Investigation of defoliator pests and screening of resistance genotypes against borers and defoliator pests of soybean plants *(Glycine max)*

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ABSTRACT: *Present study is based on experiment carried out for the study of the insect defoliators of the soybean crop near Dehradun. Experiment was performed from the month of February to July 2024. It has been observed from the study that, major insect species or the pest of soybean were stem fly (Melanogromyza sojae), tobacco caterpillar (Spodoptera litura), semiloopers, girdle beetle, pod borer, stem borer, white fly and Bihar hairy caterpillar (Spilosoma obliqua) were commonly observed. Bihar hairy caterpillar (Spilosoma obliqua) is the major insect pest of Soybean in Uttarakhand. On the basis of the incidence of the pest defoliation, genotype JS335 and JS-20-34 was found to be highly susceptible and genotype DSB-21, DS-3108 and BRAG was found to be least susceptible against the defoliators and they are also categorized in highly resistant to defoliators.*

INTRODUCTION

Soybean (*Glycine max*) is one of the most important Pulse-cum-oilseed crops which have high yielding potential. It also possesses a very high nutritional value as contains about 20% edible oil and 40% protein of high quality. Its protein content has special significance, as it is rich in valuable amino acid lycine (5%), which is deficient in many cereals. Fortification of soybean with cereal foods can ensure balanced food, because it not only satisfies the needs of carbohydrates, proteins and oil. It also contains a good amount of minerals, salts and vitamins (thiamine and riboflavin) and its sprouting grains contain a considerable amount of vitamin C. It also contains a Carotene, which is the precursor for vitamin A. Specially; soybean is more useful for growing children. A large number of Indian and western dishes, such as bread, "chapati", milk, sweets, pastries, etc. can be prepared with soybean. Soybean oil is used for manufacturing Vanaspati ghee and several other industrial products. Soybean is used for making high protein food for children.

I addition to its food values, soybean is used for number of other applications like industrial production of antibiotics, commercial production of edible oil and production of biodiesel. From agriculture point of view, it is an important crop because it built up the soil fertility by fixing large amount of atmospheric nitrogen through the root nodules and also through the leaf fall on the ground at maturity therefore, it is useful for crop rotation and intercrop. It can be used as green fodder as well as hay or silage. Soya meal is a wonderful protein rich cattle feed. Due to its multiple uses of great socio economic importance, it is aptly called as a 'Wonder crop'. Although, it is both pulse and oilseed, but due to high oil content and greater response to applied nitrogen, it is classified by the FAO as an oilseed and not as a pulse and now it is placed in oilseed category.

The Cultivated Soybeans are reported to have originated in eastern Asia and China. As its wild form progenitor (a slender twinning vine) *Glycine ussuriensis* grows wildly in China, Korea and Manchuria. The first written record of the plant is contained in an ancient Chinese book "Pen Ts'ao Kong Mu (*Materia medica*)" which is about 5000 years old. Soybean grain was reported to be one of the five sacred grains of China. It has been known to man over 5000 years. Although there is no available record as to when soybean was introduced into India. It has been traditionally grown in the Northern hills and several other scattered pockets in the country for many centuries and has become an essential part of the daily diet in these regions. Soybean has been known by various names in India such as Bhat, Bhatman, Ramkulthi, Bhut, Kalitur, teliakulth and Garryakalay. However the varieties grown in these areas had small black seeds with twinning growth habit and were poor yielding types. A fresh interest in soybean became evident with the preliminary studies conducted at Pantnagar and Jabalpur during the years 1963-1966 using improved varieties from the USA. Some of the US varieties yielded between 30 and 36

quintals per hectare. Encouraged by these results, the ICAR initiated on All India co-ordinated research Project on Soybean, in 1967 with three main centres at Pantnagar, Jabalpur and Delhi along with several subcenters covering different agro-climatic regions.

