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Screening Of Germplasms and Population Dynamics of Major Insect Pests of Spring Green Gram *Vigna Radiata* (Linn.).

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Abstract
The present investigation was conducted during *Spring* season of 2021-22 at Norman. E. Borlaug. Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) and Morphology laboratory of Department of Entomology with the objectives screening of green gram germplasms in field as well as laboratory conditions and occurrence of major insect pests in field conditions. In field conditions major insect pests were observed using various methods such as whiteflies in a whitefly cage, jassids/trifoliate, knockdown approach for thrips and sweep net method for pod bug population. Under laboratory conditions germplasms were screened against *Spodoptera litura* using choice test method. Investigations on population dynamics shows that population of whitefly was highest during 17th SMW while thrips population was at peak during 19th SMW followed by jassid in 17th SMW and pod bugs in 19th SMW. Based on data recorded among various entries SSME 21-70, SSME 21-55 and SSME 21-53 were found superior among all the test entries against *B. tabaci*, *M. distalis*, *E. kerri* and *C. gibbosa* infesting green gram. Data of laboratory experiments revealed that when castor was used as standard host, preference index varied significantly from 0.02 (SSME 21-48) to 1.00 (SSME 21-55) at P = 0.05 level of significance while when PM-5 was taken as standard host, significant variation in preference index was recorded from SSME 21-70 (0.01) to SSME 21-43 (1.16) at P = 0.05.

Keywords: Vigna radiata, Germplasms, Population dynamics, Spodoptera litura, Preference index.

1. INTRODUCTION

The word "pulses" refers to annual legumes (seeds that grow within pods) that are harvested solely for dry grain, oil extraction and are rich source of proteins, dietary fibre, and many vitamins and minerals yielding between 1 to 12 grains with variable size, shape and colour within a pod, used for both food and feed **(1)**. They are a good source of protein and vitamins; the average protein content of pulses is 20-30%.

Green gram, *Vigna radiata* (Linn.) Wilczek (Family: Fabaceae, Subfamily: Papilionaceae) commonly known as mung dal is the third most important pulse crop after chickpea and red gram in India **(2)**.

During 2019-20, India imported approximately 2.63 million metric tonnes of pulses **(3)**. Among various pulse crops, mainly chickpea dominates with over 40 % share of total pulse production followed by pigeon pea (18-20%), mung bean (11%), urd bean (10-12%), lentil (8-9%) and other legumes (20%) **(4)**.

The green gram is infested by various insects which are categorized as pod borers such as Spotted bod borer (*Maruca vitrata*), Gram caterpillar (*Helicoverpa armigera*), foliage feeders like Tobacco caterpillar *(Spodoptera litura)*, Bihar hairy caterpillar (*Spilarctia obliqua*), and sucking pests such as Jassids (*Empoasca* sp.), Whiteflies (*Bemisia tabaci*), Green leaf hopper (*Nephotettix* sp.), Aphid (*Aphis craccivora*) and others like Grey weevil (*Myllocerus* sp.), Blister beetle (*Mylabris pustulata*), Epilachna beetle (*Epilachna* sp.), thrips (*Caliothrips* sp. and *Megalurothrips distalis* Karny) **(5)**. Among these, whiteflies act as vector of mungbean yellow mosaic virus (MYMV) **(6)**.

Insect population dynamics is based upon insect-host relationships: (a) endemic insects reacting weakly to environmental conditions, and are limited by host defence (b) cyclic or insects having abundance directly proportional to fluctuations in food resources (c) flareups or epidemics recurring at irregular intervals which are mediated through the host by environmental stress conditions **(7).** Screening of resistant or tolerant genotypes is advantageous as it does not impair the quality of the environment, no significant cost to the farmers are involved and is generally compatible with other pest control methods.

2. MATERIALS AND METHODS

The field experiments were carried out to study the population dynamics of major insect pests of green gram and screening of green gram germplasms against major insect pests in field conditions prevalent in Pantnagar during *spring* crop seasons 2021-22 at Norman E. Borlaug Crop Research Centre (NEBCRC) of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar while the laboratory experiment was carried out to screen germplasms of green gram against *Spodoptera litura* at Morphology laboratory of Department of Entomology, College of Agriculture at GBPUA&T, Pantnagar.

Field Layout for Varietal trials

The field experimentation was carried out as per following details in **Table 1.**

Table No.1: Field details for screening and population dynamics of major insect pests of *spring* green gram during 2021-2022 at Pantnagar, Uttarakhand

Date of sowing	03-03-2021
Plot size	2m X 0.60mX 10 lines
Number of treatments	70 test lines with checks
Replications	03
Design	Randomised Block Design
Row to Row Distance	30cm
Row length	2m

Plate 1: Experimental site

To study the population dynamics of major insect pests infesting *spring* green gram.

The observations regarding population dynamics of major insect pest of green gram were recorded twice a standard meteorological week under natural conditions without any insecticidal treatments so that the population of pest could build-up. The first observation was taken thirty-five days after germination. The Observations on population of whitefly *Bemesia tabaci* (Gennadius) was recorded soon after their appearance. By visually counting whiteflies in a whitefly cage, the number of whiteflies infesting the green gram was determined. The data was collected twice a week throughout the standard meteorological week, between 07:00 and 09:00 a.m. Observations were made randomly on 5 different plants at random. The observation on Jassids *Empoasca kerri* (Pruthi**)** was recorded between 07:00 and 09:00 A.M. The population of jassids was observed by visually counting the jassids/trifoliate from five random plants twice a week during a standard meteorological week. The knockdown approach was used to study the thrips *Megalurothrips distalis* (L.) population. Observations were made from ten flowers by tapping each random plant twice on a white sheet of paper and then counting the fallen thrips. The incidence of pod bugs *Clavigralla gibbosa* (L.) was determined using the sweep net method. One sweep action is defined as the whole oscillation of the net from left to right and vice versa at an angle of 180^0. Five similar sweeps were carried out from five separate locations as part of a strategy to capture the pod bug. The captured pod bugs were numbered and documented before being released back into their natural surroundings. Observations were recorded twice a week, according to the standard meteorological week.

