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RESEARCH PAPER

Identification of potential resistant genotypes against defoliators in soybean

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Abstract: Investigation was carried out at the All India Co-ordinated Research Project (AICRP) on Soybean, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif* 2023. Among 22 soybean genotypes screened for the resistance against defoliators including *Spodoptera litura* (Fab.), *Thysanoplusia orichalcea* (Fab.) and *Spilarctia obliqua* (Walk.) the genotype SL 1311 was found to be a superior over rest of genotypes with least per cent defoliation (12.07) and categorized as highly resistant. It was followed by genotypes VLS 108 and AMS 2021-3 with comparatively least per cent defoliation (16.52 and 16.80%, respectively) and was classified as resistant. Moderately resistant genotypes included Himso 1696, DSb 40, NRC 258 and AS 34. Genotypes KDS 1203, NRCSL 5, MACS 1756, JS 24-34, MAUS 824, KDS 1188 and Pusa Nipani 433 were categorized as least resistant. Genotypes NRC 257, RSC 1172, MAUS 814 and DSb 39 were susceptible. Furthermore, the genotypes NRC 259, NRC 260, AMS 2021-4 and JS 335 showed the most severe levels of defoliation (33.03, 32.42, 32.41 and 34.41%, respectively) and categorized as highly susceptible. Correlation studies revealed that biophysical traits such as thicker leaves and higher trichome density were linked to greater resistance and reducing rate of defoliation.

Key words: Biophysical parameters, Defoliators, Genotypes, Soybean

Introduction

Soybean (*Glycine max* (Linn.) Merrill) is one of the oldest legume in the history of crop cultivation. Soybean supplies half of the global demand for vegetable oil and protein (Oerke and Dehne, 2004). Soybean was originated in China about 5000 years ago, gaining global significance by the late 18th century, its introduction to India as a food source occurred notably in 1935 (Sharma, 1996). Soybean holds significant importance globally due to its adaptability, nutritional value, unique chemical composition and diverse end-uses. In India, soybean cultivation spans approximately 11.85 million hectares, with a total production of 11.87 million metric tons and an average productivity of 1002 kilograms per hectare (SOPA, 2023). The luxurious growth of soybean crop, characterized by soft and succulent foliage, attracts a multitude of insects, providing them with an abundant supply of food, space and shelter. Luckmann (1971) stated that around 380 insect species have been identified on soybean crops across different regions of the world. Among them, defoliators such as tobacco caterpillar, *Spodoptera litura*, semilooper, *Thysanoplusia orichalcea* and Bihar hairy caterpillar, *Spilarctia obliqua* pose substantial threats by feeding on foliage, flowers and pods consequently leading to considerable yield losses (Singh and Singh, 1990).

Sustainable agriculture is greatly aided by encouraging the adoption of pest-resistant crop cultivars. These resistant cultivars contribute to the general well-being of agricultural ecosystems by reducing the need on hazardous chemical pesticides and considerably lowering yield losses caused by insect pests. In this context field screening trail was undertaken to identify potential resistant genotypes against defoliators using All India Co-ordinated Research Project on Soybean (AICRPS) method of categorization by considering mean and critical difference value.

Material and methods

About 22 soybean genotypes obtained from All India Co-ordinated Research Project on Soybean, Indore and AICRP on Soybean, University of Agricultural Sciences, Dharwad center were evaluated in the field condition to find out their resistance against defoliators. Field experiment was carried at the AICRP on Soybean, Main Agricultural Research Station, Dharwad during *kharif* 2023 in Randomized Block Design with two replications. Each of the soybean genotypes were sown in three rows of 3 m length with a spacing of 30 cm × 10 cm and susceptible check JS 335 was sown after every five genotypes. Crop was raised as per the package of practices, except plant protection measures against defoliators.

Observations on larval population of leaf eating caterpillars *viz*., *S. litura*, *T. orichalcea* and *S. obliqua* were recorded at three randomly selected spots of one meter row length (mrl) in each genotype and mean was reported in numbers per mrl. Total per cent defoliation was recorded on five randomly selected plants based on visual observation by following standard procedure. Five plants were selected randomly from each plot for recording observations on various biophysical parameters *viz*., leaf thickness (mm) and trichome density (No per 5 mm^2). Similarly, correlation coefficient analysis was worked out to explore the relationship between different biophysical parameters of soybean genotypes with defoliator infestation. The seed yield of soybean per plot was recorded and computed to quintals per hectare.