The soybean being soft and succulent foliage, it attracts many insects and provides a shelter, food and space for many insect and pests. Approximately, 380 species of insects have already been identified and reported on soybean crop from different parts of the world. During the introduction of soybean in India in early dates, only about a dozen minor insect pest were recorded, but in 1997, the figure grows to 270 insects besides one mites, 2 millipedes, 10 vertebrates and 1 snail as reported by Singh in 1999. About 65 insects have been reported to attack soybean from cotyledon to harvesting stage from Karnataka. Among these defoliators are leaf miner *Aproaerema modicella* Deventer and stem fly *Melanogromyza sojae* Zehnter are known to cause 100% damage resulting in reduction of yield by 20 to 30 percent. The defoliators *Spodoptera litura*, *Thysanoplusia orichalcea*, *Spilarctia obliqua* and *Helicoverpa armigera* feeds on foliage, flowers and pods causing significant yield loss (Singh & Singh, 1990). The infestation of *Thysanoplusia orichalcea* (fab) can result into 30% undeveloped pods and about 50% yield loss. In case of heavy attack, the caterpillars are also found to feed on flowers and pods. *Bemisia tabaci* (Genn) and *Thrips palmi* (karny) both are sucking pest cause an economic damage. The Bihar hairy caterpillar, *Spilarctia obliqua* (walk) is a voracious feeder which feeds gregariously on soybean leaves in early instars. In case of severe infestation, the entire crop is damaged badly thus causing 40% defoliation of leaves. Soybean is attacked by about twenty different major insect pest. The predominant insects in the central part of the country are Stem fly (*Melanogromyza sojae*), girdle beetle (*Oberiopsis brevis*) and green semilooper (*Chrysodexcis acuta).* This insects-pest accounts for more than 25% reduction in yield.

Therefore, to avoid losses caused by these defoliator pests, various control measures were attempted; earlier chemical control measures were found effective. Dust and granules were applied to the soil in bulk quantity which affected and polluted the soil. Indiscriminate use of chemicals led to many environmental problems which are risk to humans and animal health besides environmental pollution. Hence, Integrated Pest Management (IPM) is perceived as the only alternative to solve such issues, which includes biological method, cultural method and also the use of biorationals.

So, the most economical way to deal with these insects- pests and avoid yield losses is to cultivate the insect resistant/tolerant varieties. Hybridization which involves the identified resistant sources and agronomical suitable genotypes is in progress at National Research Centre for Soybean (NRCS) Indore (M.P).

The field experiment conducted during the kharif 2010-2011 and 2011-2012 at Parbhani (Maharasthra) by **A.A Motaphale, B.B Bhosle** and **F.S Khan** reported that their present investigations were similar to those of **Salunke (1999),** who conducted the experiment on screening 14 cultivars against girdle beetle (O brevis) at Marathwada Agricultural university during 1998 and reported that comparatively less girdle beetle damage was observed in the cultivar JS-335. They also observed the tolerance against the stem fly of soybean and found that the lowest per cent stem length tunneled by stem fly were observed in genotypes JS335 and J8-80-21. **J Upadhyay**, department of plant breeding and genetics and JNKW Jabalpur, Madhya Pradesh conducted the experiment during the kharif season (2014-15).Experiment was based on screening the soybean genotypes/varieties against a stem fly. Where, 9 genotypes with one checked variety (JS 20-29) are tested for relative field resistance against stem fly and found that none of the genotypes was found free from stem fly infestation. Where he concluded that on the basis of the incidence of stem fly, genotype JS-20-108 was found to be less susceptible and check variety JS 20-29 was highly susceptible against stem fly.

Therefore, investigation of defoliator pests and screening of resistance genotypes against borers and defoliator pests of soybean plants (Glycine max) becomes important. In order to identify potential resistant genotypes/varieties against the major insect defoliators, theses must be investigated and screening of resistance genotypes against borers and defoliator pests of soybean plants (Glycine max) becomes very

important. In present study, the field screening has been carried out to study the incidence of major pest of soybean crops and to determine the soybean cultivars that are resistant to major insect defoliators (stem fly, girdle beetle, whitefly and green semilooper).

MATERIALS AND METHODS

To determine the soybean cultivars that are resistant to major insect defoliators and the screening of soybean genotypes/varieties against a stem fly, girdle beetle, whitefly and green semilooper. The experiment was conducted in the month of feb-july in the DCAST college experimental farm (Rampur field). Fifteen (15) genotypes of soybean were screened against the defoliator pests. Field experiment was carried out in randomized block designed with three replications, having the plot size 15m x 9m area with a spacing of 3m x 3m for each plot and plant to plant distance was 50cm each.

The sowing of soybean seed was done in the month of February, 2023. The temperature recorded during the time of sowing was 21^{o}C in Dehradun. The seeds were soaked in water (at room temperature) overnight (for 12 hours) before sowing, each different varieties were soaked in different bowls, the seeds when soaked in water they starts to swell up and becomes a little larger due to the absorption of water in their cotyledons. The soaked seeds germinates faster than those which are not soaked before planting. The soaked seeds were put into the well prepared soil just a shallow or a few centimeters deep.

Since a soybean plant grow well in a loamy soil, the soil needs to be prepared before sowing, a manure was prepared from the cow dung along with the other disposed off materials, the prepared manure was then spread evenly in the field, where the soybeans will be planted.