Field studies for screening of green gram germplasm against major insect pests of green gram

Seventy germplasms were screened against major insect pests of green gram as whiteflies/cage for *Bemisia tabaci*, thrips/10 flowers for *Megalurothrips distalis*, jassids/trifoliate for *Empoasca kerri*.and sweep net method for pod bug *Clavigralla gibbosa* and promising germplasms were selected for laboratory experiment.

Laboratory studies on screening of germplasm of green gram against *Spodoptera litura (*Fabricius)

The laboratory experiment was based on screening of twenty distinct genotypes which were found promising in field for resistance to *Spodoptera litura* (Fabricius) feeding. The experiment was carried out at the Morphology laboratory of the Department of Entomology, College of Agriculture Pantnagar, using a Completely Randomized Design (CRD) with three replications. Twenty germplasms were tested for resistance to *S. litura* (Fabricius) in comparison with the standard host. Standard hosts used were Castor and

Pant Mung 5 according to choose test between the favourable host and the test line followed by **(8).** The egg mass of *S. litura* were reared under laboratory conditions. Two sets of sixteen-square-centimeter leaf discs were placed in twenty petri dishes of the standard (A) and test (B) host plants coated with wet filter paper in an ABAB pattern. Seven days old, two hours starved larvae of *S. litura* were released at a rate of five larvae per petri dish in a Complete Randomized Design (CRD) with twenty treatments having three replications each. The experiment was carried out until more than 75% of the area of the standard host's leaf disc was eaten in any treatment. The consumed leaf area was measured using graph paper, and the preference index was computed using **Kogan and Goeden's formula (1970).**

C = 2B/ (A+B)

Where,

A = Feeding on standard host

B = Feeding on test host

Kogan and Goeden, (1970) established the preference index as the relative quantity of feeding on two plant/varieties present in the arena on a scale of 0 to +2. The following criteria were used to determine the preference of the test host over the regular host.

Table No. 2: Criteria for preference of test host with respect to standard host

C value	**Preference remark**
>1	Indicated a preference for the test plant
1	Feeding on test plant is equal with standard plant
<1	Indicated a lesser acceptance of the test plant
<0.5	Lower limit of acceptance of test plant
<0.1	Rejection of test plant

Plate 2: Screening of promising germplasms of green gram against *S. litura* under laboratory conditions

To check the impact of trichome density and length on feeding of *Spodoptera litura* in green gram using Scanning electron microscopy:

Promising germplasms under laboratory conditions in comparison with PM-05 were taken for the estimation of leaf pubescence parameter trichome length using Scanning electron Microscopy (SEM) at the Electron Microscopy Laboratory, College of Veterinary, GBPUA&T, Pantnagar in accordance with the standard protocol established by **(9).**

Standard protocol for imaging leaf under Scanning electron microscopy for Trichome density and length:

Fresh leaves from each test genotypes were collected and chopped into $5mm^2$ area and immediately submerged in separate vials containing 2.5 percent glutaraldehyde solution for primary fixation and stored overnight at 4°C. After that, the leaf specimens were rinsed three times with phosphate buffer solution (pH-7.2-7.4) for 15 minutes each. Dehydration of the specimen discs was performed using different grades of ethanol (30, 50, 70, 90 and 100%) each for a period of 15 minutes whereas the final dehydration (with 100% ethanol) was performed for 30 minutes. The specimens were dried to critical point in CO_2 at 5ºC and mounted on aluminium stub using double-sided carbon tape. Each specimen leaf disc was mounted with its lower surface up allowing the lower epidermal surfaces of each leaf to be examined. The mounted leaf specimens were sputter-coated with a thin layer of gold using an automated sputter coater JAFC 1600. Finally, the specimens were examined and imaged using JASM 6610LV Scanning Electron Microscope (**10**).

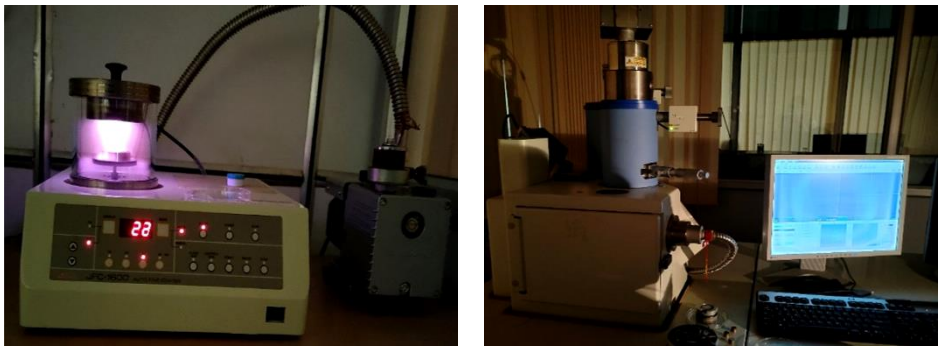

Plate 3: Steps for imaging leaf under scanning electron microscopy (SEM) for Trichome density and length

3. RESULT AND DISCUSSION

Different insect pests were associated at various stages of crop during spring season at NEBCRC, Pantnagar. In the present study insects that were found associated with green gram were whiteflies *Bemisia tabaci* (Gennadius), thrips *Megalurothrips distalis* (L.), jassids *Empoasca kerri* (Pruthi), tur pod bug *Clavigralla gibbosa* (L.). Infestations of *B. tabaci* and *E. kerri* were recorded during the vegetative stage of crop growth, while infestations of M. distalis were recorded during the flowering stage of crop growth, and *C. gibbosa* were recorded during the pod formation and maturation stage of crop growth **(Table 3).**

Table No.3: Population of major insect pests infesting green gram at various stages of crop growth during spring 2021.

