Chapter 7

Screening of Soybean (*Glycine Max* (L.) Merrill) Genotypes for Resistance to Rust, Yellow Mosaic and Pod Shattering

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Additional information is available at the end of the chapter

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1. Introduction

Soybean (Glycine max (L.) Merrill) is known as 'Golden bean' and miracle crop of 20th century. Soybean is a native of North China, Asia belongs to family fabaceae. It is a versatile and fascinating crop with innumerable possibilities of not only improving agriculture but also supporting industries. Soybean besides having high yielding potential (40-45 q/ha) also provides cholesterol free oil (20%) and high quality protein (40%). It is a rich source of lysine (6.4%) in addition to other essential amino acids, vitamins and minerals. Its oil is also used as a raw material in manufacturing antibiotics, paints, varnishes, adhesives and lubricants etc.

Like other economically important crops soybean is also suffering from many diseases viz, rust (*Phakopsora pachyrhizi* Syd.) and yellow mosaic (Mungbean Yellow Mosaic Virus) are the major disease under Indian conditions, which causes considerable reduction in yield up to 80 per cent under severe conditions [3]. Further, another major problem in soybean is pods shattering which also reduces yield and in some varieties 100 per cent yield losses have been observed. The extent of yield loss due to pod shattering may range from negligible to significance levels depending upon the time of harvesting, environmental condition and genetic endowment of the variety [11]. Hence screening for soybean genotypes for identifying resistance to above major problems with high yielding potential will help to increase the production to a greater extent.

2. Materials and methods

The material consisted of 84 genotypes of soybean originated from different places of India and abroad. The experiment was laid in augmented design at the Research Farm of Kisan (PG) College, Simbhaoli, Ghaziabad, during *kharif*, season of 2008. In each replication the genotypes were grown in 2 m long rows with spacing of 40cm × 10cm for row to row and plant to plant, respectively. Within a row, seeds were hand dibbled 10 cm apart. Standard package of practices was followed to raise the crop. Ten competitive plants were randomly selected from each treatment in each replication and data were recorded on 3 qualitative characters namely, pod shattering resistance, rust resistance and yellow mosaic disease resistance.

2.1. Screening for pod shattering resistance

The pod shattering resistance was recorded at physiological maturity of the pod. The screening was done under laboratory condition by following the methodology adopted by IITA [4]. The results were recorded as percentage of pod shattering. IITA method of calculating pod shattering under lab conditions:

A sample of 25 pods were collected and kept in oven at 40°C for 7 days.

On the 7th day the number of shattered pods were counted and expressed in percentage as below,

Number of pods shattered

Pod shattering percentage (%) = x 100

Total number of pods

The genotypes were classified into different categories based on their reaction to pod shattering. The scoring rate was followed according to method adopted by IITA.

Sl.No	Category Resistant reaction
1.	No pod shattering Shattering resistant
2.	<25% pod shattering Shattering tolerant
3.	25-50% pod shattering Moderately shattering
4.	51-75% pod shattering Highly shattering
5.	>75% pod shattering very highly shattering

2.2. Screening for rust resistance

The scoring for rust was done just after initiation of flowering and before pod formation. The observations were taken on lower, middle and upper leaves for density of pustule and

sporulating intensity. Based on the symptoms, pustule density and sporulation intensity grades were given. The genotypes were later grouped into different categories from immune to highly susceptible. The scale (0-9) used was as follows:

Sl. No.	Scale	Category
1.	0	Immune
2.	1	Resistant
3.	3	Moderately resistant
4.	5	Moderately susceptible
5.	7	Susceptible
6.	9	Highly susceptible

2.3. Screening for yellow mosaic disease resistance

84 soybean genotypes grown in natural (field) conditions at Research Farm of Kisan (PG) College, Simbhaoli, Ghaziabad during *kharif*, 2008 were screened. Number of plants showing distinct symptoms in each line was counted 60 days after sowing and per cent disease incidence was calculated by using the following formula:

Number of plants infected in a row

Per cent Disease Incidence (PDI) = x 100

Total number of plants in a row

The genotypes were later grouped into different categories from immune to highly susceptible [7]. The scale used was as follows (0-9):

Scale	Description Category
0	No symptoms of plants Immune
1	1% or less plants exhibiting symptoms resistant
3	1 to 10% plants exhibiting symptoms moderately resistant
5	11 to 20% plants exhibiting symptoms moderately susceptible
7	21 to 50% plants exhibiting symptoms susceptible
9	51% or more plants exhibiting symptoms highly susceptible

