



Screening of soybean (*Glycine max* L.) genotypes/lines against yellow mosaic disease

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Abstract

Soybean (*Glycine max* L.) is a highly valued crop due to its remarkable protein content of 40 per cent and high-quality oil content of 20 per cent. However, its production potential is consistently hindered by various pests and diseases. Of particular concern is the yellow mosaic disease, caused by the mungbean yellow mosaic virus (MYMV) and mungbean yellow mosaic India virus (MYMIV) transmitted by the whitefly (*Bemisia tabaci*), creating a significant threat to soybean cultivation worldwide. A study was conducted at the Agricultural Research Station (ARS) in Bidar, India during 2023-24 aimed at the identification of resistant genotypes against yellow mosaic disease in soybean. A total of 67 genotypes including the susceptible check variety JS-335, were screened under natural epiphytotic conditions. The experiment was carried out in a paired row system in a randomized block design with two replications. Among them, five genotypes-ARS-5, NRC-270, DS-1547, DLSb-6 and NRCSL-8 exhibited resistance to yellow mosaic disease. Furthermore, DS 1589 and DLSb 5 displayed moderate resistance, while 6 genotypes showed moderately susceptible reactions. Additionally, 9 genotypes were found to be susceptible and the remaining 38 genotypes displayed highly susceptible reactions to the disease. The genotypes with YMV resistance would stand as a barrier against the spread of the disease to newer areas and thus can boost the production and productivity of soybean in the country.

Keywords: Mungbean yellow mosaic virus, Mungbean yellow mosaic India virus, Yellow mosaic disease. soybean and genotypes

Introduction

Soybean (*Glycine max* L. Merrill) is one of the major oil seed crops grown worldwide, occupying the top position among the oil seed. It is one of the oldest crops in the world and it was found to have originated in Southeast Asia. Chinese farmers cultivated and used them for the first time around 1100 BC. Soybean is thought to have flowed out of China to neighbouring countries as land and maritime trading expanded. This crop is now grown in over 50 countries and is the most widely produced and consumed oil seed crop (Wilcox, 2004).

Soybean occupies third place in India among the oil seed crops, next to groundnut and rapeseed mustard. India ranks fifth in the production of soybean after USA, Brazil, Argentina and China, which altogether produce 90 to 95 per cent of world soybean as compared to 2.5 per cent share of India (Anon., 2023)

The low productivity of soybean at the state and national level is attributed to biotic and abiotic stresses like excess rainfall during pod maturity stage, drought, weeds, insect pests and diseases. As more than 90 per cent of the total area under soybean is grown under rainfed conditions which exposes them to numerous abiotic stresses. Among the biotic stresses, it is affected by several diseases *viz.*, rust (*Phakopsora pachyrhizi*), Alternaria leaf spot (*Alternaria* sp.), downy mildew (*Peronospora manshurica*), bacterial leaf spot (*Xanthomonas campestris* pv. *glycines*), anthracnose (*Colletotrichum* sp.), charcoal rot (*Macrophomina phaseolina*), purple seed stain (*Cercospora kikuchi*), soybean cyst nematode (*Heterodera glycines*) and viral diseases.

Soybean is a natural host for 33 potential important viruses (Sutic *et al.*, 1999). Among them six viral diseases have

some economic significance in India. These are yellow mosaic virus (YMV), soybean mosaic virus (SMV), peanut bud necrosis virus (PBNV), bean pea mottle virus (BPMV), soybean crinkle leaf geminivirus, cowpea mild mottle carla virus (CMMV) are the major viral diseases of soybean in India (Lal *et al.*, 2005). Among the viral diseases, yellow mosaic virus disease has been considered as an economically important disease, which is a limiting factor on crop growth and yield.

More than four begomoviruses namely mungbean yellow mosaic virus (MYMV), mungbean yellow mosaic India virus (MYMIV), dolichos yellow mosaic virus (DoYMV) and horsegram yellow mosaic virus (HgYMV) were known to cause yellow mosaic disease on different leguminous crops. Among these MYMV and MYMIV are known to cause the yellow mosaic disease in soybean (Usharani *et al.*, 2004). The disease incidence was ranging from 20 to 80 per cent (Qazi *et al.*, 2007). Hence the screening of genotypes is carried out to identify the resistant sources against the yellow mosaic disease.

Material and Methods

The experiment was conducted to test the reaction of various soybean genotypes available at soybean AICRP volunteer centre at Agriculture Research Station Halladkeri, Bidar during the *summer-2024*. A total of 60 genotypes/lines were tested, which included 19 entries under station trials, 24 entries under initial varietal trials, 5 entries under advanced varietal trials and 12 entries under multi-location trials under different breeding programs. These genotypes were sown at 30 x 10 cm spacing with 2 rows of 5 m each for each genotype were sown. Here we used the infector row method, for every ten entries one

susceptible check JS-335 was sown to screen for the reaction against the yellow mosaic disease. Normal agronomic and cultural practices were followed, weekly observations were taken for disease incidence in each entry and calculated based on the following (0 to 5) disease scale and the ratings were designated to each entry (Bashir, 2005).

