showed decreasing trend at different time intervals. The decrease in population was, however, significant only after 7 days.

4.3.3. Girdle beetle, Oberon brevis (Swed.)

The data on average plant damage by girdle beetle in different treatments are tabulated in table-6.

From the table it is clear that the differences in percentage plant damage was not significant at 24 hours before and 24 hours after the treatment but the same were significant at 72 hours, 7 and 15¹⁵ 21 days after treatment. In

Table-8: Average per cent plant infestation by Girdle beetle/25 plants (Average of 4 replications).

S.No.	Treatment	72 hours	7 days	15 days	21 days	Total	Mean
1.	Senvalerate	26 (30.60) *	29 (32.36) *	31 (33.73) *	33 (35.03*)	119 (131.72)	29.75 (32.93)
2.	Decamethion	24 (29.13)	28 (31.92)	30 (33.10)	30 (33.00)	112 (127.15)	28.00 (31.78)
3.	Cypermethrin	19 (26.83)	22 (27.85)	25 (29.83)	26 (30.48)	92 (114.99)	23.00 (28.74)
4.	Monocrotophos	18 (24.93)	21 (27.04)	22 (27.85)	23 (28.48)	84 (108.30)	21.00 (27.07)
5.	Endosulfan	19 (25.68)	22 (27.65)	26 (30.97)	27 (31.26)	94 (115.16)	23.50 (28.79)
6.	Dimethoste	18 (24.93)	22 (27.85)	28 (31.92)	28 (31.92)	96 (116.62)	24.00 (29.25)
7.	Trizophos	23 (28.63)	26 (30.50)	29 (32.36)	30 (33.00)	108 (114.98)	27.00 (28.74)
8.	Control	30 (33.20)	36 (36.85)	40 (39.22)	54 (47.16)	160 (156.43)	40.00 (39.40)
Mean		22.12 (27.99)	25.75 (29.62)	28.87 (31.13)	31.37 (33.79)		
S.E.m ±		Sig 1.64	2.07	1.90	2.06		
C.D. at 5%		4.81	6.12	5.61	6.09		

* Angular transformed values.

pre-treatment observations the plant damage was equally distributed in the crop as is evident from its nonsignificance.

72 hours after the treatment, monocrotophos 0.04% with 18.00 per cent plant damage proved to be significantly most effective followed by dimethoate 0.03%, endosulfan 0.07%, and Cypermethrin 0.009% as compared to fenvalerate 0.02% and Control (26 per cent to 30 per cent).

At 7 days, monocrotophos 0.04% was significantly most effective in reducing the plant damage (21 per cent) followed by endosulfan 0.07%, dimethoate 0.03%, cypermethrin 0.009% and trizophos 0.07% in reducing the plant damage as compared to decamethrin, fenvalerate and control (29 per cent to 36 per cent).

At 15 days, monocrotophos 0.04% again proved to be significantly most effective (22 per cent plant) followed by cypermethrin 0.009%, endosulfan 0.07%, dimethoate 0.03% and trizophos 0.07% in reducing the plant damage as compared to decamothrin, fenvalerate and control (28 to 36 per cent).

At 21 days after the treatment, monocrotophos 0.04% again proved to be significantly most effective (23 per cent) as compared to fenvalerate and control (33 to 54 per cent plant).

Taking into consideration the average plant damage in different treatments and different time intervals, it was seen that differences in average plant damage among different treatments and that of time interval were significant. All insecticidal treatments proved to be significantly superior to control in reducing the plant damage. Monocrotophos 0.04% followed by cypermethrin 0.009% were the most effective treatments (21 per cent to 23.00 per cent) as compared to control (40 per cent).

The average per cent plant damage was significantly highest at 15 and 21 days after the treatments (28.87 per cent and 31.37 per cent respectively). The plant infestation was thus, low which subsequently increased with time and was highest at 21 days after treatment.

4.3.4. stemfly, Melanagromyza phaseoli (Tryon.)

The data on average plant damage and average per cent stem length tunnelled and yield are tabulated in table-9.

From the table it is clear that differences in the percentage plant damage by stemfly among different treatments were significant. Monocrotophos 0.04% and dimethoate 0.03% with 12.50 and 17.50 per cent plant damage respectively were significantly most effective in reducing the plant infestation by stemfly as compared to control with 40 per cent plant

infestation. The differences in per cent stem tunnelled and yield of 10 observed plants among different treatments were also found to be significant.

Table-9: Average per cent plant infestation, the per cent length tunnelled by stemfly and yield of soybean in g/10 plants.

S.No.	Treatment	Percentage plant damage	Per cent plant stem length tunnelled	yield in g/10 plants
1.	Fenvalerate	27.50 (28.60)	56.90 (49.05)	53.30
2.	Decamethrin	30.00 (31.72)	67.80 (53.89)	60.90
3.	Cypermethrin	25.00 (29.36)	46.90 (43.20)	60.37
4.	Monocrotophos	12.50 (17.89)	45.70 (42.00)	75.02
5.	Endosulfan	22.50 (28.22)	59.12 (50.13)	66.52
6.	Dimethoate	17.50 (22.50)	49.25 (44.80)	70.87
7.	Trizophos	25.00 (29.36)	66.15 (54.54)	64.55
8.	Control	40.00 (39.16)	73.57 (59.11)	50.20
Sig.		Sig.	Sig.	Sig.
S.E.m \pm		4.06	3.34	3.76
C.D. at 5%		11.97	9.85	11.09

Figures in parentheses are Angular transformed values.

The stem length tunnelled by stemfly was significantly lowest in monocrotophos 0.04% followed by cypermethrin 0.009% (42.00 per cent to 46.90 per cent) as compared to endosulfan 0.07%, decamethrin 0.004%, trizophos 0.07% and control (39.12 to 73.57 per cent). Next in order of superiority were dimethoate 0.03% and fenvalerate 0.02% which also recorded significantly lowest stem tunnelling as compared to control. Monocrotophos 0.04% with 75.02 g followed by dimethoate 0.03%, endosulfan 0.07% and trizophos 0.07% gave the highest yield as compared to control (50.29 g).