3. Experimental results

3.1. Screening for pod shattering

84 genotypes of soybean were screened for pod shattering resistance in order to identify resistant cultivars during *kharif*, 2008. The screening was done according to method adopted by IITA, Nigeria. The data presented in Table 1 revealed that pod shattering percentage ranged from 8.7 (Himsoy-1560) to 93.3 per cent (Punjab- 1). The result indicated that there is no variety, which is resistant to pod shattering. However, some of the varieties *viz*., Bragg, CGP-76, EC-322536, EC-34092, JS 93-05, Lee, MAUS-2, NRC-7, EC-34101, EC-34092, JS 71-05, EC-34101, EC-392536, G-26, Himsoy-1560, Himsoy-1514, Pusa-16, Pusa-22, VLS-1, VLS-2, VLS-47 and the check JS-335 were found to be tolerant. Later these genotypes were grouped into different categories based on IITA, Nigeria scale and the data is presented in Table 2. The results revealed that none of the genotypes were immune or resistant to pod shattering.

Sl. No	Genotypes	Shattering %	Grade	Sl No	Genotype	Shattering %	Grade
1.	Alankar	58.7	HS	43.	EC-392536	16.0	TO
2.	Ankur	47.0	MS	44.	EC-394839	45.3	MS
3.	AGS-34	59.7	HS	45.	G-48	15.0	TO
4.	AGS-50	52.7	HS	46.	G-479	35.0	MS
5.	Bragg	15.3	TO	47.	G-482	51.7	HS
6.	Local black soybean	78.3	VHS	48.	G-7340	83.7	VHS
7.	CO-1	80.3	VHS	49.	G-26	35.7	MS
8.	CO-2	57.0	HS	50.	G-5-1	61.7	HS
9.	CGP-76	15.3	TO	51.	Hardee	46.0	MS
10.	CGP-248	62.0	HS	52.	Hara soya	17.3	MS
11.	CGP-2037	46.0	MS	53.	Himsoya-1560	8.7	TO
12.	DSb-1	46.3	MS	54.	Himsoya-1514	11.8	TO
13.	DSb-2	41.7	MS	55.	Improved pelican	83.3	VHS
14.	DSb-3-4	44.3	MS	56.	Indira Soya 9	32.0	MS
15.	DSb-5	48.7	MS	57.	C-39506	51.7	HS
16.	DSb-6-1	37.7	MS	58.	IC-49859	56.7	HS
17.	DSb-7	56.0	HS	59.	IC-104877	46.3	MS
18.	DSb-8	45.0	MS	60.	JS-2	83.0	VHS
19.	DS-17-5	35.3	MS	61.	JS-71-05	18.0	TO
20.	EC-103369	58.3	MS	62.	JS-72-280	36.7	MS

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Sl. No	Genotypes	Shattering %	Grade	Sl No	Genotype	Shattering %	Grade
21.	EC-109923	75.0	VHS	63.	JS-72-44	44.3	MS
22.	EC-322536	20.7	TO	64.	JS-75-46	55.0	HS
23.	EC-241778	36.7	MS	65.	JS-76-205	31.9	MS
24.	EC-241780	63.3	HS	66.	JS-80-21	67.0	HS
25.	EC-34092	16.0	TO	67.	JS-90-41	55.7	HS
26.	EC-118420	61.3	HS	68.	JS-93-105	19.0	TO
27.	EC-34101	22.0	TO	69.	JS-87-25	31.7	MS
28.	EC-251449	72.7	HS	70.	KB-79	30.0	MS
29.	Lee	15.0	TO	71.	Pusa-20	32.7	MS
30.	MACS-13	43.0	MS	72.	Pusa-22	16.3	TO
31.	MACS-330	72.7	VHS	73.	Pusa-24	33.0	HS
32.	MACS-450	57.3	MS	74.	Pusa-37	62.3	HS
33.	MACS-57	46.0	MS	75.	Pusa-40	74.7	HS
34.	MAUS-47	85.0	VHS	76.	Samrat	31.3	MS
35.	MAUS-68	73.0	HS	77.	T-49	71.7	HS
36.	MAUS-2	19.0	TO	78.	VLS-1	12.1	TO
37.	NRC-7	19.7	TO	79.	VLS-2	25.3	TO
38.	NRC-12	26.3	MS	80.	VLS-21	31.7	MS
39.	PK-1024	80.0	VHS	81.	VLS-47	17.0	TO
40.	PK-1029	32.0	MS	82.	JS-335 (C)	10.3	TO
41.	Punjab-1	93.3	VHS	83.	KHSb-2(C)	43.5	MS
42.	Pusa-16	23.7	TO	84.	Monetta (C)	90.7	VHS