Per cent disease incidence was calculated by using the following formula

$$\text{Disease incidence (\%)} = \frac{\text{Number of plants infected}}{\text{Total number of plants observed}} \times 100$$

Disease scale for yellow mosaic virus infecting soybean

Disease Score	Percent Infection	Infection Category	Reaction
0	All plants free of disease symptoms	Highly resistant	HR
1	1 - 10% Infection	Resistant	R
2	11 -20% infection	Moderately resistant	MR
3	21-30% infection	Moderately susceptible	MS
4	30-50 % infection	Susceptible	S
5	More than 50% infection	Highly susceptible	HS

In order to know the quantitative summary of yellow mosaic disease intensity in soybean during the *summer* 2024, the area under the disease progress curve (AUDPC) was calculated using the formula as suggested by Wilcoxson *et al.* (1975).

$$\text{AUDPC} = \sum_{i=1}^K \frac{1}{2} (S_i + S_{i-1}) \times d$$

Where,

- S_i = Disease incidence at ith day of evaluation
 - K = Number of successive evaluations of the disease
 - d = Interval between i and i-1 evaluation of the disease.
- To know the apparent rate of infection (r), disease incidence was recorded at weekly interval from the onset of the disease till the end of crop. Then rate of development of disease (r) at different intervals was calculated by the formula given by Van der plank (1963).

$$r = \frac{23}{t_2 - t_1} \left[\log \frac{x_2}{1 - x_2} - \log \frac{x_1}{1 - x_1} \right]$$

Where,

- r = Apparent rate of infection or spread
- x₁ = Per cent disease index at time t₁
- x₂ = Per cent disease index at time t₂
- t₂-t₁ = Time interval in days between the two consecutive observations

Traditionally, managing viral diseases has relied on chemical insecticides to control the vectors (such as whiteflies) responsible for disease spread. However, this approach isn't always economically viable. Alternatively, using resistant cultivars plants that naturally fend off both the virus and its vectors proves highly effective. To achieve this, screening plant material becomes crucial. Identifying sources of resistance allows us to develop durable solutions for breeding programs, especially in managing viral diseases. Unlike chemical treatments, which may not exist for certain viruses, resistant varieties offer a sustainable way to combat the disease-causing agent and its carrier.

The symptoms appeared on the susceptible check JS-335 after 22-25 days after sowing with the symptoms of small yellow specs followed by intermingling of dark green and yellow patches on fully formed first trifoliolate leaves. Disease intensity increased over time. A similar spread of disease was seen by Jalaluddin and Sheikh (1981).

Out of 60 genotypes screened against yellow mosaic disease of soybean. The disease incidence range 6.2 to 100 per cent. Among these genotypes, none of them showed highly resistant reaction, five of the genotypes showed resistant reaction i.e. ARSB-05, DLSb 6, NRCSL 8, NRC 270 and DS 1547 with disease incidence of 6.20, 7.30, 8.20, 9.7 and 9.1 per cent respectively (Plate 1a & 1b.). DS 1589 and DLSb 5 showed moderately resistant reaction with disease incidence of 20.40 and 11.7 per cent respectively. ARSB-10, NRC 142, DSb 23, AMS 22-16, MACS 1810 and NRC 269 showed moderately susceptible reactions. The remaining genotypes were found highly susceptible to YMV infecting soybean (Table 1.).

Results and Discussion



JS-335 (HS)

ARSB-05 (R)

NRCSL-8 (R)

Plate 1a. Promising soybean genotypes showing resistant reaction to yellow mosaic disease with susceptible check



DLSb-06 (R)

DS-1547 (R)

NRC-270 (R)

Plate 1b. Promising soybean genotypes showing resistant reaction to yellow mosaic disease with susceptible check

Table 1: Reaction of soybean genotypes against YMD during *summer* 2024 at ARS Bidar

Sl. No.	Genotypes	Disease incidence (%)	Disease score	Disease reaction
1	ARSB-01	37.50	3	S
2	ARSB-02	100	5	HS
3	ARSB-03	100	5	HS
4	ARSB-04	100	5	HS
5	ARSB-05	6.20	1	R
6	ARSB-06	100	5	HS
7	ARSB-07	100	5	HS
8	ARSB-08	100	5	HS
9	ARSB-09	100	5	HS
10	ARSB-10	23.00	3	MS
11	ARSB-11	47.30	4	S
12	ARSB-12	38.30	4	S
13	ARSB-13	49.40	4	S
14	KDS 726	34.50	4	S
15	MAUS 162	95.00	5	HS
16	MAUS 612	83.30	5	HS
17	KDS 344	72.70	5	HS
18	MAUS 71	81.60	5	HS
19	MAUS 158	100	5	HS
20	MACS 1460	100	5	HS
21	MACSNRC 1900	88.50	5	HS
22	NRC 142	26.00	3	MS
23	MACS 1188	100	5	HS
24	DSb 21	100	5	HS
25	DLSb 3	35.30	4	S
26	DLSb 5	20.40	2	MR
27	DLSb 6	7.30	1	R
28	NRC SL 8	8.20	1	R
29	DSb 23	21.30	3	MS
30	DSb 38	100	5	HS
31	NRC 137	88.20	5	HS
32	NRC 136	79.00	5	HS
33	DSb 34	94.10	5	HS
34	JS 335	100	5	HS
35	DSb 40	100	5	HS
36	DS 3163	100	5	HS
37	NRC 270	9.70	1	R
38	AMS 22-16	25.80	3	MS
39	MAUS 816	100	5	HS
40	Pusa Sipani BS 8	54.60	5	HS
41	KDS 992	34.60	4	S
42	DS 1589	11.70	2	MR
43	RSC 11-95	100	5	HS
44	KDS 753	100	5	HS
45	BAUS (M) 6	100	5	HS
46	KBSL 23-36	50.80	5	HS