Thus, taking into consideration all the parameters i.e. plant damage, stem length tunnelling and yield, monocrotophos 0.04% registered its superiority.

4.4. Correlation studies

The correlation between tunnel length by stemfly Melanagromyza phaseoli Tryon. and yield was found to be non-significant ($r = 0.20012$). It means that tunnel length did not affect the yield of soybean.

The correlation between different maturity groups (early, medium and late) and population of leaf miner, leaf folder, and per cent plant damage by stemfly were found to be nonsignificant except that in between maturity groups and plant damage by girdle beetle. It was found that plant

Fig. 12. INCIDENCE OF MAJOR INSECT PESTS ON DIFFERENT MATURITY GROWTH OF SOYBEAN

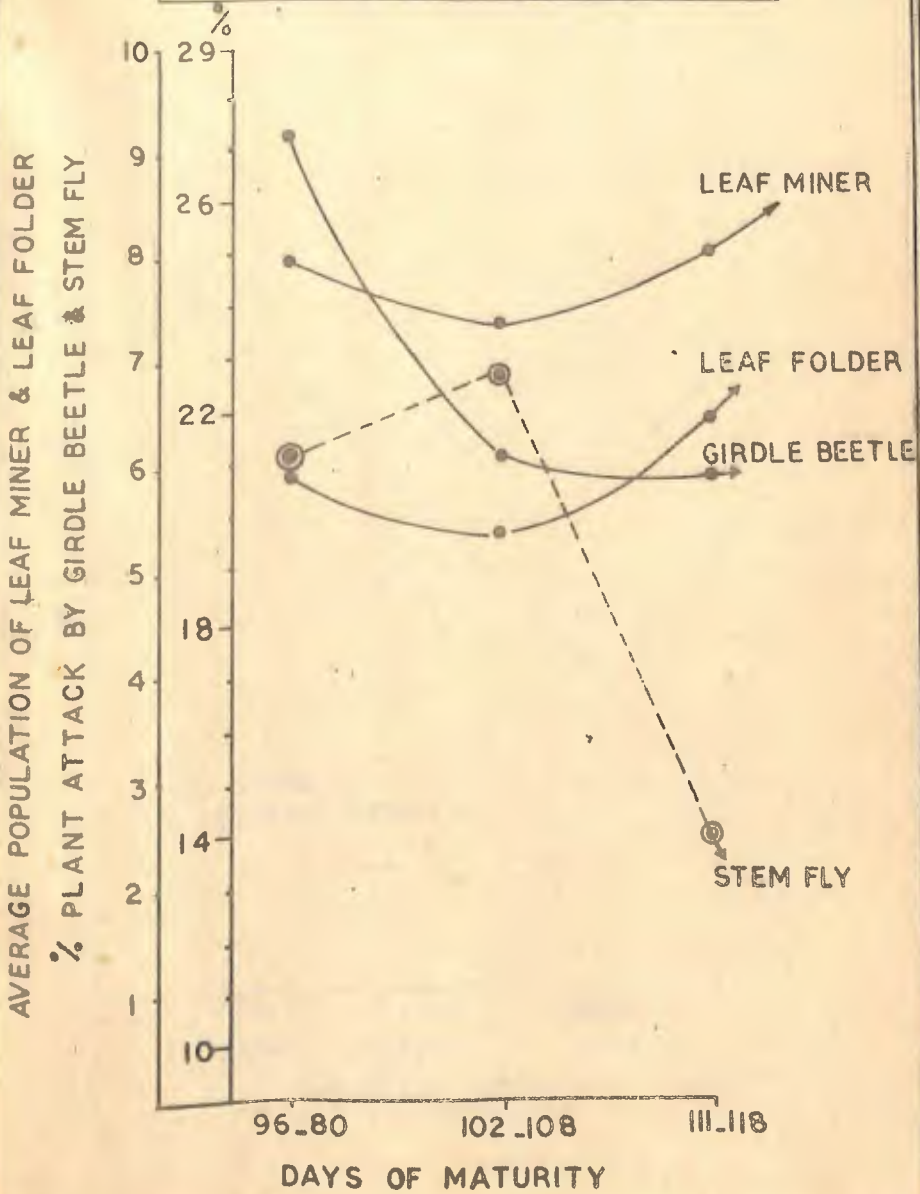
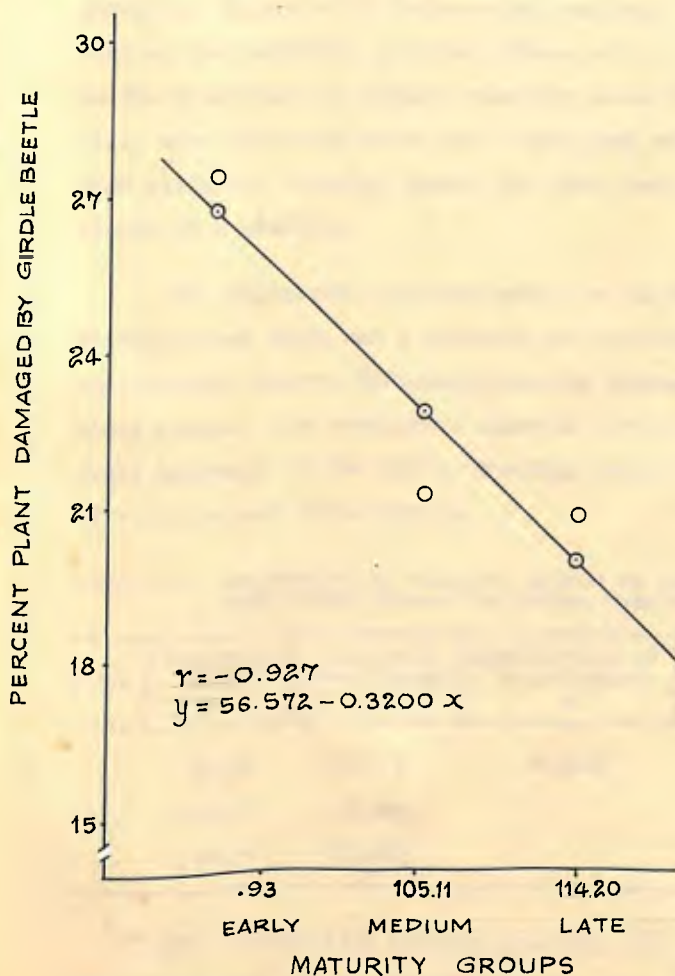