Table 1. Screening of soybean genotypes for pod shattering resistance

3.2. Screening for rust resistance

Growing resistant varieties is the most economical and safe method of controlling the rust of soybean, which is a devastating disease resulting in heavy yield loss. In order to identify the resistant cultivars 84 genotypes of soybean were screened for rust resistance during *kharif* 2008 under natural epiphytotic conditions at Dharwad. The rust incidence was recorded at physiological maturity of the genotypes and the results are presented in Table 3. Reactions of 84 genotypes to rust revealed that, none of the genotypes showed immune reaction to rust. Two genotypes *viz*., EC 241778 and EC 241780 showed resistant reaction (1 grade), which were considered as resistant and the remaining 82 genotypes as highly susceptible (9 grade).

Sl. No.	Category	Resistant reaction	Number of genotypes	Genotypes
1	No pod shattering	Shattering resistant	00	-
2	< 25% pod shattering	Shattering tolerant	20	Bragg, CGP-76, EC-322536, EC-34092, JS 71-05, JS-93-05, Lee, MAUS-2, WEC-7, EC-34101, EC-392536, G-26, Himsoya-1560, Himsoya-1514, Pusa-16, Pusa-22, VLS-1, VLS-2, VLS-47, JS-335(C)
3	25-50% pod shattering	Moderately shattering	32	Ankur, CGP-2037, DSb-1, DSb-2, DSb-3-4, DSb-5, DSb-6-1, DSb-8, PS-17-5, EC-103369, EC-241778, IC-104877, JS 72-280, JS 72-44, JS 76-205, JS 87-25, KB-79, MACS-13, MACS-450, MACS-57, NRC-12, PK-1029, EC-394839, G-48, G-7340, Hardee, Harasoya, Indira soya, Pusa-20, Samrat, VLS-21, KHSb-2 (C).
4	51-75% pod shattering	Highly shattering	21	Alankar, AGS-34, AGS-50, CO-2, CGP-248, DSb-7, EC-241780, EC-118420, IC-39506, IC-49859, JS 75-46, JS 80-21, JS 90-41, MAUS-68, EC-251449, G-479, G 5-1, Pusa-24, Pusa-37, Pusa-40, T-49
5	>75% pod shattering	Very highly shattering	11	Local black soybean, CO-1, EC-109923, JS-2, MACS-330, MAUS-47, PK-1024, G-482, Improved pelican, Punjab-1, Monetta (C)

Table 2. Grouping of Soybean genotypes for pod shattering resistance

Sl. No.	Reaction	Grade (0-9)	Number of genotypes	Genotypes responded
1	Immune	0	00	-
2	Resistant	1	02	EC- 241778, EC- 241780
3	Moderately resistant	3	00	-
4	Susceptible	5	00	-
5	Moderately Susceptible	7	00	-
6	Highly Susceptible	9	82	Alankar, Ankur, AGS-34, AGS-50, Bragg, Local black soybean, CO-1, CO-2, CGP-76, CGP-248, CGP-2037, DSb-1, DSb-2, DSb 3-4, DSb-5, DSb 6-1, DSB-74, DSb-8, DS 17-5, EC-103369, EC-109923, EC-322536, EC-34092, EC-118420, EC-34101, EC-251449, EC-392536, EC-394839, G-48, G-479, G-482, G-7340, G-26, G-5-1, Hardee, Harasoya, Himsoya-1560, Improved pelican, Indirasoya, IC-39506,

Sl. No.	Reaction	Grade (0-9)	Number of genotypes	Genotypes responded
				IC-49859, IC-104877, JS-2, JS 71-05, JS 72-280, JS 72-44, JS 75-46, JS 76-205, JS 80-21, JS 90-41, JS 93-105, JS 87-25, KB-79, Le, MACS-13, MACS-330, MACS-450, MACS-57, MAUS-47, MAUS-68, MAUS-2, NRC-7, NRC-12, PK-1024, PK-1029, Punjab-1, Pusa-16, Pusa-20, Pusa-22, Pusa-24, Pusa-37, Pusa-40, Samrat, T-49, VLS-1, VLS-2, VLS-21, VLS-47, JS-335 (C), KHSb-2 (C), Monetta (C).