47	VLS 106	35.40	3	S
48	SL 1315	100	5	HS
49	TS 101	66.10	5	HS
50	THPS 6	100	5	HS
51	KDSIS 1394	100	5	HS
52	NRC 271	57.90	5	HS
53	Lok-Soya 03	100	5	HS
54	KSS 225	35.40	3	S
55	DS 1547	9.10	1	R
56	MACS 1810	23.40	3	MS
57	JS 25-08	94.80	5	HS
58	ASb 101	100	5	HS
59	NRC 268	97.80	5	HS
60	NRC 269	24.70	3	MS

These genotypes were subjected to grouping based on their reaction revealing a range of responses. None of the genotypes exhibited a highly resistant reaction. However, five genotypes showed resistance reactions. Two genotypes

exhibited moderately resistant reactions. Six genotypes were moderately susceptible, nine were susceptible and the remaining 38 genotypes were found to be highly susceptible to the disease (Table 2.).

Table 2. Performance of soybean genotypes against yellow mosaic virus disease in the field during *summer* 2023-24 at ARS Bidar

Sl. No.	Genotypes	04/02/2024	11/02/2024	18/02/2024	25/02/2024	03/03/2024	10/03/2024	17/03/2024	24/03/2024	31/03/2024	07/04/2024	14/04/2024
1	ARSB-01	0.00	0.00	4.50	10.00	14.50	16.65	23.65	26.45	28.45	32.35	37.50
2	ARSB-02	0.00	0.00	6.00	18.65	25.55	32.65	41.55	59.65	65.76	83.65	100.00
3	ARSB-03	0.00	0.00	9.78	22.52	35.50	41.65	57.56	71.65	83.55	92.45	100.00
4	ARSB-04	0.00	0.00	11.55	21.35	39.65	47.70	54.50	68.50	73.75	85.50	100.00
5	ARSB-05	0.00	0.00	0.00	0.00	0.00	0.00	2.50	3.65	6.20	6.20	6.20
6	ARSB-06	0.00	0.00	3.65	19.85	35.86	43.72	59.33	73.34	84.71	94.12	100.00
7	ARSB-07	0.00	0.00	12.46	26.48	39.60	49.32	61.82	77.41	83.73	91.48	100.00
8	ARSB-08	0.00	0.00	13.32	27.43	36.31	58.49	68.37	81.26	89.10	93.33	100.00
9	ARSB-09	0.00	0.00	9.63	21.83	36.33	42.82	59.82	70.45	89.38	98.35	100.00
10	ARSB-10	0.00	0.00	3.62	7.64	11.62	15.52	17.33	19.32	21.32	21.85	23.00
11	ARSB-11	0.00	0.00	0.00	5.83	16.53	22.76	26.45	33.33	38.26	44.35	47.30
12	ARSB-12	0.00	0.00	0.00	6.30	13.80	17.35	21.93	29.37	32.33	35.52	38.30
13	ARSB-13	0.00	0.00	2.45	4.80	9.20	11.49	19.51	21.62	35.68	46.82	49.40
14	KDS 726	0.00	0.00	5.52	12.36	16.48	21.89	26.33	28.44	29.33	33.33	34.50
15	MAUS 162	0.00	1.42	13.50	26.37	37.88	51.46	63.04	71.40	79.32	86.38	95.00
16	MAUS 612	0.00	0.00	3.79	14.72	30.82	56.93	78.34	80.12	80.48	82.71	83.30
17	KDS 344	0.00	0.00	5.19	19.33	33.33	42.80	51.22	59.31	66.54	72.70	72.70
18	MAUS 71	0.00	0.00	10.34	23.65	31.46	49.47	53.56	69.41	75.35	78.33	81.60
19	MAUS 158	0.00	0.00	13.44	27.93	36.93	47.92	51.42	68.33	81.34	89.44	100.00
20	MACS 1460	0.00	0.00	12.57	26.44	41.34	53.61	61.32	76.45	86.57	97.48	100.00
21	MACSNRC 1900	0.00	0.00	10.32	28.62	37.61	58.34	69.32	77.56	81.36	88.50	88.50
22	NRC 142	0.00	0.00	0.00	0.00	0.00	2.80	10.20	15.70	21.32	25.00	26.00
23	MACS 1188	0.00	0.00	7.38	18.82	29.46	44.82	67.83	73.82	81.72	99.00	100.00
24	DSb 21	0.00	0.00	11.76	27.54	36.54	44.67	60.21	73.53	88.30	90.34	100.00
25	DLSb 3	0.00	0.00	0.00	6.34	11.68	18.45	21.07	24.87	26.76	33.33	35.30
26	DLSb 5	0.00	0.00	0.00	0.00	6.80	10.34	15.32	16.66	18.32	20.40	20.40
27	DLSb 6	0.00	0.00	0.00	0.00	0.00	1.22	3.45	4.82	6.52	7.30	7.30
28	NRCSL 8	0.00	0.00	0.00	0.00	1.10	2.27	3.82	6.38	7.50	7.90	8.20
29	DSb 23	0.00	0.00	0.00	0.00	0.00	5.80	11.50	16.73	18.43	20.61	21.30
30	DSb 38	0.00	0.00	12.63	23.92	38.62	44.33	59.72	70.61	81.64	90.12	100.00
31	NRC 137	0.00	0.00	3.44	19.34	25.83	41.83	60.17	77.33	81.43	85.20	88.20
32	NRC 136	0.00	0.00	7.82	18.92	29.62	36.85	43.73	55.79	69.34	77.45	79.00
33	DSb 34	0.00	0.00	13.94	26.82	32.48	55.81	62.83	70.81	82.37	91.38	94.10
34	JS 335	0.00	0.00	12.43	23.67	33.65	57.64	69.74	80.32	91.34	98.34	100.00
35	DSb 40	0.00	0.00	13.33	26.92	46.53	59.64	70.32	75.73	88.33	94.17	100.00
36	DS 3163	0.00	0.00	10.58	26.73	39.78	51.93	62.38	72.73	81.34	89.85	100.00
37	NRC 270	0.00	0.00	0.00	0.00	1.32	3.47	5.52	7.52	8.82	9.70	9.70
38	AMS 22-16	0.00	0.00	0.00	3.20	6.45	9.12	11.64	15.73	16.43	21.66	25.80
39	MAUS 816	0.00	0.00	10.72	24.12	37.43	44.63	58.45	69.33	82.33	91.33	100.00
40	Pusa Sipani BS 8	0.00	0.00	0.00	4.98	10.32	18.45	24.64	39.43	42.63	51.45	54.60
41	KDS 992	0.00	0.00	0.00	1.43	12.46	18.43	21.84	25.32	28.45	34.60	34.60
42	DS 1589	0.00	0.00	0.00	0.00	2.32	4.92	6.23	7.12	8.34	10.33	11.70
43	RSC 11-95	0.00	0.00	10.43	27.32	37.82	51.33	59.45	66.44	79.33	94.33	100.00
44	KDS 753	0.00	0.00	12.98	23.43	36.33	45.32	56.32	63.54	79.43	87.34	100.00
45	BAUS (M) 6	0.00	0.00	14.23	26.12	31.84	43.66	51.73	62.42	73.83	99.32	100.00