Results and discussion

Population of *S. litura* was recorded at 30, 40, 50, 60 and 70 days after germination. The genotype SL 1311 recorded the least mean population of 2.44 larvae per mrl and it was followed by genotypes VLS 105, AMS 2021-3, Himso 1696 with mean larval population of 2.72, 2.80 and 2.98 per mrl, respectively. In other hand genotype JS 335 had the highest mean larval population across all time intervals, with an average of 5.07 larvae per mrl and it was followed by NRC 259 and NRC 260 with 5.00 and 4.89 larvae per mrl, respectively. These findings are supported by the reports of Muralidhar *et al*. (2021) who opined that soybean genotypes JS 20-98, NRC 116, KDS 753, RVS 2008-24, RSC 10-46, KDS 869 and RVS 2008-8 were highly resistant to *S. litura* and recorded the least larval population of 1.17, 1.18, 1.40, 1.70, 1.83, 2.17 and 2.18 larvae/mrl, respectively, whereas JS 335 was highly susceptible to *S. litura* and recorded the 7.00 larvae/mrl.

Table 1. Larval population, per cent defoliation, yield and reaction of different soybean genotypes against defoliators

Genotypes	Mean larval population of defoliators per mrl			Defoliation (%)					Yield (q/ha)	Reaction to defoliators
	Spodoptera litura	*Thysanoplusia orichalcea*	*Spilarctia obliqua*	30 DAG	45 DAG	60 DAG	75 DAG	Mean		
AMS 2021-3	2.80	0.55	1.93	9.15^{ab}	16.65^{b}	23.05^{b}	18.35^{b}	16.80	20.68^{a}	R
AMS 2021-4	4.66	1.33	4.19	17.15^{hi}	33.63^{ij}	45.00^{gh}	33.85^{g-i}	32.41	12.29^{e-g}	HS
AS 34	3.74	0.69	2.65	10.85^{b-d}	21.30^{d-f}	27.75^{b-d}	22.30^{b-e}	20.55	16.22^{cd}	MR
DSb 39	4.77	1.19	4.18	17.85^{hi}	30.91^{h-j}	45.10^{gh}	30.35^{f-g}	31.25	12.89^{d-g}	S
DSb 40	3.39	0.61	2.24	10.35^{bc}	20.43^{b-d}	26.30^{bc}	21.60^{b-d}	19.67	18.99^{a-c}	MR
Himso 1696	2.98	0.59	2.08	9.70^{ab}	20.10^{b-d}	26.15^{bc}	21.35^{bc}	19.33	19.69^{ab}	MR
JS 24-34	3.91	0.72	3.03	12.75^{c-e}	25.50^{e-g}	31.25^{c-e}	25.92^{c-f}	23.85	15.96^{cd}	LR
KDS 1188	4.24	1.21	3.98	17.25^{hi}	25.73^{fg}	41.75^{gh}	28.77^{fg}	28.37	13.56^{d-g}	LR
KDS 1203	3.98	0.99	3.34	13.95^{e-g}	26.85^{g-i}	34.35^{d-f}	26.75^{ef}	25.48	14.74^{d-f}	LR
MACS 1756	4.39	1.10	3.59	15.30^{e-h}	27.93^{g-i}	37.40^{e-g}	27.90	27.13	14.63^{d-f}	LR
MAUS 814	4.33	1.13	3.85	16.10^{f-i}	26.75^{g-i}	41.95^{f-h}	29.95^{f-h}	28.69	13.83^{d-g}	S
MAUS 824	4.29	1.18	3.53	16.60^{g-i}	28.35^{g-i}	42.55^{gh}	28.25^{f}	28.94	14.18^{d-f}	LR
NRC 257	4.77	1.07	4.08	16.90^{g-i}	26.09^{gh}	41.75^{gh}	30.20^{f-h}	28.73	13.50^{d-g}	S
NRC 258	3.57	0.66	2.35	10.65^{bc}	20.95^{c-e}	27.40^{b-d}	22.25^{b-e}	20.31	16.50^{b-d}	MR
NRC 259	5.00	1.43	4.39	18.15^{hi}	31.75^{ij}	46.45^{h}	35.78^{i}	33.03	10.39^{g}	HS
NRC 260	4.89	1.38	4.17	17.45^{hi}	31.78^{ij}	45.35^{h}	35.10^{hi}	32.42	11.22^{fg}	HS
NRCSL 5	4.02	0.86	3.11	13.35^{d-f}	25.89^{f-h}	31.15^{c-e}	26.24^{d-f}	24.16	15.18^{de}	LR
Pusa Nipani 433	4.24	0.73	3.20	12.91^{c-e}	25.78^{fg}	32.30^{c-e}	26.15^{d-f}	24.28	15.64^{c-e}	LR
RSC 1172	4.36	1.31	3.90	16.10^{f-i}	24.03^{d-g}	41.30^{fg}	29.05^{fg}	27.62	14.95^{de}	S
SL 1311	2.44	0.44	1.56	7.70^{a}	11.15^{a}	16.10^{a}	13.32^{a}	12.07	21.25^{a}	HR
VLS 105	2.72	0.53	1.81	8.70^{ab}	16.43^{b}	22.80^{b}	18.15^{b}	16.52	20.87^{a}	R
JS 335 (SC)	5.07	1.51	4.58	18.45^{i}	35.55^{j}	46.80^{h}	36.85^{i}	34.41	10.29^{g}	HS
S.Em. ±	-	-	-	0.85	1.32	1.93	1.45	-	0.87	-
C.D. at 5 %	-	-	-	2.51	3.89	5.67	4.26	-	2.57	-
C.V.(%)	-	-	-	10.58	9.11	9.48	9.37	-	9.86	-