FIG.13. REGRESSION OF DIFFERENT MATURITY GROUPS OF SOYBEAN ON PERCENT PLANT DAMAGED BY Oberea brevis Swed



damaged by girdle beetle was 27.49 per cent in maturity groups of 93 days. With increase in maturity, there was a progressive reduction in plant damage and it was lowest that is 20.93 per cent in longest maturity group of 114.20 days. It is thus seen that there was a very weak correlation between different maturity groups and plant damage by girdle beetle ($r = -0.927$).

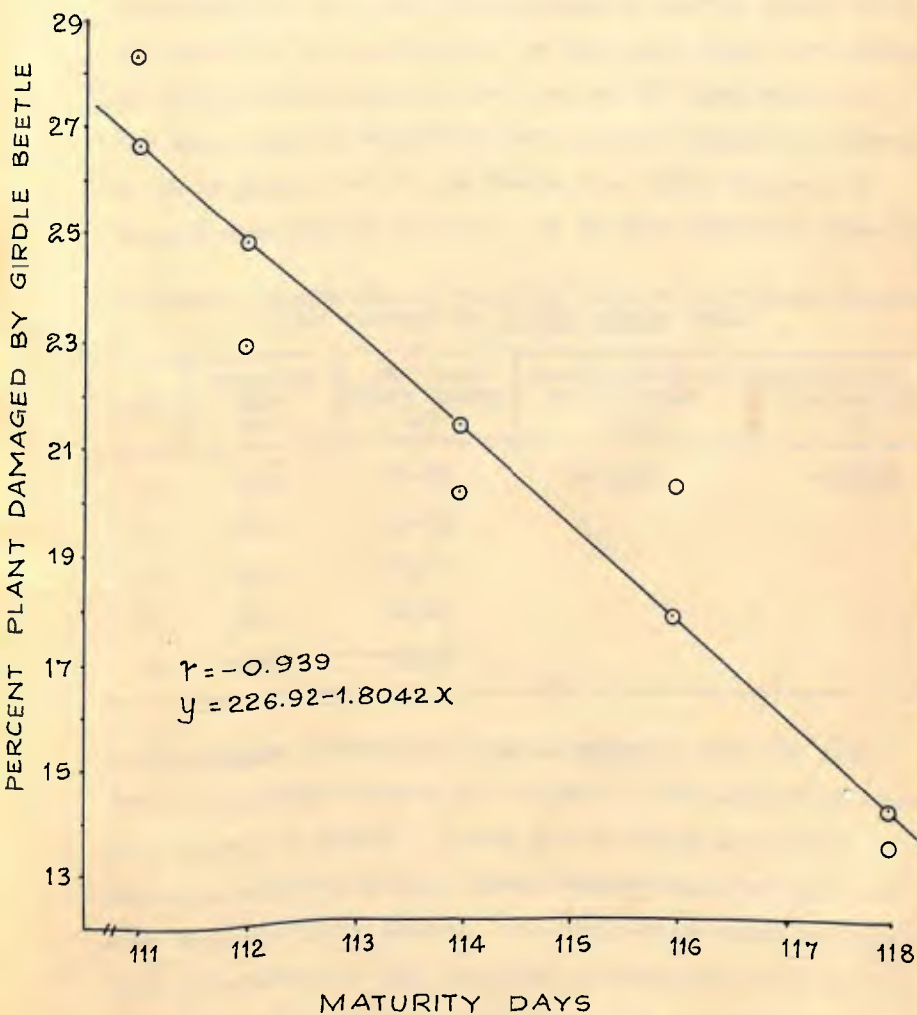
The regression equation being $y = 56.572 - 0.3200 x$. It shows that there was a negative correlation with linear relationship between different maturity groups and per cent plant damage. The regression equation indicates that with every increases of one day's maturity, there was a reduction of 0.32 per cent plant damage.

Table-10: Regression of maturity groups of soybean on per cent plant damaged by *Oberes brevis* Swed.

S.No.	Maturity group x	Per cent plant damage y	Coefficient of correlation (r)	Coefficient of regression b
1.	93.00	27.49	-0.927	-0.3200
2.	105.11	21.36		
3.	114.20	20.93		

The correlations between maturity days among different maturity groups and population of leaf miner, leaf folder and per cent plant damage by girdle beetle and stemfly were found

FIG.14.. REGRESSION OF MATURITY DAYS OF SOYBEAN
ON PERCENT PLANT DAMAGED BY
oberea brevis swed



to be nonsignificant except that in between maturity days of late maturing group and plant damage by girdle beetle which was found to be significant. It was found that plant damaged by girdle beetle was 28.3 per cent at 111 days maturity. As the crop maturity increased there was a progressive reduction in plant damage and it was lowest i.e. 13.33 per cent at longest maturity of 118 days. It is thus seen that there was

Table-11: Regression of maturity days of soybean on per cent plant damaged by Oberoa brevis Swed.