Table 3. Grouping of soybean genotypes for soybean rust resistance

3.3. Screening for yellow mosaic disease (YMD)

84 genotypes of soybean were screened for yellow mosaic disease under natural conditions at Research Farm of Kisan (PG) College, Simbhaoli, Ghaziabad during *kharif*, 2008. The data presented in Table 4 revealed that, YMD incidence ranged from 0.95 to 90.12 per cent. Among the 84 genotypes screened lowest incidence was recorded with genotype MACS 57 (0.48%), followed by EC 241778 (0.49%). Genotypes JS 90-41 (90.12) recorded highest incidence followed by JS 76-205 (89.15%) and T 49 (86.21%). All the genotypes and their percent disease incidence are tabulated in Table 5, which categorizes these genotypes based on 0-9 scale into different reaction types. It is evident from the table that none of the genotypes tested were immune or resistant.

Sl. No	Genotypes	PDI*	Reaction	Sl No	Genotype	PDI*	Reaction
1.	Alankar	9.25	MR	43.	EC-392536	27.00	S
2.	Ankur	0.75	R	44.	EC-394839	42.12	S
3.	AGS-34	8.21	MR	45.	G-48	15.25	MS
4.	AGS-50	7.68	MR	46.	G-479	17.25	MS
5.	Bragg	8.58	MR	47.	G-482	25.65	S
6.	Local black soybean	61.25	HS	48.	G-7340	32.15	S
7.	CO-1	3.58	MR	49.	G-26	9.12	MR
8.	CO-2	7.54	MR	50.	G-5-1	42.12	S
9.	CGP-76	15.61	MS	51.	Hardee	39.15	S
10.	CGP-248	19.25	MS	52.	Hara soya	33.89	S
11.	CGP-2037	9.21	MR	53.	Himsoya-1560	19.14	MS
12.	DSb-1	25.23	S	54.	Himsoya-1514	40.01	S
13.	DSb-2	32.15	S	55.	Improved pelican	42.15	S

Sl. No	Genotypes	PDI*	Reaction	Sl No	Genotype	PDI*	Reaction
14.	DSb-3-4	15.25	MR	56.	Indira Soya 9	0.45	R
15.	DSb-5	75.25	HS	57.	C-39506	7.12	MR
16.	DSb-6-1	13.25	MS	58.	IC-49859	62.15	HS
17.	DSb-7	27.85	S	59.	IC-104877	75.12	HS
18.	DSb-8	26.32	S	60.	JS-2	46.12	S
19.	DS-17-5	16.25	MR	61.	JS-71-05	78.98	HS
20.	EC-103369	0.75	R	62.	JS-72-280	46.25	S
21.	EC-109923	39.25	HS	63.	JS-72-44	29.12	S
22.	EC-322536	0.52	R	64.	JS-75-46	89.12	HS
23.	EC-241778	0.49	R	65.	JS-76-205	8.81	MR
24.	EC-241780	9.85	MR	66.	JS-80-21	90.12	HS
25.	EC-34092	45.25	S	67.	JS-90-41	11.85	MS
26.	EC-118420	37.12	S	68.	JS-93-105	8.82	MR
27.	EC-34101	13.25	MS	69.	JS-87-25	7.81	MR
28.	EC-251449	8.25	MR	70.	KB-79	6.23	MR
29.	Lee	46.3	S	71.	Pusa-20	7.15	MR
30.	MACS-13	5.12	MR	72.	Pusa-22	0.92	R
31.	MACS-330	81.21	HS	73.	Pusa-24	8.25	MR
32.	MACS-450	0.89	R	74.	Pusa-37	7.10	S
33.	MACS-57	0.48	R	75.	Pusa-40	29.12	S
34.	MAUS-47	0.56	R	76.	Samrat	36.57	S
35.	MAUS-68	85.12	HS	77.	T-49	86.21	HS
36.	MAUS-2	31.25	S	78.	VLS-1	40.25	S
37.	NRC-7	0.78	R	79.	VLS-2	79.85	HS
38.	NRC-12	16.25	MS	80.	VLS-21	33.25	S
39.	PK-1024	0.85	R	81.	VLS-47	30.5	S
40.	PK-1029	0.52	R	82.	JS-335 (C)	30.96	S
41.	Punjab-1	5.23	MR	83.	KHSb-2(C)	28.25	S
42.	Pusa-16	6.12	MR	84.	Monetta (C)	7.6	MR