Stage of crop growth	***Bemisia tabaci* (Whitefly/cage)**	***Megalurothrips distalis* (Thrips/10 flowers)**	***Empoasca kerri* (Jassids/trifoliate**	***Clavigralla gibbosa* (Bugs/5 sweeps)**
Vegetative stage	61 7.89	9 3.14	32 5.73	0 1.00
Flowering stage	38 6.24	71 8.47	20 4.57	3 1.98
Pod formation	25 5.08	31 5.65	15 3.98	38 6.23
Pod maturation	7 2.81	4 2.22	5 2.44	13 3.68
SEm±	**2.06 (0.18)**	**2.7 (0.22)**	**2.15 (0.31)**	**2.22 (0.27)**
C.D. P=0.05	**7.27(0.65)**	**9.53 (0.79)**	**7.59 (0.78)**	**7.95 (0.96)**

Parentheses values are square root transformed values $\sqrt{x+0.5}$

Study on population dynamics of major insect pests infesting spring green gram revealed that population of whitefly was recorded during 15th SMW with a low population of 6 whiteflies/cage and reached at peak with population of 38 whiteflies/cage in 17th SMW, after which its population declined significantly in upcoming standard weeks. Thrips incidence was highest at flower initiation stage. At 15th SMW population of thrips was found to be 9 thrips/10 flowers and reached peak at 19th SMW with 31 thrips/10 flowers. The jassids population first appeared during the 15th SMW with a population of 12 jassids/trifoliate, followed by rapid growth to a maximum population of 26 jassids/trifoliate during the

17th SMW, after which there was a gradual decrease in jassid population. Pod bugs in the field appeared at 17th SMW, with a sparse population of 4 bugs/5 sweeps, and continued until maturity. The population of bug attained peak of 26 bugs/5 sweeps during 19th SMW. This pest showed its major activity from flowering to pod maturity stage. **(Table 4)** The influence of meteorological factors on the population build-up of insect pests infesting the green gram was studied using correlation and regression analysis **(Table 5).**

Table No. 4 Correlation studies on major insect pests of green gram with weather parameters during *spring* 2021

Insect	Temperature ^{0}C		Relative humidity %		Rainfall mm	Sunshine hours	Wind velocity km/hr	Evaporation mm
	Max	Min	Max	Min				
Bemisia tabaci	0.898**	0.761*	0.984**	-0.374	-0.346	0.909 **	-0.191	0.317
Megalurothrips distalis	0.934**	0.959**	0.817*	0.911	0.672	-0.374	0.327	-0.651
Clavigralla gibbose	-0.346	0.435	-0.242	-0.215	-0.319	-0.348	0.118	-0.504
Empoasca kerri	0.710 *	0.638	-0.958	0.990**	0.862	0.371	0.114	-0.864**

* Significant at 5%

** Significant at 1%

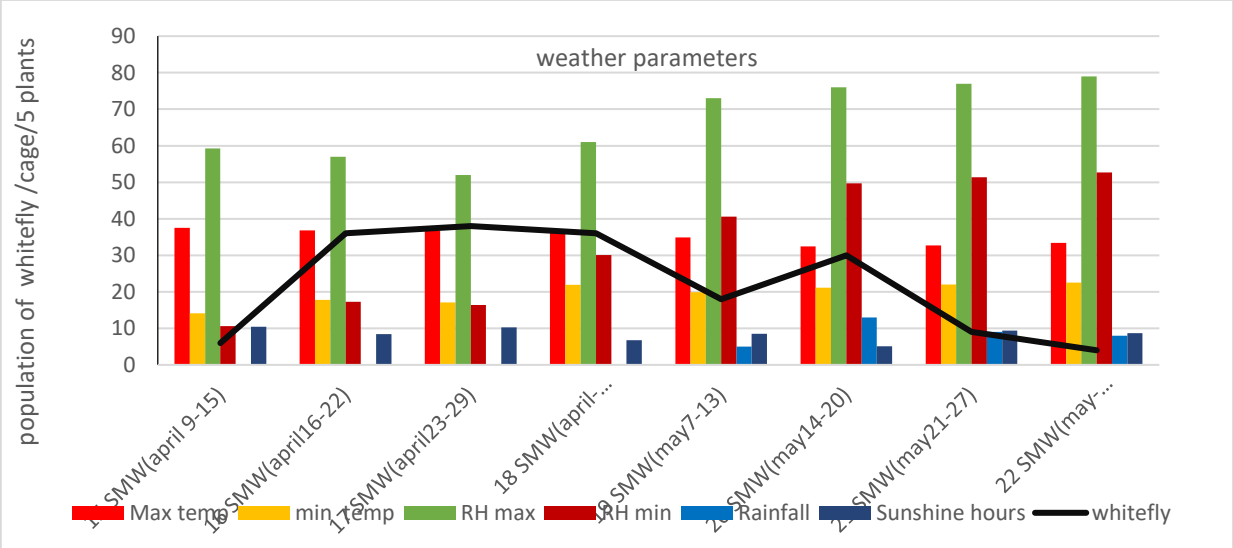

Fig. 1: Correlation of whitefly *B. tabaci* population with weather parameters during spring crop season 2021 at Pantnagar, Uttarakhand