S.No.	Maturity days (x)	Per cent plant damage (y)	Coefficient of correlation (r)	Coefficient of regression (b)
1.	111	28.33	-0.939	-1.8042
2.	112	22.91		
3.	114	20.08		
4.	116	20.00		
5.	118	13.33		

a significant correlation between maturity days and plant damaged by girdle beetle ($r = -0.939$). The regression equation being $y = 226.92 - 1.8042 x$. It shows that there was a negative correlation with linear relationship between maturity days and plant damage. The regression equation indicates that with every one day's increase in maturity there was a decrease of 1.8 per cent plant damage by girdle beetle.

CHAPTER-V

DISCUSSION

The findings on the incidence of different insect pests of soybean, susceptibility of different soybean varieties against major pests, viz. leaf miner Stenopteryx subsecivolla Zeller, leaf folder Lamprosema indicata F., girdle beetle, Oberea brevis Swed. and stemfly, Molenaeromyia phaseoli Tryon and their chemical control have been discussed below.

5.1. Incidence of insect pests of soybean

Among different insect pests appearing on soybean crop, the leaf miner, leaf folder, girdle beetle and stemfly were found to be the major pests of soybean.

5.1.1. Leaf miner, Stenopteryx subsecivolla Zeller

The population of leaf miner was highest i.e. 10.93 larvae/20 plants at vegetative stage of crop which subsequently decreased during flowering and podding stage and was lowest in maturity stage.

The present findings confirm the findings of Dutt (1915), Fletcher (1920), Vander Iaan (1953) and Gangrade (1971-72) who also reported the leaf miner Stenopteryx subsecivolla Zeller to be serious pest of soybean at Maharashtra, Java and Sumatra and Jabalpur, respectively.

5.1.2. Leaf folder, Lamprosema indicata F.

Leaf folder was also a major pest. The population of leaf folder was found to be high in vegetative stage i.e. 8.51 larvae/20 plants which subsequently decreased during flowering and podding stage and was lowest at maturity stage.

The present findings confirm the findings of Fletcher (1914), Plank (1946), Gangrade (1971) and Bhattacharjee (1977) who also reported the leaf folder Lamprosema indicata F. to be a serious pest of soybean at South India, Puertorico, Jabalpur and Delhi, respectively. The present findings are also in accordance with that of Gangrade (1971) who reported the appearance of leaf folder Lamprosema indicata F. from August to end of September, but low population i.e. about 4 to 5 larvae/100 plants in Kharif season was reported by him.

5.1.3. Girdle beetle, Oberoa brevis Swed.

Girdle beetle was also recorded to be a major pest of soybean causing 27.75% plant damage till maturity.

The present findings are in accordance with the findings of Pruthi (1940), Ayyar (1940) and Kapoor (1971) who also reported the girdle beetle Oberoa brevis Swed. to be a serious pest of soybean at South India and Jabalpur respectively. The present findings also confirm the findings of

Kapoor et al. (1971), who reported plant damage by girdle beetle to vary from 1 per cent to 29.4 per cent.

5.1.4. Stemfly, Melanagromyza phaseoli Tryon

The stemfly has also been recorded as a major pest of soybean. The plant damage by stemfly was as high as 25.52 per cent till maturity stage of crop.

The present findings confirm the findings of Chewsepong (1949), Singh (1968) and Gangrade (1973) who also reported stemfly Melanagromyza phaseoli Tryon to be a serious pest of soybean at Pantnagar and Jabalpur respectively. But Singh (1968) and Gangrade (1973) reported still more plant infestation i.e. 60 to 100 per cent and 95 per cent plants respectively as compared to that of present findings.

5.1.5. Other insect pests

Among other insect pests appearing on soybean crop, the tobacco caterpillar Spodoptera litura F., green semilooper Plusia orichalcea Fb., green bug Nasara viridula L., gram pod borer Heliothis armigera Hb., Jassid Empoasca Sp. and Aphids Aphis craccivora appeared in low numbers and thus were the minor pests. Their population was very low i.e. 0.73, 0.11, 0.18, 0.15, 0.08, 0.06/10 plants respectively only during vegetative stage of crop which subsequently decreased

during flowering, podding and maturity stages except that of green bug, the population of which was more at maturity stage of crop.

The present findings do not support the findings of Sonan (1937), Singh (1969) who reported the tobacco caterpillar Spodoptera litura F. and Spodoptera littoralis as serious pests of soybean crop and also that of Singh and Chibbar (1969) who reported green semilooper Plusia orichalcea Fb. to be serious pest at Pant Nagar. The present findings are not in accordance with that of Isley (1936), Shchegolev (1939) who reported the gram pod borer Heliothis sp. to be a serious pest of soybean crop at Arkansas and North Caucasus but confirm the findings of Gangrade (1971-72) who reported this to be a sporadic pest at Jabalpur.

The present findings do not confirm the findings of Flint (1930), Ayyar (1940), Kretschmar (1949) who reported the leaf hopper jassids Empoasca sp. to be a serious pest of soybean at U.S.A.

The present findings also confirm the findings of Khan and Rao (1950) who reported the two species of aphids viz., Myzus persicae Sulz and Aphis craccivora Koch on cotyledonous leaves of soybean crop.

The present findings also confirm the findings of Todd et al. (1973) who reported the green bug Nasara viridula L. to feed on developing pods and seeds of soybean.

5.2. Varietal Susceptibility

5.2.1. Leaf miner, Stenopteryx subsecivolla Zeller

The population of leaf miner among 20 different varieties varied from 5.66 larvae/20 plants in JS-2 to 11.06 larvae/20 plants in JS 78-77.

Taking into consideration the average larval population of leaf miner in all three observations taken together and also that of each observation individually the varieties found in different susceptibility groups were:

JS-2, JS 78-67, JS 71-5 and Pb-1 - Least susceptible

JS 76-188, Cocker-stuart, JS 78-77 and JS 78-80 - Most susceptible.

Kalitur, JS 75-19, JS 72-280, JS 75-46, T-49, JS 72-44, Ankur, JS 72-185, Bragg, JS 76-259, JS 78-72 and JS 76-205 - Intermediate in susceptibility.