* Percent disease incidence

Table 4. Screening of soybean genotypes for yellow mosaic disease resistance

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Scale	Description	Category	Number of genotypes	Genotypes
0	No symptoms on plants	Immune	00	-
1	1% or less plants exhibiting symptoms	Resistant	12	Ankur, EC-103369, EC-322536, EC-241778, Indirasoya 9, MACS-450, MACS-57, MAUS-47, NRC-7, PK-1024, PK-1025, Pusa-22
3	1-10% plants exhibiting symptoms	Moderately resistant	22	Alankar, AGS-34, Bragg, AGS-50, CO-1, CO-2, CGP-2037, DSb 3-4, PS-17-5, EC-241780, EC-251449, G-26, IC-39506, JS 80-21, JS 87-25, KB-79, MACS-13, Punjab-1, Pusa-16, Pusa-20, Pusa-24, Monetta (Check).
5	11-20% plants exhibiting symptoms	Moderately susceptible	10	CGP-76, CGP-248, DSb-6-1, EC-34101, G-48, G-479, Himory-1560, IC- 49859, JS-93-105, NRC-12
7	21-50% plants exhibiting symptoms	Susceptible	28	DSb-1, DSb-2, DSb-7, DSb-8, EC-34092, EC-118420, EC-392536, EC-394839, G-7340, G-482, G-5-1, Hardee, Harasoya, Improved pelican, JS 71-05, JS 72-44, JS 75-46, Lee, MAUS-2, Pusa-37, Pusa-40, Samrat, VLS-1, Himsoya-1514, VLS-21, VLS-47, JS-335(C), KHSb-2 (Check)
9	51% or more plants exhibiting symptoms	Highly susceptible	12	Local black soybean, DSb-5, EC-109923, IC-104877, JS-2, JS 72-280, JS 76-205, JS 90-41, MACS-330, MAUS-68, T-49, VLS-2

Table 5. Grouping of genotypes into different categories for soybean yellow mosaic virus resistance

4. Discussion

4.1. Screening for pod shattering resistance

Pod shattering is one of the major constraints in soybean, which reduces the yield potential considerably. So management of pod shattering is of great importance for achieving higher productivity. Hence, the identification of resistant sources for pod shattering is one of the most important aspect in the management of pod shattering. In the present study 84 genotypes of

soybean were screened for pod shattering resistance under lab condition. The pod shattering values ranged from 8.7 to 93.3 per cent. JS-335 one of the most popular variety recorded as tolerant with mean pod shattering value of 10.3 per cent. It is evident from the table that, none of the genotypes were better than the JS-335 except Himsoy-1560, which recorded 8.7 per cent mean pod shattering value. Among 84 genotypes, 20 genotypes fall under tolerant category and 32 under moderately shattering. Fifteen Indian soybean varieties were screened for pod shattering resistance and out of these three varieties viz., JS-1515, JS-1608 and JS-1625 were found resistant against pod shattering [16]. Similarly, while screening for pod shattering resistance, Bragg and JS-71-05 recorded the lowest pod shattering and Punjab-1 with highest pod shattering value [12]. Similar results were also reported [1, 13].

4.2. Screening for rust resistance

Among many of the diseases in soybean, rust is the major fungal disease which may reduce the yield drastically. So identification of resistant sources and involving them in resistant breeding forms one of the criteria in resistant breeding programme. In the present study 84 genotypes of soybean were screened for rust resistance under natural epiphytotic condition. None of the genotypes showed immune reaction. However, genotypes EC-241778 and EC-241780 showed resistance reaction. Remaining all genotypes exhibited highly susceptible reaction. In general, over all disease incidence was very high. Similar results are reported in [9], who evaluated several soybean genotypes and varieties under natural epiphytotic condition and reported EC-392530, EC-392538, EC-392539, EC-392541, SL-423, RSC-1, RSC-2, JS-80-21 and PK-1029 as moderately resistant. Hundekar (1999) also evaluated S-22, WC-12 and 92-10 as rust resistant germplasm. Among varieties PK-1162, PK-1029, JS-80-21 and PK-1024 showed moderately resistant reaction with better yield. Basavaraja (2002) identified three useful mutants which are moderately resistant to rust among 270 induced mutant families studied in M_3 generation. Similar results were also reported by various researchers [8, 10, 14, 15]

4.3. Screening for yellow mosaic disease

Yellow mosaic is one of the major viral diseases in India and it is causing major problem during *rabi*/*summer* in Utter Pradesh in recent years. The yield loss due to disease may range from minor to complete loss depending upon severity. So identification of resistant sources will help in optimum management and thus help in future breeding programmes. In the present study, 84 genotypes of soybean were taken for screening against yellow mosaic disease under natural conditions. None of the genotypes tested were immure to the disease. Over the entire disease incidence was high which was evident from the results as most of the genotypes fall under the category moderately susceptible to susceptible. Similar results were also reported [6, 17]. They screened 88 indigenous and exotic soybean genotypes in the field and found EC-107014, EC-107003 and EC-100777 resistant.

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