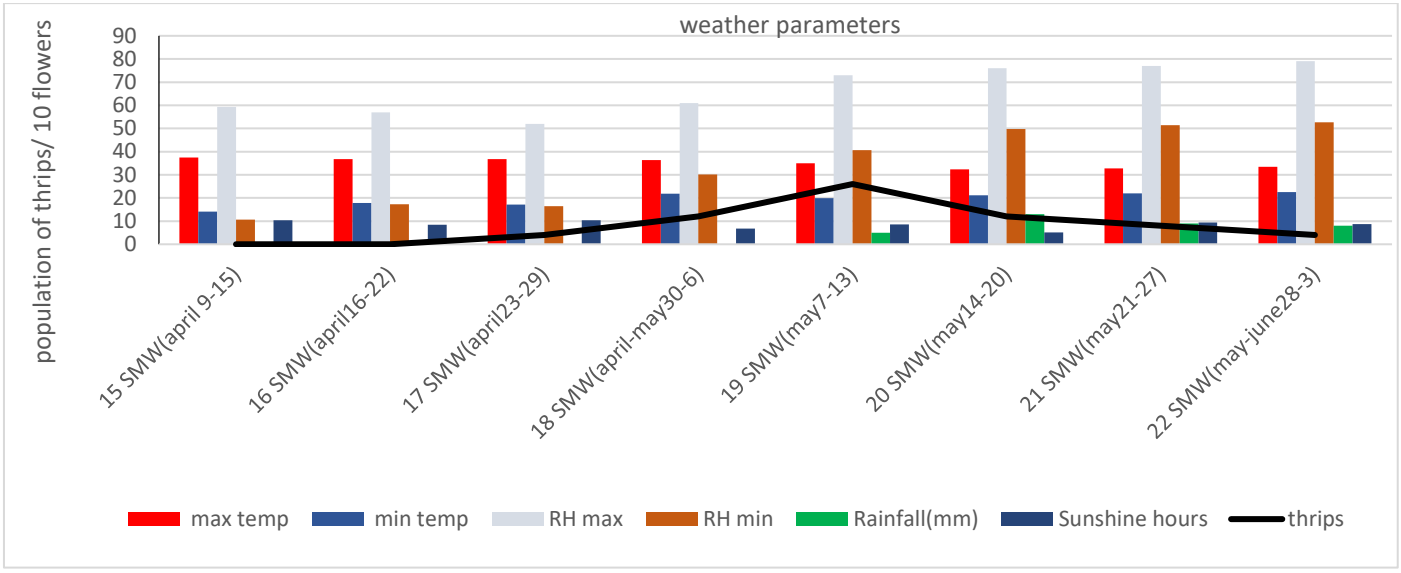

Fig. 2: Correlation of Thrips, *M. distalis* population with weather parameters during spring crop season 2021 2021 at Pantnagar, Uttarakhand

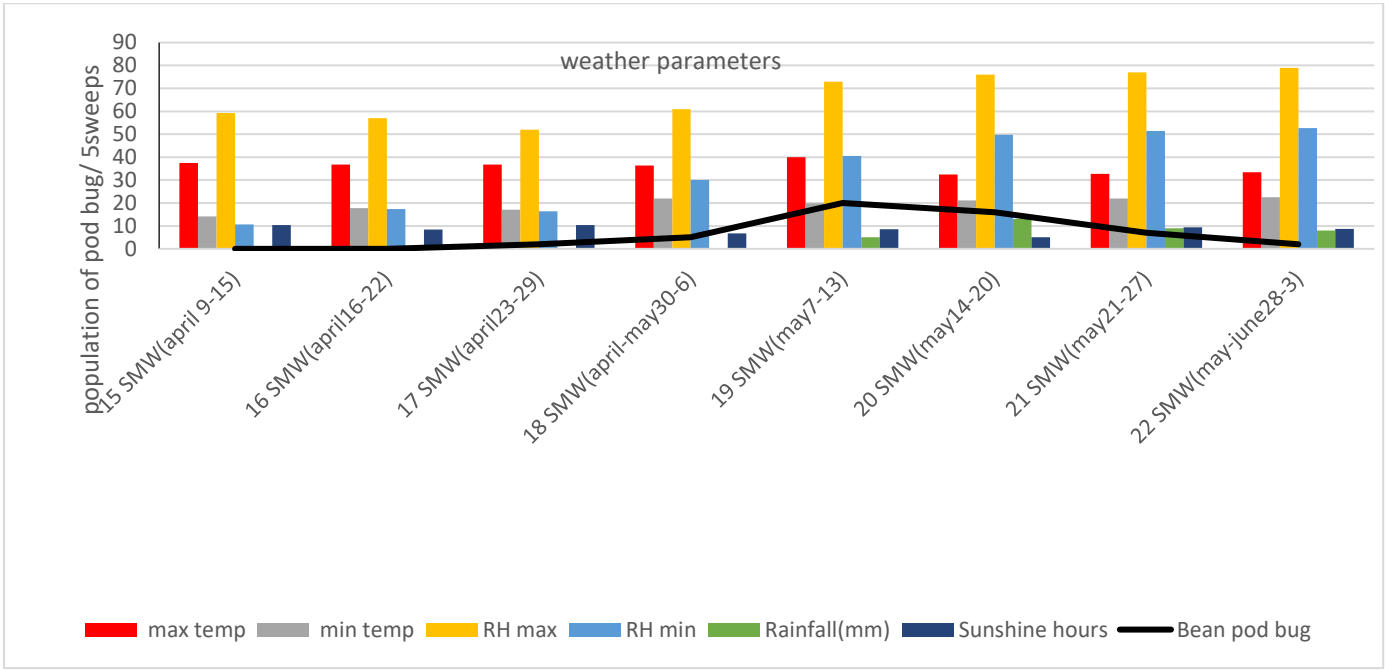

Fig. 3: Correlation of Pod bug, *C. gibbosa* population with weather parameters during spring crop season 2021 at Pantnagar, Uttarakhand