46	KBSL 23-36	0.00	0.00	4.30	12.45	18.43	24.53	33.62	39.24	41.12	48.43	50.80
47	VLS 106	0.00	0.00	0.00	0.00	6.31	11.43	19.43	24.82	28.32	33.33	35.40
48	SL 1315	0.00	0.00	15.14	30.23	46.23	64.62	76.13	80.22	90.31	96.48	100.00
49	TS 101	0.00	0.00	5.10	14.64	22.93	28.24	37.33	41.41	54.13	59.14	66.10
50	THPS 6	0.00	0.00	7.32	15.82	29.56	47.82	62.83	73.46	81.47	92.48	100.00
51	KDSIS 1394	0.00	0.00	13.30	28.54	39.56	49.62	69.64	77.33	82.82	97.33	100.00
52	NRC 271	0.00	0.00	5.80	14.64	26.53	33.33	38.45	43.44	49.47	55.45	57.90
53	Lok-Soya 03	0.00	0.00	12.81	23.93	33.48	42.73	63.65	71.03	83.75	91.85	100.00
54	KSS 225	0.00	0.00	0.00	4.44	11.45	14.76	18.64	21.03	26.32	33.33	35.40
55	DS 1547	0.00	0.00	0.00	0.00	0.00	1.45	3.72	5.55	9.10	9.10	9.10
56	MACS 1810	0.00	0.00	0.00	0.00	4.08	9.01	11.05	14.72	16.65	22.31	23.40
57	JS 25-08	0.00	0.00	6.34	28.33	39.45	53.92	67.33	72.82	85.83	87.63	94.80
58	ASb 101	0.00	0.00	10.50	24.50	37.42	63.73	71.82	79.49	91.85	96.42	100.00
59	NRC 268	0.00	0.00	8.35	21.78	37.52	58.42	68.63	74.83	83.72	89.74	97.80
60	NRC 269	0.00	0.00	3.45	4.62	10.24	12.52	14.82	17.68	19.43	23.68	24.70

Similar results were reported in the study conducted by Basavaraja *et al.* (2021), which focused on developing soybean genotypes with resistance to multiple diseases, several notable findings were reported. The genotype DLSb 1 demonstrated a high level of resistance to yellow mosaic disease (YMD) across different locations, including Ludhiana, Delhi and Jabalpur. In contrast, DLSb 2 showed a high resistance in Ludhiana and a moderate resistance in Jabalpur. Additionally, several genotypes, such as VLS 101, Himso-1692, NRC 109, RVS 2011-10, TS 20-5 and SL 1250, were found to exhibit resistant reactions. Conversely,

BAUS 96-17 was observed to be susceptible to YMD in Jabalpur.