The present findings confirm the findings of Jakhmola et al. (1980-81) and Thombre (1983) in respect of least susceptibility of JS-2 to leaf miner while they do not support the findings of Bhattacharya (1982-83) and Bichoo (1982-83) who reported the JS-2 to be moderately susceptible. The present findings are also in accordance with Jakhmola et al. (1980-81)

who reported the varieties Pb-1 and JS 71-5 to be least susceptible and JS 72-44, Ankur and Bragg to be intermediate in susceptibility. The present findings, however, do not support the findings of Jakhmola et al. (1980-81) in respect of varieties JS 76-188, T-49, JS 72-280 and Kalitur, who reported the variety JS 76-188 to be intermediate in susceptibility and varieties JS 72-280, Kalitur, T-49 to be most susceptible. Present findings regarding susceptibility of JS 72-44 confirm that of Bichoo (1982-83) who also reported it to be intermediate in susceptibility. On the other hand, Dhattacharya (1980-81), Bhattacharjee (1982-83) reported JS 72-44 to be least susceptible. While Thombro (1983) JS 72-44 to be most susceptible. As regards the variety JS 75-46 the present findings do not support the findings of Bhattacharya (1980-81) and Kawathekar (1981-82) who reported it to be least susceptible.

5.2.2. Leaf folder, Lamprosema indicata F.

The population of leaf folder among 20 different varieties varied from 2.83 larvae/20 plants in JS-2 to 9.25 larvae/20 plants in JS 72-80. Taking into consideration the average larval population of leaf folder of all three observation taken together and also that of each observation individually the varieties found under different susceptibility groups were:

JS-2, Pb-1 and JS 75-46 - Least susceptible.

JS 76-259, JS 78-80 and JS 78-72 - Most susceptible.

JS 72-44, JS 71-5, JS 78-67, Bragg, JS 75-19, Cocker-stuart, T-49, JS 78-77, JS 72-280, Kalitur, JS 72-185, JS 76-188, Ankur and JS 76-205 - Intermediate in susceptibility.

The present findings confirm the findings of Gangrade (1970) who reported the number of larvae of leaf folder Lamprosema indicata F. per 100 plants to range from 2.85 to 14.47 although incidence reported by him was slightly lower.

5.2.3. Girdle beetle, Oberon brevis Swed.

The average per cent plant damage by girdle beetle among different varieties varied from 12.58 per cent in JS 72-280 to 42.91 per cent in JS 78-72. Taking into consideration the average plant infestation by girdle beetle of all three observations taken together and also that of each observation individually the varieties found under different susceptibility groups were:

JS 72-280, T-49, Pb-1, JS-2 -- Least susceptible

JS 71-5, JS 78-77 and JS 78-72 -- Most susceptible

JS 72-44, JS 76-188, JS 76-205, Ankur, Kalitur, Bragg, Cocker-stuart, JS 75-19, JS 78-67, JS 78-80, JS 72-185, JS 76-259, JS 75-46 -- Intermediate in susceptibility.

The present findings confirm the findings of Bichoo (1983) who reported the varieties JS 78-80 and JS 72-44 to be intermediate in susceptibility but confirm his findings regarding varieties JS-2, JS 78-82, which were reported to be intermediate in susceptibility.

5.2.4. Stemfly, Melanogromyza phaseoli Tryon

The per cent plant damage varied from 7.50 per cent in Kalitur to 30 per cent in JS 75-46 while stem tunnelled varied from 45.70 per cent in Kalitur to 69.77 per cent in JS 78-67. Taking into consideration the plant damage and per cent stem length tunnelled by stemfly, the varieties found in different susceptibility group were:

Kalitur -- Least susceptible.

JS 79-19, Pb-1, Bragg, JS 75-46 and JS 78-80 -- Most susceptible.

JS-2, JS 78-67, JS 78-72, JS 76-188, Cocker-stuart, Ankur, JS 76-259, T-49, JS 76-205, JS 71-5, JS 78-77, JS 72-185, JS 72-280 and JS 72-44 -- Moderately susceptible.

The present findings confirm the findings of Rawat et al. (1967-68) and Gangrade (1970) who reported the plant infestation by stemfly to vary from 2.97 per cent to 32.98

per cent in five different varieties and 67.05 per cent to 86.20 per cent among 20 different varieties of soybean.

The present findings also confirm the findings of Beohar et al. (1980) who reported the Kalitur variety to be least susceptible. The present findings, however, do not confirm the findings of Rawat et al. (1968) who reported Pb-1 and Bragg varieties to be moderately susceptible.

As regards tunnel length made by stemfly, no work on varietal differences seems to have been done elsewhere as is evident from the literature.

5.3. Chemical Control

5.3.1. Leaf miner, Stomonteryx subseivella Zeller

Among all insecticidal treatments the trizophos 0.07% followed by dimethoate 0.03% were found to be significantly most effective in reducing the leaf miner population upto the 15 days after the treatment. The average larval population of leaf miner was highest at 72 hours after treatment (6.87 larvae/25 plants) as compared to that of at 15 days after treatment (3.15 larvae/25 plants). Endosulfan 0.07% stood third in order of superiority at 72 hours after treatment. But Gangrade (2973) reported the endosulfan 0.07% to be most effective against leaf miner even upto 72 hours after the treatment.

5.3.2. Leaf folder, Lamprosema indicata F.

Among all insecticidal treatments, monocrotophos 0.04% followed by cypermethrin 0.009% were found to be significantly most effective in reducing the leaf folder population even upto 15 days after the treatment. The average larval population was significantly highest at 24 hours after the treatment (4.21 larvae/25 plants) as compared to that at 15 days after the treatments (1.48 larvae/25 plants).

The present findings also confirm the findings of Rawat (1977-79) and Thombre (1983) who reported the monocrotophos 0.04% to give complete protection to crop against leaf folder even upto 7 days after the treatment. Effectiveness of cypermethrin 0.01% against leaf folder has been reported by Thombre (1983) also.