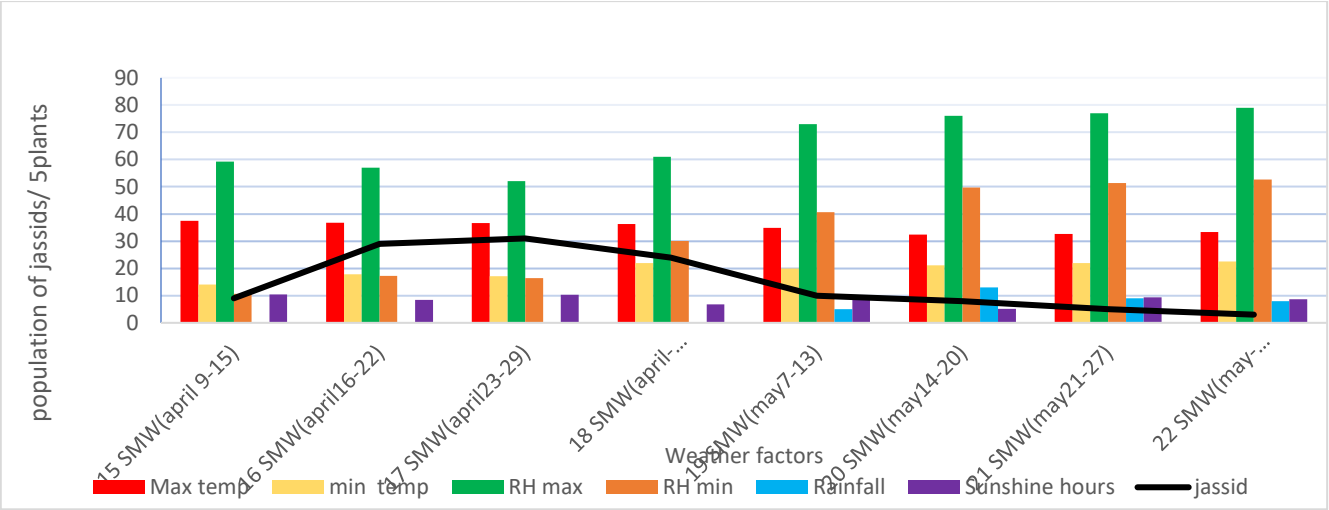

Fig. 4: Correlation of Jassids, *E. kerri* population with weather parameters during spring crop season 2021 at Pantnagar, Uttarakhand

Table No. 5 Regression analysis between weather parameters and population of major insect pests in green gram during spring 2021.

Name of insect	**Regression equation**	**Coefficient of determination**
Bemisia tabaci	$Y= 122.72-1.08X_1-2.55X_2-0.51X_3+0.92X_4-1.24X_5+0.97X_6$	0.96
Megalurothrips distalis	$Y= -287.39+5.35 X_1+4.87X_2+0.56X_3-0.92X_4+2.87X_5+2.10X_6$	0.99
Clavigralla gibbosa	$Y= -348.53+9.79 X_1+0.80 X_2-0.97 X_3+0.92 X_4+2.74 X_5+1.75 X_6$	0.98
Empoasca kerri	$Y= 328.42-2.38X_1-5.90X_2-2.47X_3+2.53X_4-3.34X_5-2.58X_6$	0.96

X_1= maximum temperature ^{0}C, X_2= minimum temperature ^{0}C, X_3= maximum R.H. %, X_4= minimum R.H. %, X_5= rainfall mm, X_6= sunshine hours

Castor as standard host

When castor was used as standard host, preference index varied significantly from 0.02 (SSME 21-48) to 1.00 (SSME 21-55) at P = 0.05 level of significance. Preference index (C-value) revealed that all breeding lines except SSME 21- 55 were not preferred host of S. litura in comparison to castor. Maximum preference index of tobacco caterpillar was found in germplasm SSME 21-55 (1.00) followed by SSME 21-15 (0.85) while minimum preference was seen in SSME 21- 48 (0.02) and SSME 21-41 (0.03). C-value revealed that among the twenty germplasm/varieties, two germplasm SSME 21-48 and SSME 21-41 were completely rejected by the tobacco caterpillar (C = 0.03 and 0.02) while, ten germplasm had lower limit of acceptance (C = < 0.5) and seven germplasm were reported to have lesser acceptance (C = < 1) by S. litura

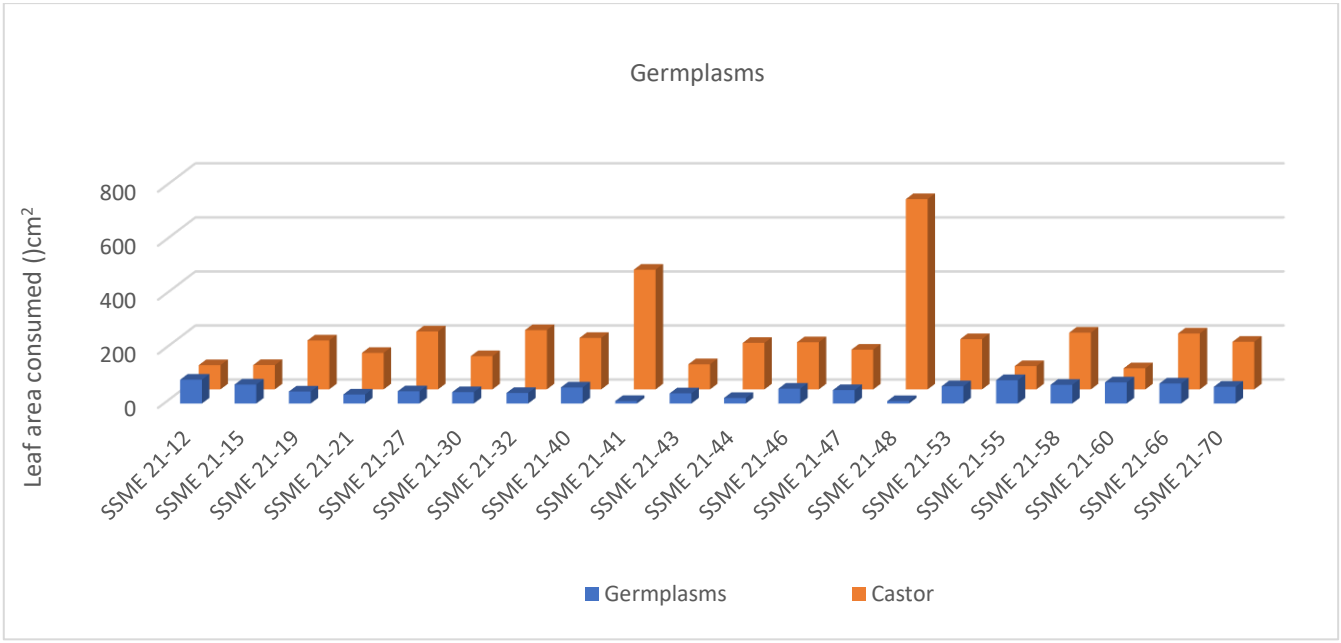

Fig. 5: Host preference of *S. litura* on green gram when standard host was castor