The well prepared soil ensures the faster germination of the seeds as well as growth of the plants. The seeds start to germinate after two to three days of sowing in a favourable environment (warm temperature). The two cotyledons burst out from the soil after 3-4 days, after five to six days, the soybean plant starts to give out their first two leaf's.

And then, the further growth was observed and recorded, moreover the regular watering is also done during the time of sowing , in order to keep the seeds and soil hydrated, the soil needs to be keep moist and aerated.

Five lines of each variety were sown in replications, all the recommended practices were followed, except the insect pest control measures (such as used of insecticides and pesticides and chemical fertilizers). No chemicals were used in the entire experiment and the plants were allowed to grow naturally. The incidence of defoliator pest and other insect pest were observed and recorded from the time of seed germination till the flowering stage and pod bearing.

Table 1: List of genotypes evaluated against the defoliator pest.

1	JS-20-34
2	JS 5335
3	C-14
4	C-18
5	DS
6	DS-3108
7	PROT
8	DSB-21
9	NRC-131
10	RSC-11-17
11	BRAGG
12	RVSM 2011-35
13	MACS-450
14	MACS-1493
15	MACS- 1566

RESULTS AND DISCUSSION

Result of the present investigation on the incidence of defoliator pest of soybean and screening of resistant varieties against the defoliators pest of soybean are described below:

Incidence of insect defoliators

Some of the major lepidopteran defoliators associated with the soybean crop observed during the experiment season are listed below-

1) Stem fly (*Melanogromyza sojae* Zehnter)
2) Tobacco caterpillar (*Spodoptera litura* Fabricius)

3) Green semilooper (*Chrysodiexis acuta* Walker, *Gesonia gemma* and *Diachrysia Orichalcea* Fabriciussensu Hubner)
4) Girdle beetle (*Obereopsis brevis*)
5) Pod borer (*Helicoverpa armigera* Hubner)
6) White fly (Bemisia tabaci Gennadius)
7) Bihar hairy caterpillar (*Spilosoma oblique* walker)

Soybean stem fly (*Melanogromyza sojae*)

This is a serious pest of soybean in northern India and has been identified as a major pest of soybean in India.

Nature of damage

a) The adult stem fly deposits eggs in the leaf tissue in soybean seedlings. Eggs are laid in the soft tissues of the leaf and hatch in two to seven days.
b) Larvae start feeding in the leaf and move towards the centre of the stem, penetrating through the petiole.
c) Maggots mine the leaves or bore into the leave petiole or tender stem, which ultimately cause extensive tunneling resulting in withering, drooping and eventually the death of the plant.

Tobacco caterpillar (*Spodoptera litura* Fab)

A female moth lays masses of eggs on the underside of young leaves. After the egg hatch, the larva of Spodoptera litura Fab, were noticed feeding at early vegetative stage of the crop.

The newly hatched caterpillars had a gregarious feeding behavior, they feed on chlorophyll content of the leaves from under the surface and skeletonized them. The grown up larva feed on leaves eating away the entire portion.

The semilooper (*Thysanoplusia orichalcea* fab)

The semilooper, Thysanoplusia orichalcea Fab early instar larvae fed on the leaves by scratching the green matter, grown up larvae consumed the entire leaves leaving behind only the midribs and veins. The pest was noticed defoliating at vegetative stage of the crop. The leaves are with holes and severe damage results in skeletonized and defoliation.

Girdle beetle, Ash weevil Myllocerus undecimpustulatus.

Girdle beetle is another serious pest of soybean. This reduces 50 percent pods and grains by infesting a soybean plant. The adult is a medium sized cerambycid beetle.

Females make two parallel girdles usually on the petiole or on the main stem or side branches. The newly emerged larvae feed inside the stem, the trifoliate leaves begin drying around the edges and results in the curling up of the leaf margins and finally the entire leaflets dries up.

When adult weevils feed on leaves, they feed Inward from the top margins or edges causing the typical leaf notching. There are some instances where the leave material is almost completely defoliated, where the weevil has fed along the leaf veins. The adults prefer new plant growth.

Pod borer (*Helicoverpa armigera* Hubner)

On hatching, the larva feed for a short time on the tender leaflets by scrapping green tissue and then shift to flower buds and tender shoots, slowly it enters and feeds on the seeds insides the pod. The half portion of the larva remains inside the pod, while feeding on the developing seeds.

Bihar hairy caterpillar (*Spilosoma obliqua*)

It is a serious pest of soybean, especially in the Northern India and in Uttarakhand.