5.3.3. Girdle beetle, Oberea brevis Swed.

Among all insecticidal treatments the monocrotophos 0.04% followed by cypermethrin 0.009% proved significantly most effective in reducing the plant damage by girdle beetle (21 to 23 per cent) as compared to control (40 per cent). The average per cent plant damage was highest at 15 and 21 days after the treatment. Endosulfan 0.07% was also found to be equally effective in reducing girdle beetle damage.

The present findings confirm the findings of Kapoor et al. (1971) who reported endosulfan 0.05% to be most effective against girdle beetle. But the findings do not confirm those of Gangrade (1973) in part, who reported endosulfan 0.05% and dimethoate 0.03% to be significantly most effective than monocrotophos 0.04%.

5.3.4. Stemfly, Melanagromyza phaseoli Tryon

Among all insecticidal treatments the monocrotophos 0.04% followed by dimethoate 0.03% proved most effective against stemfly. Monocrotophos treated plots recorded not only least per cent plant damage (12.50 per cent/10 plants) and stem length tunnelling (45.70 per cent/10 plants) but also recorded highest yield (75.02 g/10 plants) as compared to other insecticidal treatments and control. Endosulfan 0.07% stood third in order of superiority.

The present findings confirm the findings of Gangrade (1972-73) and Kapoor (1973) who reported monocrotophos 0.04%, dimethoate 0.03% and endosulfan 0.07% respectively to be most effective against stemfly. As against present findings, the average length of stem tunnelled reported by Gangrade (1972-73) was very high while reduction in stem tunnelling in dimethoate treated plot was also very high as compared to present findings.

As regards the yield, the present findings confirm the findings of Shrivastava (1971) and Kapoor et al. (1971). The former reported the mixture of dimethoate 0.03% and diazinon 0.03% in the ratio of 1:1 to give an average increase of 42.06 per cent yield over the check plot. While Kapoor et al. (1971) found the monocrotophos 0.04% and dimethoate 0.03% to give highest yield.

The present findings do not support the findings of Gangrade (1971) who reported differences in yield among insecticidal treatments and check plots to be nonsignificant.

5.4. Correlation Studies

The correlation between the tunnel length and yield among different varieties were found to be nonsignificant. Thus, the infestation of stemfly (tunnel length) did not seem to affect the yield.

Gangrade (1970) on the other hand reported the correlation between the average tunnel length and yield to be negative.

The present findings support the findings of Bhattacharya and Rathore (1979) who reported that the tunnel length made by stemfly failed to show direct loss in the yield of soybean.

SUMMARY

6.1. Incidence of insect pests of soybean

Fortnightly survey of soybean crop grown at J.N.K.V.V. Research Farm revealed that leaf miner, Stomopteryx subsecivella Zeller; leaf folder, Lamprosema indicata F. and girdle beetle, Oberes brevis Swed. and stemfly, Melanagromyza phaseoli Tryon were the major pests causing losses on soybean crop. The incidence of first two was higher during vegetative stage but that of other two was higher from vegetative through maturity stage of crop.

6.2. Varietal susceptibility

Twenty varieties of soybean were tested for their susceptibility to above-mentioned four major pests.

6.2.1. Leaf miner, Stomopteryx subsecivella Zeller

The varieties JS-2, JS 78-67, JS 71-5 and Pb-1 were found to be least susceptible while JS 76-188, Cocker-stuart, JS 78-77 and JS 78-80 were found to be most susceptible against leaf miner. Rest of the varieties were found to be moderately susceptible.

6.2.2. Leaf folder, Lamprosema indicata F.

The varieties JS-2, Pb-1 and JS 75-46 were found to be least susceptible while JS 76-259, JS 78-80 and JS 78-72 were most susceptible against leaf folder. Rest of the varieties were found to be moderately susceptible.

6.2.3. Girdle beetle, Oberoa brevis Swed.

JS 72-280, T-49, Pb-1 and JS-2 were found to be least susceptible while JS 71-5, JS 78-77 and JS 78-72 were most susceptible against girdle beetle. Rest of the varieties were found to be moderately susceptible.

6.2.4. Stemfly, Melanogromya phaseoli Tryon

Kalitur was least susceptible while JS 75-19, Pb-1, Bragg, JS 75-46 and JS 78-80 were found to be most susceptible against stemfly. Rest of the varieties were found to be intermediate in susceptibility. Taking the overall picture of pests incidence in different varieties and their yield record, JS-2, Pb-1 seemed to be most promising varieties.

6.3. Chemical Control

Seven modern insecticides were evaluated against these major pests so as to find most effective insecticides against these major pests.

6.3.1. Leaf folder, Lamprosema indicata F.

Among insecticidal treatments, monocrotophos 0.04% followed by cypermethrin 0.009% were found to be significantly most effective in reducing the leaf miner population even upto 15 days after the treatment.

6.3.2. Leaf miner, Stomopteryx subsecivella Zeller

Among all insecticidal treatments the trizophos 0.07% followed by dimethoate 0.03% was found to be significantly most effective in reducing the leaf miner population upto 15 days after the treatments. Endosulfan 0.07% stood third in order of superiority.

6.3.3. Girdle beetle, Oberesa brevis Swed.

Among all insecticidal treatments the monocrotophos 0.04% followed by cypermethrin 0.009% proved significantly most effective in reducing the plant damage by girdle beetle as compared to control.

6.3.4. Stemfly, Melanagromyza phaseoli Tryon

Among all insecticidal treatments the monocrotophos 0.04% followed by dimethoate 0.03% proved most effective against stemfly. Monocrotophos 0.04% followed by dimethoate 0.03% gave highest yield.

6.4. Correlation Studies

The correlation between the tunnel length by stemfly Melanagromyza phaseoli Tryon and yield was found to be non-significant ($r = 0.10212$).