Pant Mung-5 as standard host

When PM-5 was taken as standard host, significant variation in preference index was recorded from SSME 21-70 (0.01) to SSME 21-43 (1.16) at P = 0.05. The C value of SSME 21-70 (C = 0.01) followed by SSME 21-55 (C = 0.02) while, highest 'C' value was in germplasm SSME 21-43 (C = 1.16). This study revealed that two germplasms were completely rejected by the larva as compared to PM 05. However, among the twenty tested germplasm, one germplasm *viz.*, SSME 21-47 was found to have lower limit of acceptance (C = < 0.5) and seventeen germplasm *viz.*, SSME 21-12, SSME 21-15, SSME 21-19, SSME 21-21, SSME 21-27, SSME 21-30, SSME 21-32, SSME 21-40, SSME 21-41, SSME 21-43, SSME 21-44, SSME 21-46, SSME 21-48, SSME 21-53, SSME 21-58, SSME 21-60, SSME 21-66 had lesser acceptance (C < 1) by tobacco caterpillar with respect to standard host (PM-05).

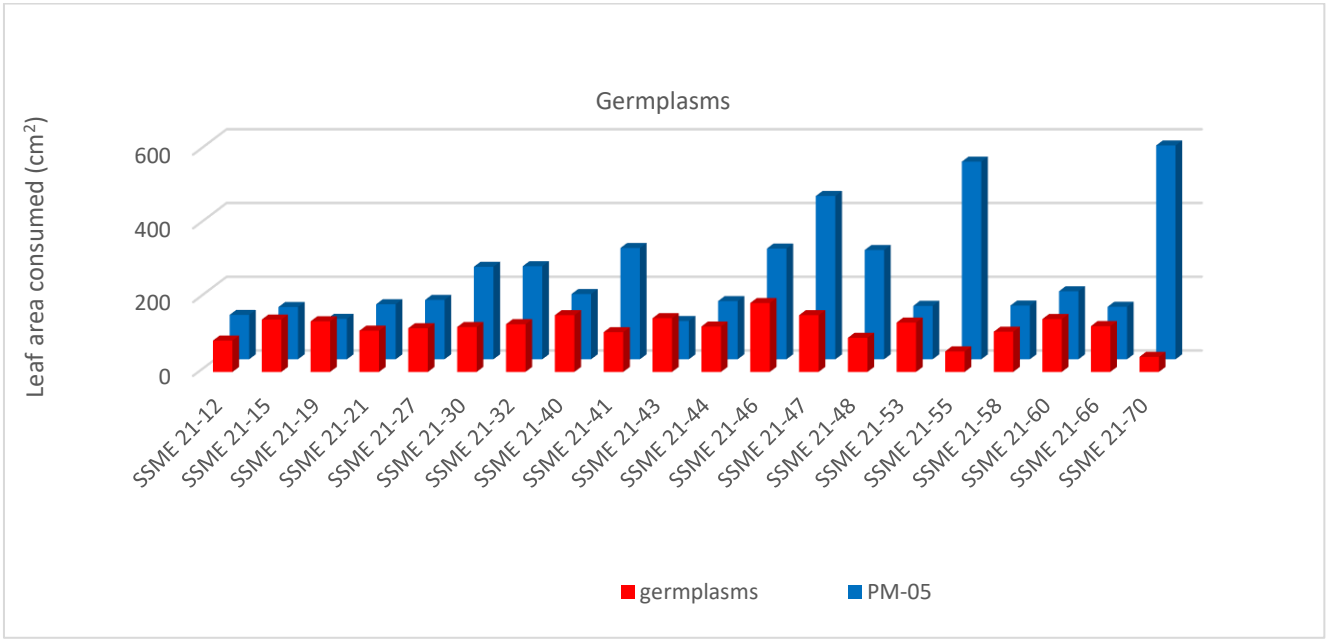

Fig. 6: Host preference of *S litura* when standard host was Pant Mung-5.

Trichome density and length on leaves of promising green gram germplasms

The results of the trichome density and trichome length in least susceptible green gram germplasms are presented in Table.6 and Fig.7. In the previous experiment performed on the basis 'C value' it was observed that the non-glandular trichomes were observed in least susceptible germplasms and check of green gram. The length of non-glandular trichomes varied significantly between the germplasms. The highest trichome density was observed in SSME 21-70(193.0a) followed by SSME21-55 having 181.3d, SSME 21-48 (155.6c), SSME 21-41 (139.0b) as compared to PM-05 having 104.3a. The number of non-glandular trichomes observed in lower leaf surface varied significantly among the germplasms. The maximum number of trichomes was observed in SSME 21-70 (215.6e) followed by SSME 21-55 (194.6d), SSME 21-48 (172.6c) and SSME 21-41 (149.0b) as compared to PM-05 (118.3a). The length of trichomes on leaves of promising green gram germplasm are presented in **Table. 7**. The maximum length of non-glandular trichomes was observed in SSME 21-70 (1357d) followed by SSME 21-55 (1186.3c), SSME 21-48 (1173.3c) and SSME 21-41 (1031.7b) as compared to PM-05 having trichome length (918a). More number of trichomes were observed in lower surface as compared to upper surface. Similar trend was seen in estimation of trichome length.

Table 6: Trichome density and Trichome length on leaves of promising germplasms of green gram.