mrl- meter row length, DAG-Days after germination, SC – Susceptible check, HR - Highly Resistant, R- Resistant, MR –Moderately Resistant, LR - Low Resistant, S – Susceptible, HS - Highly Susceptible, Means followed by the same alphabet are do not differ significantly by DMRT (P=0.05)

The incidence of *T. orichalcea* was observed during 40 DAG. The larval population of *T. orichalcea* remained relatively low throughout the study period. The genotype SL 1311 recorded the least mean population with 0.44 larvae per mrl and it was followed by genotypes VLS 105, AMS 2021-3 and Himso 1696 with mean larval population of 0.53, 0.55 and 0.59 per mrl, respectively. In contrast the genotypes JS 335 witnessed highest mean larval population with an average of 1.51 larvae per mrl and it was followed by genotypes NRC 259 and NRC 260 with 1.43 and 1.38 larvae per mrl, respectively. These findings are consistent with Kumar and Yadav (2022) who noticed that the minimum population of *T. orichalcea* was recorded on genotype JS-20-34 (1.10 larvae/mrl). The maximum larval population of *T. orichalcea* was recorded on cultivars AMS-100-39 (1.90 larvae/mrl).

The least mean larval population of *S. obliqua* was recorded on genotype SL 1311 with 1.56 larvae per mrl and it was followed by genotypes VLS 105, AMS 2021-3 and Himso 1696 were recorded the mean larval population of 1.81, 1.93 and 2.08 per mrl, respectively. In contrast the genotype JS 335 displayed highest mean larval population with an average of 4.58 larvae per mrl and it was followed by NRC 259 and AMS 2021-4 with 4.39 and 4.19 larvae per mrl, respectively (Table 1).

The present investigation demonstrated significant variability in defoliation percentages among soybean genotypes across different growth stages due to different defoliators. Among 22 genotypes tested, SL 1311 exhibited the lowest average defoliation rate of 12.07 per cent, indicated its resistance over rest of the genotypes. It was followed by genotypes VLS 105 and AMS 2021-3 with average defoliation of 16.52 and 16.80 per cent, respectively. The genotypes Himso 1696

Table 2. Morphological characters of different soybean genotypes influencing defoliators infestation

Genotypes	Leaf thickness (mm)	Leaf trichome density (No. per 5 mm^2)
AMS 2021-3	0.32	108.67
AMS 2021-4	0.21	33.67
AS 34	0.29	132.17
DSb 39	0.28	31.83
DSb 40	0.31	142.54
Himso 1696	0.29	123.17
JS 24-34	0.27	101.67
KDS 1188	0.23	35.34
KDS 1203	0.25	55.12
MACS 1756	0.23	88.33
MAUS 814	0.19	35.17
MAUS 824	0.22	39.34
NRC 257	0.23	42.67
NRC 258	0.32	121.12
NRC 259	0.18	47.06
NRC 260	0.19	58.33
NRCSL 5	0.27	50.50
Pusa Nipani 433	0.27	34.50
19RSC 1172	0.24	37.33
20SL 1311	0.34	159.50
21VLS 105	0.31	140.50
22JS 335 (SC)	0.22	37.83
Correlation coefficient	-0.891**	-0.734**

SC - Susceptible check, ** Significance at 0.01 level

Table 3. Categorization of soybean genotypes for their relative resistance against defoliators

Class	Genotypes
Highly Resistant (HR)	SL 1311
Resistant (R)	VLS 108, AMS 2021-3
Moderately Resistant (MR)	Himso 1696, DSb 40, NRC 258, AS 34
Low Resistant (LR)	KDS1203, NRCSL 5, MACS6, JS 24-34, MAUS 824, KDS 1188,Pusa Nipani 433
Susceptible (S)	NRC 257, RSC 1172, MAUS 814, DSb 39
Highly Susceptible (HS)	NRC 259, NRC 260, AMS 2021-4, JS 335

(19.33%), DSb 40 (19.67%), NRC 258 (20.3%) and AS 34 (20.55%) displayed a relatively lower per cent defoliation and indicated moderate resistance. In contrast, genotypes JS 335, NRC 259, NRC 260 and AMS 2021-4 were the most susceptible genotypes and registered the mean defoliation of 34.41, 33.03 and 32.42 per cent respectively. This may be due to their genetic susceptibility, lack of structural and chemical defenses, which could cause serious pest damage, particularly at the later growth stages of the crop (Table 1).