The correlation between different maturity groups (early, medium and late) and leaf miner, leaf folder and per cent plant damage by stemfly were found to be nonsignificant except that in between maturity groups and plant damage by girdle beetle ($r = -0.927$). The regression equation being $y = 36.572 - 0.3200 x$. It shows that there was a negative correlation with linear relationship between different maturity groups and per cent plant damage. The regression equation indicates that with every increases of one day's maturity there was a reduction of 0.32 per cent plant damage.

The correlation between maturity days of only late maturing varieties of soybean and per cent plant damaged by girdle beetle Oberea brevis Swed. was found to be significant ($r = -0.939$). The regression equation being $y = 226.92 - 1.8042 x$. It shows that there was a negative correlation with linear relationship between maturity days and plant damage. The plant damage decreased by 1.8 per cent with increase of one day's maturity.

The population of leaf miner and leaf folder and plant damage by stemfly in all maturity groups and by girdle beetle in early and medium maturity groups were not found to be correlated.

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APPENDICES

Appendix-1: Analysis of variance for Average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	1.0941	0.3647		
2.	Treatment	19	14.884225	0.7833	4.58	
3.	Error	57	9.8264	0.1723		
Total		79				
S.Em \pm = 0.00.20				C.D. at 5% = 0.59		

Appendix-2: Analysis of variance for Average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	1.5013	0.5004		
2.	Treatment	19	8.395025	0.4418	2.009	
3.	Error	57	12.533975	0.21989		
Total		79				
S.Em \pm = 0.23				C.D. at 5% = 0.66		

Appendix-3: Analysis of variance for Average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	0.389145	0.129715		
2.	Treatment	19	12.264615	0.645506	3.58	
3.	Error	57	10.25073	0.1798373		
Total		79				
S.Em \pm = 0.21				C.D. at 5% = 0.59		

Appendix-4: Analysis of variance for Average larval population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	0.70566	0.23522		
2.	Treatment	19	24.865475	1.30870	7.01	
3.	Error	57	10.638065	0.1866327		
Total		79				

S.Em \pm = 0.21

C.D. at 5% = 0.61

Appendix-5: Analysis for variance for Average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	1.80495	0.60165		
2.	Treatment	19	5.992479	0.31539	1.42	
3.	Error	57	12.656873	0.22205		
Total		79				

S.Em \pm = 0.23 N.Sig.

Appendix-6: Analysis of variance for Average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	3.075865	2.0252		
2.	Treatment	19	11.106815	0.5845	4.33	
3.	Error	57	7.69211	1.13944		

S.Em \pm = 0.18

C.D. at 5% = 0.52

Appendix-7: Analysis of variance for percentage plant damage by girdle beetle.

S.No.	Source of variation	d.f.	M.S.	M.S.S.	F cal	F 5%
1.	Replication	3	849.865	283.28		
2.	Treatment	19	3153.328	165.96	2.23	
3.	Error	57	4231.1869	74.23		
Total		79				
S.E _m ± 4.30			C.D. 5% = 12.28			

Appendix-8: Analysis of variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	563.216	187.738		
2.	Treatment	19	3724.497	196.026	4.21	
3.	Error	57	2654.017	46.561		
S.E _m ± = 3.41		C.D. 5% = 9.71				

Appendix-9: Analysis for variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	1006.7472	335.58		
2.	Treatment	19	2489.9584	131.05	3.093	
3.	Error	57	2474.7654	42.36		
Total		79				
S.E _m ± = 3.25			C.D. at 5% = 8.18			

Appendix-10: Analysis of variance for per cent plant damage by stemfly.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	306.93	102.31		
2.	Treatment	19	4885.398	257.12	1.67	
3.	Error	57	8744.976	153.42		
Total		79				
S.E.m \pm = 6.19				C.D. at 5% = 17.65		

Appendix-11: Analysis of variance for per cent stem tunneled length by stemfly.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	43.72	14.57		
2.	Treatment	19	1675.08	88.163	2.49	
3.	Error	57	2012.909	35.37		
Total		79				
S.E.m \pm = 2.98				C.D. at 5% = 8.48		

Appendix-12: Analysis of variance for yield of soybean varieties.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	649.297	92.757		
2.	Treatment	19	6550.77	344.78	2.65	
3.	Error	57	7392.89	129.69		
Total		79				
S.E.m \pm = 5.69				C.D. at 5% = 16.79		

Appendix-13: Analysis of variance for average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	2.5510378	0.85034		
2.	Treatment	7	0.964175	0.1378	0.901	
3.	Error	21	3.209340	0.1528		
Total		31				

Nonsignificant. $S.E.m \pm = 0.19$

Appendix-14: Analysis of variance for average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	2.1243075	0.7081025		
2.	Treatment	7	0.627495	0.0896421	0.8200	
3.	Error	21	2.2956	0.1093		
Total		31	5.04742			

Nonsignificant. $S.E.m \pm = 0.16$

Appendix-15: Analysis of variance for average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	0.190775	0.0635		
2.	Treatment	7	3.6642	0.52845	2.55	
3.	Error	21	4.303775	0.20494		
Total		31	8.13875			

$S.E.m \pm = 0.226$

C.D. at 5% = 0.66

Appendix-16: Analysis of variance for average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	0.613275	0.204425		
2.	Treatment	7	4.4698	0.63859	4.63	
3.	Error	21	2.690125	0.13762		
Total		31	7.9732			

S.Em \pm = 0.19

C.D. at 5% = 0.54

Appendix-17: Analysis of variance for average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	0.0826625	0.2942		
2.	Treatment	7	6.966325	0.99518	11.9	
3.	Error	21	1.7441125	0.08305		
Total		31	9.593100			

S.Em \pm = 0.14

C.D. at 5% = 0.42

Appendix-18: Analysis of variance for average population of leaf miner.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	0.8196	0.2732		
2.	Treatment	7	0.4256	0.0608	0.082	
3.	Error	21	1.5484	0.7374		
Total		31	2.7936			