Germplasm	Trichome density on lower leaf surface per 5mm^2	Trichome density on upper leaf surface per 5mm^2	Trichome length µm
SSME 21-70	215.6^e	193.0^e	1357.0^d
SSME 21-55	194.6^d	181.3^d	1186.3^c
SSME 21-48	172.6^c	155.6^c	1173.3^c
SSME 21-41	149.0^b	139.0^b	1031.7^b
PM-05	118.3^a	104.3^a	918.0^a
CD at 5%	**0.243**	**0.307**	**0.004**
SEm±	**0.076**	**0.096**	**0.001**

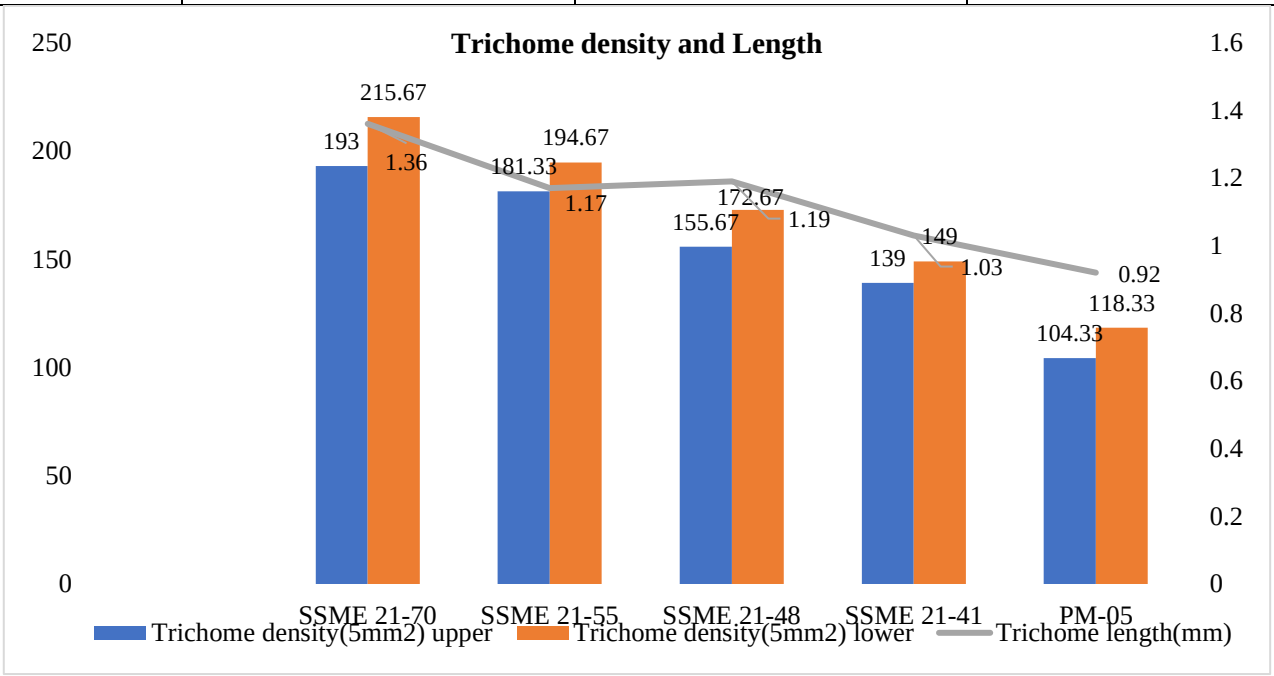

Fig. 7: Trichome Density and Length of promising germplasms under laboratory conditions

Screening of green gram germplasms against major insect pests under field conditions revealed that mean whitefly population was least in SSME 21-70 (1.41) followed by SSME 21-55 (1.52) as compared to check PM-05 (3.99 whiteflies/cage), for thrips lowest incidence was recorded in germplasm SSME 21-70 (1.52 thrips/10 flowers) followed by SSME 21-53 (1.80) as compared to PM 05 (3.69 thrips/10 flowers), for jassids minimum population was recorded in SSME 21-48 (1.41) followed by SSME 21-24 (3.91) as compared to PM 05 (3.69 thrips/10 flowers) similarly, for pod bug lowest incidence was recorded in germplasm SSME 21-70 (1 bug/5 sweeps) followed by SSME 21-55 (1.71 bugs/5 sweeps) as compared to PM 05 (2.93 bugs/5 sweeps).

Results of laboratory revealed that when castor was used as standard host, preference index varied significantly from 0.02 (SSME 21-48) to 1.00 (SSME 21-55) at P = 0.05 level of significance. C-value revealed that among the twenty germplasm/varieties, two germplasm SSME 21-48 and SSME 21-41 were completely rejected by the tobacco caterpillar (C = 0.03 and 0.02) while, ten germplasm had lower limit of acceptance (C = < 0.5) and seven germplasm were reported to have lesser acceptance (C = < 1) by *S. litura*. When PM-5 was taken as standard host, significant variation in preference index was recorded from SSME 21-70 (0.01) to SSME 21-43 (1.16) at P = 0.05. C-value revealed that two germplasms were completely rejected by the larva as compared to PM 05. However, among the twenty tested germplasm, one germplasm *viz.*, SSME 21-47 was found to have lower limit of acceptance (C = < 0.5) and seventeen germplasm had lesser acceptance (C < 1) by tobacco caterpillar with respect to standard host (PM-05). The less susceptible germplasms were observed to evaluate trichome density and trichome length using Scanning electron microscopy (SEM) the results revealed that the non-glandular trichomes were observed in least susceptible. In upper surface non-glandular trichomes varies significantly among the germplasms the highest trichome density was observed in SSME 21-70 (193.0^{a}) followed by SSME 21-55 having $181.3^{d,}$ SSME 21-48 (155.6^{c}), SSME 21-41 (139.0^{b}) as compared to PM-05 having 104.3^{a}. The number of non-glandular trichomes observed in lower leaf surface varied significantly among the germplasms. The maximum number of trichomes were observed in SSME 21-70 (215.6^{e}) followed by SSME 21-55 (194.6^{d}), SSME 21-48 (172.6^{c}) and SSME 21-41 (149.0^{b}) as compared to PM-05 (118.3^{a}). The maximum length of non-glandular trichomes was observed in SSME 21-70 (1357^{d}) followed by SSME 21-55 (1186.3^{c}), SSME 21-48 (1173.3^{c}) and SSME 21-41 (1031.7^{b}) as compared to PM-05 having trichome length (918^{a}). Comparatively higher non-glandular trichomes were observed in resistant germplasm SSME 21-70 followed by SSME 21-55, SSME 21-48 and SSME 21-41 and shortest length of trichomes were seen in PM-05.