Area under disease progress curve (AUDPC) was computed for all these entries which showed varied levels of the disease ranging from 432.6 to 12680.64 (Table 3.). As the AUDPC value increases the genotypes shows increased susceptibility to the disease and also as the AUDPC decreases show the increased resistance. The lower the AUDPC lower the intensity of the disease and vice-versa. Hoque and Haque, (2024) reported the similar trend.

Table 3. Area under disease progress curve for different soybean genotypes in field during *summer* 2023-24 at ARS Bidar

Sl. No	Genotypes	AUDPC value										
		04/02/2024	11/02/2024	18/02/2024	25/02/2024	03/03/2024	10/03/2024	17-03-2024	24-03-2024	31-03-2024	07-04-2024	14/04/2024
1	ARSB-01	0.00	15.75	66.50	152.25	261.28	402.33	577.68	769.83	1000.65	2001.30	4002.60
2	ARSB-02	0.00	21.00	107.28	261.98	465.68	725.38	1079.58	1518.51	2098.67	4197.34	8394.68
3	ARSB-03	0.00	34.23	147.28	350.35	620.38	967.61	1419.85	1963.05	2605.47	5210.94	10421.88
4	ARSB-04	0.00	40.43	155.58	369.08	674.80	1032.50	1463.00	1960.88	2569.00	5138.00	10276.00
5	ARSB-05	0.00	0.00	0.00	0.00	0.00	8.75	30.28	64.75	108.15	216.30	432.60
6	ARSB-06	0.00	12.78	95.03	290.01	568.54	929.22	1393.56	1946.74	2593.22	5186.44	10372.88
7	ARSB-07	0.00	43.61	179.90	411.18	722.40	1111.39	1598.70	2162.69	2805.74	5611.48	11222.96
8	ARSB-08	0.00	46.62	189.25	412.34	744.14	1188.15	1711.85	2308.11	2969.96	5939.92	11879.84
9	ARSB-09	0.00	33.71	143.82	347.38	624.40	983.64	1439.59	1998.99	2661.82	5323.64	10647.28
10	ARSB-10	0.00	12.67	52.08	119.49	214.48	329.46	457.73	599.97	755.09	1510.18	3020.36
11	ARSB-11	0.00	0.00	20.41	98.67	236.18	408.42	617.65	868.21	1167.67	2335.34	4670.68
12	ARSB-12	0.00	0.00	22.05	92.40	201.43	338.91	518.46	734.41	981.61	1963.22	3926.44
13	ARSB-13	0.00	8.58	33.95	82.95	155.37	263.87	407.82	608.37	906.15	1812.30	3624.60
14	KDS 726	0.00	19.32	81.90	182.84	317.14	485.91	677.60	879.80	1103.20	2206.40	4412.80
15	MAUS 162	4.97	57.19	196.74	421.61	734.30	1135.05	1605.59	2133.11	2743.23	5486.46	10967.95
16	MAUS 612	0.00	13.27	78.05	237.44	544.57	1018.01	1572.62	2134.72	2707.95	5415.90	10831.80
17	KDS 344	0.00	18.17	103.99	288.30	554.75	883.82	1270.68	1711.15	2198.49	4396.98	8793.96
18	MAUS 71	0.00	36.19	155.16	348.04	631.30	991.90	1422.30	1928.96	2478.28	4956.56	9913.12
19	MAUS 158	0.00	47.04	191.84	418.85	715.82	1063.51	1482.64	2006.48	2641.17	5282.34	10564.68
20	MACS 1460	0.00	44.00	180.53	417.76	750.09	1152.34	1634.54	2205.11	2858.10	5716.20	11432.40
21	MACSNRC 1900	0.00	36.12	172.41	404.22	740.04	1186.85	1700.93	2257.15	2851.66	5703.32	11406.64
22	NRC 142	0.00	0.00	0.00	0.00	9.80	55.30	145.95	275.52	441.14	882.28	1764.56
23	MACS 1188	0.00	25.83	117.53	286.51	546.49	940.77	1436.54	1980.93	2616.95	5233.90	10467.80
24	DSb 21	0.00	41.16	178.71	402.99	687.23	1054.31	1522.40	2088.80	2747.85	5495.70	10991.40
25	DLSb 3	0.00	0.00	22.19	85.26	190.72	329.04	489.83	670.53	887.74	1775.48	3550.96
26	DLSb 5	0.00	0.00	0.00	23.80	83.79	173.60	285.53	407.96	543.48	1086.96	2173.92
27	DLSb 6	0.00	0.00	0.00	0.00	4.27	20.62	49.56	89.25	137.62	275.24	550.48
28	NRC SL 8	0.00	0.00	0.00	3.85	15.65	36.96	72.66	121.24	176.19	352.38	704.76
29	DSb 23	0.00	0.00	0.00	0.00	20.30	80.85	179.66	302.72	441.77	883.54	1767.08
30	DSb 38	0.00	44.21	172.13	391.02	681.35	1045.52	1501.68	2034.55	2670.29	5340.58	10681.16
31	NRC 137	0.00	12.04	91.77	249.87	486.68	843.68	1324.93	1880.59	2474.29	4948.58	9897.16
32	NRC 136	0.00	27.37	120.96	290.85	523.50	805.53	1153.85	1591.80	2110.99	4221.98	8443.96
33	DSb 34	0.00	48.79	191.45	399.00	708.02	1123.26	1591.00	2127.13	2744.77	5489.54	10979.08
34	JS 335	0.00	43.51	169.86	370.48	689.99	1135.82	1661.03	2261.84	2931.53	5863.06	11726.12