Nonsignificant S.Em \pm = 0.42

Appendix-19: Analysis of variance for average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	2.0051095	0.6683		
2.	Treatment	7	0.283572	0.0405	0.332	
3.	Error	21	2.5568155	0.1217		
Total		31				

Nonsignificant $S.E_m \pm = 0.17$

Appendix-20: Analysis of variance for average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	0.30554	0.10184		
2.	Treatment	7	2.01354	0.28764	4.56	
3.	Error	21	1.3247	0.06297		
Total		31				

$S.E_m \pm = 0.12$

C.D. at 5% = 0.36

Appendix-21: Analysis of variance for average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	F 5%
1.	Replication	3	1.01104	0.33701		
2.	Treatment	7	0.90074	0.12867	2.54	
3.	Error	10	2.06321	0.05062		
Total		31				

$S.E_m \pm = 0.11$

C.D. at 5% = 0.32

Appendix-22: Analysis of variance for average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	0.88266	0.295		
2.	Treatment	7	6.96632	0.996	11.86	
3.	Error	21	1.74411	0.084		
Total		31				
S.E.m \pm = 0.14				C.D. at 5% = 0.41		

Appendix-23: Analysis of variance for average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	0.38775	0.12924		
2.	Treatment	7	1.38112	0.19730	2.69	
3.	Error	21	1.53899	0.07328		
Total		31				
S.E.m \pm = 0.13				C.D. at 5% = 0.38		

Appendix-24: Analysis of variance for average population of leaf folder.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	0.8196	0.2732		
2.	Treatment	7	0.4256	0.0608	0.082	
3.	Error	21	1.5484	0.7374		
Total		31				

Nonsignificant S.E.m \pm = 0.42

Appendix-25: Analysis of variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	113.26113	27.75371		
2.	Treatment	7	80.3905	4.2310789	0.0546	
3.	Error	21	1627.3184	77.491352		
Total		31				

Nonsignificant $S.E.m \pm = 4.40$

Appendix-26: Analysis of variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	77.28141	25.7604		
2.	Treatment	7	120.6675	17.23	0.486	
3.	Error	21	743.68419	35.41		
Total		31				

Nonsignificant $S.E.m \pm = 2.9$

Appendix-27: Analysis of variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	83.52512	27.841707		
2.	Treatment	7	249.65685	35.66513	3.29	
3.	Error	21	227.59403	10.837811		
Total		31				

$S.E.m \pm = 1.64$

C.D. at 5% = 4.81

Appendix-28: Analysis of variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	81.4993	27.166433		
2.	Treatment	7	317.8815	45.411643	2.634	
3.	Error	21	361.88187	17.2347		
Total		31				
S.E.m \pm = 2.075				C.D. at 5% = 6.12		

Appendix-29: Analysis of variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	123.83541	41.27847		
2.	Treatment	7	325.92217	46.56031	3.215*	
3.	Error	21	304.19412	14.435		
Total		31				
S.E.m \pm = 1.903				C.D. at 5% = 5.61		

Appendix-30: Analysis of variance for per cent plant damage by girdle beetle.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	52.0198	17.339933		
2.	Treatment	7	921.065	131.58071	7.710*	
3.	Error	21	358.3966	17.066505		
Total		31				
S.E.m \pm = 2.065				C.D. at 5% = 6.09		

Appendix-31: Analysis of variance for per cent plant damage by stemfly.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	413.58132	137.87		
2.	Treatment	7	1266.36020	180.9006	2.74	
3.	Error	21	1398.10650	66.1000		
S.E.m \pm = 4.06				C.D. at 5% = 11.97		

Appendix-32: Analysis of variance for per cent stem length tunnelled by stemfly.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	244.4694	81.48		
2.	Treatment	7	1023.15	146.16	3.27	
3.	Error	21	937.664	44.65		
Total		31				
S.E.m \pm = 3.34				C.D. at 5% = 9.85		

Appendix-33: Analysis of variance for yield of soybean/10 plants.

S.No.	Source of variation	d.f.	S.S.	M.S.S.	F cal	$\frac{F}{5\%}$
1.	Replication	3	296.7387	98.9125		
2.	Treatment	7	1541.7255	220.2465	3.89	
3.	Error	21	1189.5658	56.6450		
Total		31	3028.03			
S.E.m \pm = 3.76				C.D. at 5% = 11.09		

Appendix-34: Analysis of variance

S.No.	Different maturity group (x)	Plant damage by girdle beetle (y)	x^2	y^2	xy
1.	93.00	27.49	8649.00	755.7001	2556.57
2.	105.11	21.36	11048.112	456.2496	2245.1496
3.	114.20	20.93	13041.640	438.0649	2390.206
Total	312.31	69.78	32738.752	1650.0146	7191.9256

$$r = -0.927$$

Appendix-35: Analysis of variance

S.No.	Maturity days (x)	% plant damage by girdle beetle (y)	x^2	y^2	xy
1.	111	28.33	12321	802.5889	3144.63
2.	112	22.91	12544	524.8681	2565.92
3.	114	20.06	12996	403.2064	2289.12
4.	116	20.00	13456	400.0000	2320.00
5.	118	13.33	13925	177.6889	1572.94
Total	571	104.65	65241	2303.0603	11869.01

$$r = 0.939$$

V I T A

The author was born on 3rd May 1961 in Rewa District (M.P.). She passed her Higher Secondary School Certificate Examination from S.K. Girls' Higher Secondary School, Rewa in the year 1977 and joined the Girl's Degree College, for B.Sc. and completed the degree in the year 1980-81. After completing graduation studies, she continued her studies for M.Sc. (Agr.) in the year 1981-82 in the Department of Entomology, J.N. Krishi Vishwa Vidyalaya, Jabalpur.