A single female lays more than hundreds to thousands of eggs on the leaf surface and these pale greenish eggs hatch in three to seven days.

Young larvae feed gregariously on the under surface of the leaves and causes loss by way of defoliation and the leaves of the plant gives an appearance of net or web.

Sometimes, after defoliated the crop larvae feed on the pods. Pupation takes place in the soil under dry foliage and debris where the pupae overwintering.

Moreover the species of short horned grasshopers were also observed and were found defoliating soybean during early vegetative stage of the crop. Their incidence was sporadic in nature.

Besides them, the natural enemies Coccinellids, Chrysopids and entomopathogenic fungus, N. rileyi and many other different insects were also observed during the course of investigation.

Screening of genotypes for resistance against defoliator pest of soybean.

Fifteen genotypes including the susceptible two checked varieties (JS-335) and (JS-20-34) were tested for relative field resistance to defoliator pest.

Percent defoliation

The soybean genotypes were screened against major defoliators and results were discuss as follows:

Fifteen varieties C-14, C-18, DS, DS-3108, NRC-131, DSB-21, PROT, RSC-11-17, BRAGG, RVSM-2011-35, MACS-450, MACS-1493 and MACS-1566 along with the two standard checked variety JS-335 and JS-20-34 were tested for relative field resistance to defoliators. None of the genotypes was found free from the insect defoliators. Moreover, none of them were recorded as highly resistant. But, depending on the percent resistant to defoliation they were categorized as described below.

Table 2: Percent defoliation in different soybean genotypes

S.No	Genotypes/varieties	Per cent defoliation	Category
1	JS-20-34	62.65%	HS
2	JS335	65.67%	HS
3	C-14	47.00%	S
4	C-18	48.00%	S
5	DS	41.60%	MR
6	DS-3108	21.33%	HR
7	NRC-131	39.05%	MR
8	DSB-21	28.00%	HR
9	PROT	35.00%	MR
10	RSC-11-17	48.8%	S
11	BRAGG	15.4%	HR
12	RVSM-2011-35	32.7%	MR
13	MACS-450	43.7%	MR
14	MACS-1493	40.00%	MR
15	MACS-1566	38.00%	MR

Where: HR=Highly Resistant, MR=Moderately Resistant, HS=Highly Susceptible and S= Susceptible.

Percent defoliation in all the genotypes was found significantly superior over the checked, which was found to be on par with the check genotype JS335 and JS-20-34.

The least percent defoliation was observed in DSB-21, DSB- 3108 and BRAGG. They were categorized as highly resistant to defoliators. NRC-131, RVSM-2011-35, MACS-450,MACS-1493,MACS-1566,PROT and DS were categorized as moderately resistant to defoliators. C-14, C-18 and RSC-11-17, JS-20-34 were categorized as susceptible, whereas JS335 and JS-20-34 were recorded as highly susceptible.

DSB-21, DS-3108 and BRAGG were identified as resistant as varieties against the defoliation. Whereas, JS335 and JS-20-34 were found to be highly susceptible for defoliators. Similar observations were made by Harish and Patil (2008) who reported that JS335 and Monetta was highly susceptible for defoliation as they recorded 66.67 percent and 63.37 percent defoliation respectively. Similar types of varietal investigations and experiments were previously documented by the other workers. However, varieties in their studies were different to that of my soybean genotypes. Therefore, there is no information available to compare to the present findings.

Conclusion

The results of the investigations on the incidence of defoliator pest of soybean and resistant varieties are necessary to develop a sound pest management strategy. Over dependence on chemicals (pesticides and insecticides) for the purpose of plant protection and grain yields has created a lot of problems for the soil environment as well as towards the mankind. Therefore, alternative ways need to be created and applied. Integrated pest management (IPM) is perceived as the alternative to combat the problems, which comprises biological methods, cultural methods, used of biorationals and among these are used of resistant varieties of a particular plant species. From the study, major insect species or the pest of soybean observed are – stem fly (*Melanogromyza sojae*), Tobacco caterpillar (*Spodoptera litura*), semiloopers, girdle beetle, pod borer, stem borer, white fly and Bihar hairy caterpillar (*Spilosoma obliqua*) were commonly observed. Bihar hairy caterpillar (*Spilosoma obliqua*) is the major insect pest of Soybean in Uttarakhandh. In the basis of the incidence of the pest defoliation, genotype JS335 and JS-20-34 was found to be highly susceptible and genotype DSB-21, DS-3108 and BRAGG was found to be least susceptible against the defoliators and they are also categorized in highly resistant to defoliators.

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