35	DSb 40	0.00	46.66	187.53	444.61	816.20	1271.06	1782.24	2356.45	3015.60	6031.20	12062.40
36	DS 3163	0.00	37.03	167.62	400.40	721.39	1121.47	1594.36	2133.60	2768.29	5536.58	11073.16
37	NRC 270	0.00	0.00	0.00	4.62	21.39	52.85	98.49	155.68	220.50	441.00	882.00
38	AMS 22-16	0.00	0.00	11.20	44.98	99.47	172.13	267.93	380.49	528.29	1056.58	2113.16
39	MAUS 816	0.00	37.52	159.46	374.89	662.10	1022.88	1470.11	2000.92	2639.07	5278.14	10556.28
40	Pusa Sipani BS 8	0.00	0.00	17.43	70.98	171.68	322.49	546.74	833.95	1174.25	2348.50	4697.00
41	KDS 992	0.00	0.00	5.01	53.62	161.74	302.68	467.74	655.94	876.61	1753.22	3506.44
42	DS 1589	0.00	0.00	0.00	8.12	33.46	72.49	119.21	173.32	243.46	486.92	973.84
43	RSC 11-95	0.00	36.51	168.63	396.62	708.65	1096.38	1536.99	2047.19	2674.84	5349.68	10699.36
44	KDS 753	0.00	45.43	172.87	382.03	667.80	1023.54	1443.05	1943.45	2571.45	5142.90	10285.80
45	BAUS (M) 6	0.00	49.81	191.03	393.89	658.14	992.01	1391.53	1868.41	2476.81	4953.62	9907.24
46	KBSL 23-36	0.00	15.05	73.68	181.76	332.12	535.64	790.65	1071.91	1393.63	2787.26	5574.52
47	VLS 106	0.00	0.00	0.00	22.09	84.18	192.19	347.06	533.05	756.07	1512.14	3024.28
48	SL 1315	0.00	52.99	211.79	479.40	867.37	1360.00	1907.22	2504.08	3170.16	6340.32	12680.64
49	TS 101	0.00	17.85	86.94	218.44	397.53	627.03	902.62	1237.01	1657.81	3315.62	6631.24
50	THPS 6	0.00	25.62	106.61	265.44	536.27	923.55	1400.56	1942.82	2577.96	5155.92	10311.84
51	KDSIS 1394	0.00	46.55	192.99	431.34	743.47	1160.88	1675.28	2235.80	2875.67	5751.34	11502.68
52	NRC 271	0.00	20.30	91.84	235.94	445.45	696.68	983.29	1308.48	1684.27	3368.54	6737.08
53	Lok-Soya 03	0.00	44.84	173.43	374.36	641.10	1013.43	1484.81	2026.54	2669.66	5339.32	10678.64
54	KSS 225	0.00	0.00	15.54	71.16	162.89	279.79	418.64	584.36	800.38	1600.76	3201.52
55	DS 1547	0.00	0.00	0.00	0.00	5.08	23.17	55.62	106.89	170.59	341.18	682.36
56	MACS 1810	0.00	0.00	0.00	14.28	60.10	130.31	220.50	330.30	470.47	940.94	1881.88
57	JS 25-08	0.00	22.19	143.54	380.77	707.56	1131.94	1622.46	2177.74	2809.94	5619.88	11239.76
58	ASb 101	0.00	36.75	159.25	375.97	730.00	1204.42	1734.01	2333.70	3005.17	6010.34	12020.68
59	NRC 268	0.00	29.23	134.68	342.23	678.02	1122.70	1624.81	2179.73	2815.05	5630.10	11260.20
60	NRC 269	0.00	12.08	40.32	92.33	171.99	267.68	381.43	511.32	665.77	1331.54	2663.08

Rate of infection for the disease was computed for all the entries their mean rate of infection was ranged from 0.010-0.085 (Table 4.). Maximum mean rate of infection of 0.085 was seen in ARSB-02 and least mean rate of infection 0.010

was seen in ARSB-01. The rate of infection was varied based on disease reaction it was observed that rate of infection increased on the genotypes showing susceptible reaction and it decreased on increasing resistance to the disease.