These findings are conformity with the reports of Swathi (2018) evaluated 17 genotypes and identified the genotype DSb 15 as a highly resistant to defoliation (20.04%) and conversely JS 335 as highly susceptible genotype and registered 69.80 per cent defoliation. Similarly, Manu and Patil (2015) has documented that genotypes DSb 21 (16.67%) and DSb 1 (21.11%) exhibited the least per cent defoliation and categorized as resistant genotypes against soybean defoliators.

The maximum yield was recorded by genotypes SL 1311 (21.25 q/ha), VLS 105 (20.87 q/ha) and AMS 2021-3 (20.68 q/ha). These genotypes were resistant to defoliators, either through structural defenses like thicker leaves or chemical defenses that deter insect pests, enabling them to maintain higher productivity. In contrast, genotypes like JS 335, NRC 259, and NRC 260 were highly susceptibility to defoliation and produced lower yields of 10.29, 10.39 and 11.22 q/ ha, respectively. This low yield may be due to greater leaf damage, which likely reduced the plant's ability to photosynthesize effectively and allocate resources to seed development. Swathi (2018) reported the maximum grain yield of soybean from the genotype DSb 23 (17.35 q/ha) and DSb 1 (17.05 q/ ha) with least per cent leaf damage by the defoliators (Table 1).

The correlation between biophysical parameters of 22 genotypes of soybean and the per cent defoliation indicated that there was a significant negative correlation with the per cent defoliation for both leaf thickness and leaf trichome density with correlation coefficients of -0.891 and -0.734, respectively. Among the 22 genotypes assessed, SL 1311 (0.34 mm) exhibited the maximum leaf thickness, followed by genotypes AMS 2021-3 (0.32 mm) and NRC 258 (0.32 mm). Conversely, the minimum leaf thickness was observed in NRC 259 (0.18 mm) and NRC 260 (0.19 mm), they were more susceptible to defoliators.

The highest leaf trichome density was observed in the genotypes SL 1311 and DSb 40 with 159.50 and 142.54 trichomes per 5 mm², respectively and were found to have lower per cent defoliation. The genotypes like AS 34, Himso 1696 and NRC 258 displayed a leaf trichome density of 132.17, 123.17 and 121.12 trichomes per 5 mm² leaf area and demonstrated moderate resistance to defoliators. On the other hand, the least trichome density was found in DSb 39 and AMS 2021-4 with 31.83 and 33.67 trichomes per 5 mm², respectively. The present findings are aligned with findings of Nautiyal *et al*. (2015) they reported a highly significant negative correlation between leaf trichome density and per cent defoliation. Similarly, Sasane *et al*. (2018) found that per cent leaf damage was strongly and negatively correlated with leaf thickness and trichome density on the leaf surface (Table 2).

The genotypes were classified into different categories of resistance as per the All India Co-ordinated Research Project on Soybean method of classification based on per cent defoliation. Genotype SL 1311 was categorized as highly resistant. The genotypes VLS 108 and AMS 2021-3 were categorized as resistant. Genotypes such as Himso 1696, DSb 40, NRC 258 and AS 34 were identified as moderately resistant. Least resistant genotypes included KDS 1203, NRCSL 5, MACS 1756, JS 24-34, MAUS 824, KDS 1188 and Pusa Nipani 433. The genotypes NRC 257, RSC 1172, MAUS 814 and DSb 39 were found to be susceptible. Finally, NRC 259, NRC 260, AMS 2021-4 and JS 335 were classified as highly susceptible (Table 3).

Conclusion

Among 22 genotypes screened, SL 1311 was highly resistant. Whereas, the genotypes VLS 105 and AMS 2021-3 were categorized as a resistant with lower larval populations and defoliation rates. Genotypes Himso 1696, DSb 40, NRC 258 and AS 34 were categorized as moderately resistant. Whereas, JS 335, NRC 259 and NRC 260 exhibited high susceptibility to defoliators, resulted in significant foliage damage. Biophysical traits like, thicker leaves and dense leaf trichome of resistant genotypes were associated with lower per cent defoliation. Susceptible genotypes displayed a thinner leaf and sparse trichome density. Overall, genotypes SL 1311, VLS 105 and AMS 2021-3 were proved promising in terms of seed yield, demonstrated resilience to defoliators. Whereas, the genotypes NRC 259, NRC 260 and JS 335 recorded the least grain yield due to higher per cent defoliation and they were significantly inferior and highly susceptible among the genotypes evaluated.

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