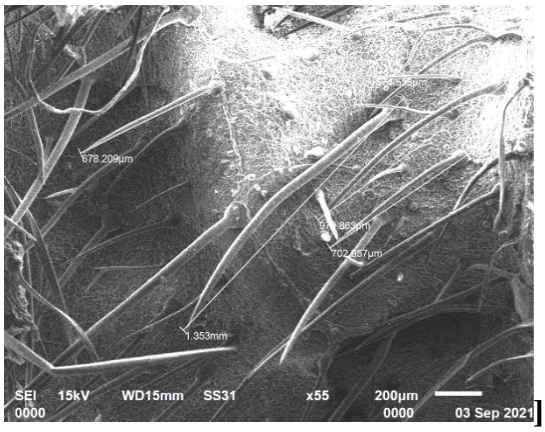

Plate 4 a) Highly resistant germplasm (SSME 21-70)

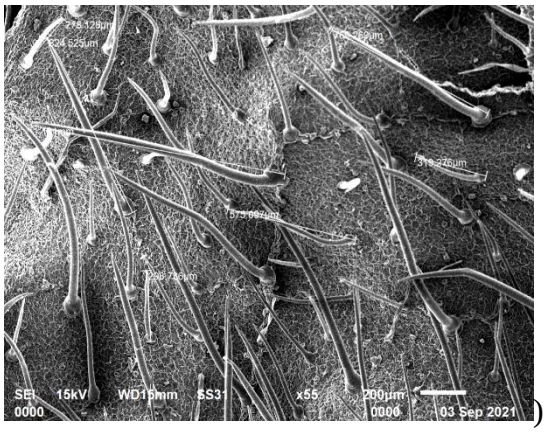

Plate 4 b) Highly resistant germplasm (SSME 21-55)

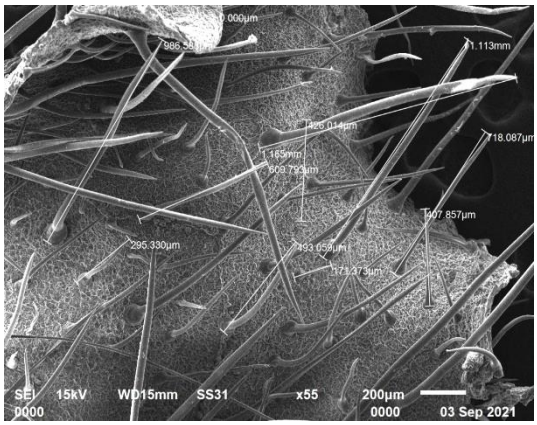

Plate 4 c) Moderately resistant germplasm (SSME 21-48)

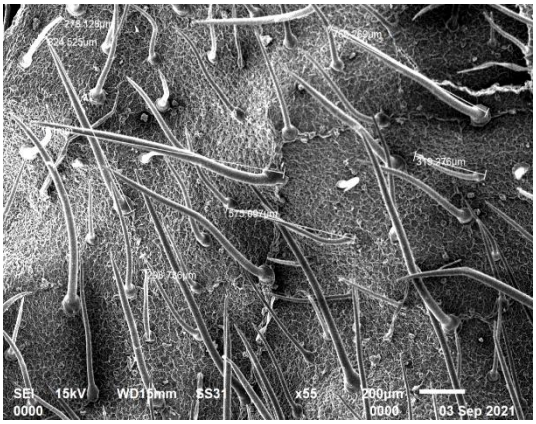

Plate 4 d) Moderately resistant germplasm (SSME 21-41)

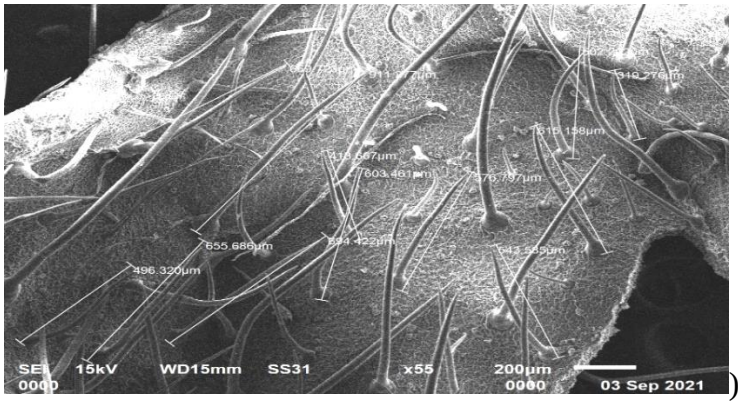

Plate 4 e) PM-05

4. CONCLUSION

During the investigation, four major insects belonging to three orders and four families were reported from *spring* green gram. The insects that attack in vegetative stage of the crop were jassids and whiteflies. Thereafter, insects attacking at flowering and initial pod formation stage were sucking bugs *viz.,* pod bug and flower thrips. The study concluded that SSME 21-70 and SSME 21-55 germplasms were found promising in field as well as under Laboratory conditions and least preferred by *S. litura* with highest trichome density as well as length which can be further utilized in experimental trials.

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