Table 4. Rate of disease development (r) among different soybean genotypes against yellow mosaic disease in field during *summer* 2023-24 at ARS Bidar

Sl. No.	Genotypes	Rate of infection r											
		04/02 /24	11/02 /24	18/02 /24	25/02 /24	03/03 /24	10/03 /24	17/03 /24	24/03 /24	31/03 /24	07/04 /24	14/04 /24	Average
1	ARSB-01	0.000	0.000	0.000	0.105	0.053	0.021	0.056	0.019	0.013	0.024	0.029	0.029
2	ARSB-02	0.000	0.000	0.000	0.159	0.052	0.044	0.049	0.092	0.032	0.109	0.331	0.079
3	ARSB-03	0.000	0.000	0.000	0.124	0.082	0.033	0.081	0.074	0.076	0.083	0.249	0.073
4	ARSB-04	0.000	0.000	0.000	0.093	0.113	0.042	0.034	0.072	0.030	0.079	0.317	0.071
5	ARSB-05	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.067	0.000	0.000	0.010
6	ARSB-06	0.000	0.000	0.000	0.232	0.104	0.042	0.079	0.075	0.075	0.096	0.227	0.085
7	ARSB-07	0.000	0.000	0.000	0.118	0.077	0.050	0.063	0.087	0.043	0.070	0.260	0.070
8	ARSB-08	0.000	0.000	0.000	0.115	0.053	0.114	0.051	0.078	0.063	0.047	0.238	0.069
9	ARSB-09	0.000	0.000	0.000	0.121	0.092	0.035	0.086	0.056	0.132	0.144	0.138	0.073
10	ARSB-10	0.000	0.000	0.000	0.095	0.057	0.042	0.017	0.017	0.016	0.004	0.008	0.023
11	ARSB-11	0.000	0.000	0.000	0.000	0.144	0.051	0.026	0.042	0.028	0.032	0.015	0.031
12	ARSB-12	0.000	0.000	0.000	0.000	0.107	0.034	0.037	0.050	0.018	0.018	0.015	0.025
13	ARSB-13	0.000	0.000	0.000	0.083	0.085	0.031	0.079	0.016	0.090	0.059	0.013	0.041
14	KDS 726	0.000	0.000	0.000	0.108	0.042	0.045	0.031	0.014	0.006	0.024	0.007	0.025
15	MAUS 162	0.000	0.000	0.286	0.106	0.068	0.070	0.058	0.045	0.048	0.052	0.096	0.075
16	MAUS 612	0.000	0.000	0.000	0.181	0.121	0.138	0.118	0.012	0.002	0.016	0.004	0.054
17	KDS 344	0.000	0.000	0.000	0.183	0.094	0.052	0.043	0.041	0.037	0.034	0.000	0.044
18	MAUS 71	0.000	0.000	0.000	0.125	0.050	0.097	0.021	0.082	0.034	0.019	0.022	0.041
19	MAUS 158	0.000	0.000	0.000	0.116	0.053	0.058	0.018	0.087	0.079	0.066	0.282	0.069
20	MACS 1460	0.000	0.000	0.000	0.116	0.086	0.062	0.039	0.083	0.072	0.144	0.164	0.070
21	MACSNRC 1900	0.000	0.000	0.000	0.158	0.052	0.106	0.057	0.048	0.025	0.057	0.000	0.046
22	NRC 142	0.000	0.000	0.000	0.000	0.000	0.000	0.166	0.062	0.048	0.027	0.007	0.028
23	MACS	0.000	0.000	0.000	0.134	0.075	0.085	0.117	0.034	0.050	0.233	0.112	0.076

1188													
24	DSb 21	0.000	0.000	0.000	0.133	0.053	0.043	0.078	0.072	0.105	0.020	0.273	0.071
25	DLSb 3	0.000	0.000	0.000	0.000	0.083	0.068	0.021	0.028	0.013	0.040	0.011	0.024
26	DLSb 5	0.000	0.000	0.000	0.000	0.000	0.056	0.056	0.013	0.015	0.017	0.000	0.014
27	DLSb 6	0.000	0.000	0.000	0.000	0.000	0.000	0.124	0.042	0.039	0.015	0.000	0.020
28	NRCSL 8	0.000	0.000	0.000	0.000	0.000	0.000	0.124	0.042	0.039	0.015	0.000	0.020
29	DSb 23	0.000	0.000	0.000	0.000	0.000	0.000	0.092	0.055	0.015	0.018	0.005	0.017
30	DSb 38	0.000	0.000	0.000	0.099	0.089	0.030	0.078	0.057	0.068	0.071	0.275	0.070
31	NRC 137	0.000	0.000	0.000	0.235	0.048	0.093	0.093	0.095	0.027	0.028	0.026	0.059
32	NRC 136	0.000	0.000	0.000	0.127	0.076	0.042	0.037	0.061	0.070	0.047	0.010	0.043
33	DSb 34	0.000	0.000	0.000	0.104	0.035	0.122	0.036	0.043	0.072	0.079	0.034	0.048
34	JS 335	0.000	0.000	0.000	0.099	0.063	0.125	0.063	0.064	0.093	0.123	0.139	0.070
35	DSb 40	0.000	0.000	0.000	0.111	0.110	0.066	0.056	0.031	0.092	0.066	0.226	0.069
36	DS 3163	0.000	0.000	0.000	0.143	0.076	0.062	0.053	0.056	0.054	0.070	0.278	0.072
37	NRC 270	0.000	0.000	0.000	0.000	0.000	0.116	0.058	0.040	0.021	0.013	0.000	0.023
38	AMS 22-16	0.000	0.000	0.000	0.000	0.088	0.046	0.034	0.044	0.007	0.043	0.029	0.026
39	MAUS 816	0.000	0.000	0.000	0.123	0.081	0.038	0.070	0.057	0.080	0.079	0.262	0.072
40	Pusa Sipani BS 8	0.000	0.000	0.000	0.000	0.096	0.085	0.047	0.088	0.017	0.045	0.016	0.036
41	KDS 992	0.000	0.000	0.000	0.000	0.274	0.058	0.027	0.025	0.020	0.037	0.000	0.040
42	DS 1589	0.000	0.000	0.000	0.000	0.000	0.092	0.030	0.017	0.021	0.029	0.017	0.019
43	RSC 11-95	0.000	0.000	0.000	0.149	0.062	0.070	0.041	0.036	0.075	0.138	0.224	0.072
44	KDS 753	0.000	0.000	0.000	0.091	0.080	0.048	0.055	0.037	0.091	0.059	0.301	0.069
45	BAUS (M) 6	0.000	0.000	0.000	0.096	0.036	0.065	0.041	0.054	0.062	0.300	0.096	0.068
46	KBSL 23-36	0.000	0.000	0.000	0.141	0.058	0.046	0.057	0.031	0.010	0.038	0.012	0.036
47	VLS 106	0.000	0.000	0.000	0.000	0.000	0.080	0.079	0.040	0.023	0.030	0.012	0.024
48	SL 1315	0.000	0.000	0.000	0.113	0.088	0.093	0.064	0.026	0.082	0.086	0.187	0.067
49	TS 101	0.000	0.000	0.000	0.143	0.070	0.036	0.053	0.022	0.065	0.025	0.036	0.041
50	THPS 6	0.000	0.000	0.000	0.108	0.103	0.100	0.076	0.058	0.051	0.098	0.249	0.076
51	KDSIS 1394	0.000	0.000	0.000	0.122	0.063	0.052	0.103	0.045	0.037	0.170	0.167	0.069
52	NRC 271	0.000	0.000	0.000	0.127	0.095	0.042	0.029	0.026	0.031	0.030	0.012	0.036
53	Lok-Soya 03	0.000	0.000	0.000	0.097	0.060	0.050	0.106	0.040	0.081	0.074	0.256	0.069
54	KSS 225	0.000	0.000	0.000	0.000	0.125	0.037	0.035	0.019	0.038	0.043	0.012	0.028
55	DS 1547	0.000	0.000	0.000	0.000	0.000	0.000	0.113	0.050	0.065	0.000	0.000	0.021
56	MACS 1810	0.000	0.000	0.000	0.000	0.000	0.103	0.028	0.041	0.018	0.046	0.008	0.022
57	JS 25-08	0.000	0.000	0.000	0.222	0.064	0.074	0.069	0.030	0.087	0.015	0.082	0.059
58	ASb 101	0.000	0.000	0.000	0.222	0.064	0.074	0.069	0.030	0.087	0.015	0.082	0.059
59	NRC 268	0.000	0.000	0.000	0.140	0.099	0.107	0.053	0.035	0.059	0.052	0.124	0.061
60	NRC 269	0.000	0.000	0.000	0.036	0.105	0.028	0.025	0.027	0.015	0.032	0.007	0.025

Similarly Mishra *et al.* (2022) found similar results out of 53 soybean genotypes screened 12 entries *viz.*, JS 20-84, AGS 111, JS 20-98, NRC127, KDS980, G-29, RSC-10-70, RSC-10-71, NRC-2, MACS-15-20, MACS-58 and JS 95-60 were found highly resistant, twenty-six genotypes showed resistant reaction, six showed moderately resistant reaction, seven genotypes showed moderately susceptible reaction and remaining 3 entries *viz.*, JS 335, RVS 2001-04 and JS 97-52 showed a highly susceptible reaction.

Conclusion

The identification of resistant sources against Yellow Mosaic Disease (YMD) in soybean is a critical step toward ensuring sustainable and high-yielding soybean production. By screening various soybean genotypes, resistant varieties can be pinpointed, offering a natural solution to mitigate the

detrimental effects of YMD, which includes yield loss, reduced seed quality and increased input costs. The use of resistant varieties not only minimizes the reliance on chemical treatments but also supports environmentally friendly farming practices. Furthermore, the development and adoption of these resistant genotypes enhance global soybean production, contributing to food security and the economic stability of farmers. Ultimately, identifying and incorporating resistance to YMD into breeding programs is essential for developing climate-resilient, high-performance soybean cultivars that can withstand the challenges posed by both the disease and changing environmental conditions.

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