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Screening of Soybean Varieties and Genotypes for Source of Resistance against Root Rot caused by *Rhizoctonia solani*

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ABSTRACT

The economically significant dicot legume known as soybean [*Glycine max* (L.) Merr.] is a member of the *Fabaceae* family. India is the world's fifth-largest producer of soybeans, and its major oilseed and legume crop. A major obstacle to the nation's soybean farming is the widespread occurrence of diseases like root rot (*Rhizoctonia solani*). The development of disease-resistant soybean cultivars is essential to resolving this problem and reducing production losses. Twenty varieties/genotypes were evaluated during *kharif* season 2023 and 2024. The disease incidence of Rhizoctonia root rot varied from 3.75 to 33.78 per cent. Out of twenty, two varieties/genotypes JS-335 and NRC-86 were exhibited as susceptible (S) reaction, nine varieties/genotypes such as JS-2029, MDS-2001, JS-20-116, NRC-146, MACS-1520, JS-2069, RKS-45, RVS-18 and NRC-130 were classified as moderately susceptible (MS) with disease incidence between 12.90% to 22.37%, seven varieties/genotypes, including NRC-148, JS-2098, NRC-127, JS-2034, MACS-1566, RVS-2002-4 and NRC-138 exhibited disease incidence ranging from 6.66% to 8.89% were categorized as moderately resistant (MR). Two varieties/genotypes, namely JS-9560 and RKS-48 were classified as resistance variety (R). None of the varieties and germplasms were found to be immune, highly resistant, and highly susceptible. These results highlight the significance of additional study and breeding initiatives to create soybean cultivars with improved resistance to root rot. In order to support sustainable soybean cultivation in India, it is imperative to identify and promote genotypes that are resistant to disease.

Key words: *Rhizoctonia solani, Germplasm, Varieties, Susceptible, Resistance.*

Introduction

Soybean [*Glycine max* (L.) Merrill], belongs to the family *Fabaceae* and also called a miracle golden bean because of its nutritive value, especially as a substitute of protein. It accounts for approximately 50% of the total production of oil seed crops in the world (Fehr, 1989). Soybean is the most important seed legume crops, which contributes 25 % edible oil, and two-thirds of the world's protein for live-stock feeding. Soybean meal is a valuable ingredient in formulated feeds for poultry and fish (Agarwal *et al.,* 2013). Soybean seeds is a good source of protein, crude fat, carbohydrate or several minerals such as of calcium, magnesium, iron, sodium, zinc, phosphorus and energy (Etiosa *et al.,* 2017). In India, soybean cover about 13.26 million-hectare area with the production and productivity of 13.06 million tonnes and 985 kg/ha respectively. The major soybean growing states are Madhya Pradesh, Maharastra, Rajasthan, Karnataka, Gujrat and Telangana (Anonymous, 2023-24). Rajasthan have third rank in area (1126.49 thousand ha) and production (1169.86 thousand tonnes) with productivity (1038 kg/ha). The major soybean growing division of Rajasthan are Kota (754.41 thousand ha), Udaipur (285.96 thousand ha), Bhilwara (105.95 thousand ha), Bharatpur (4.40 thousand ha) and Jaipur (0.63 thousand ha) (Anonymous, 2023-24). In India, soybean crops are grown during *Kharif* season, normally cultivated in June-July and harvested in October-November. Soya-based nutritious food products such as soy milk, tofu (bean curd), soy sauce, and miso have been developed for human consumption, whereas soya meal oil extracted is used as nutritious for animal feed. Aside from domestic use of soya oil has a wide range of applications in industries such as varnishes, pharmaceuticals, paints, plastics, inks, paper, pesticides, and cosmetics. Recently, the use of soya oil as biodiesel has opened up a new avenue of renewable energy for industrial applications (Pratap *et al.,* 2012). Soybean is affected by several fungal, bacterial and viral diseases. The root rot caused by *Rhizoctonia solani* (Kuhn *et al*., 1858) is the most important and serious disease that causes yield losses due to damping root rot. The prominent symptoms of this disease are seed rot, root rot and lesions on hypocotyls. The damping-off disease occurs when germinating seedlings are infected prior to emergence. Older plants or seedlings also exhibited characteristic sunken, reddish - brown lesion cankers on the lower stem near the soil surface with irregular or stunted growth (Rahman *et al.,* 2020). In Rajasthan, maximum root rot incidence (32.31 per cent) was noticed in Bhilwara district followed by Udaipur (18.90 %) and Kota (18.26 %) districts (Belkar and Gade, 2016). Chang *et al.,* (2018) to reported the yield losses 48-52% in soybean caused by root rot pathogen *Rhizoctonia solani*. Periodically, ongoing efforts were made to identify and select soybean genotypes that were resistant to the root rot disease caused by *Rhizoctonia solani*. Resistance in the host plant is a practical, cost-effective, and environmentally safer part of a comprehensive strategy to keep plant diseases below the threshold level.

Materials and Methods

The field experiment was conducted at instructional farm of Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan. Twenty soybean varieties/ genotypes were screened during *Kharif* season 2023 and 2024 under field condition for their relative resistance and susceptibility against Rhizoctonia root rot pathogen caused by *Rhizoctonia solani* under inoculated condition. Seeds of each cultivar were sown in two rows augmentation plot design (paired plot technique) of with 3 m length and maintaining row to row and plant to plant distance as 45X5 cm, respectively, with three replications in Randomized Block Design. Inoculation the resident cultures of *Rhizoctonia solani* that, was multiplied on autoclaved corn meal sand media were added 50 g/plot before sowing the seeds. Observation: the root rot disease incidence was recorded at the time of seedling root rot to 30 DAS at regular interval. Soybean disease incidence were recorded by using rating scale (0-5) (Hoong and Susan, 1962). Based on the disease incidence, the varieties and germplasms were categorized into various reaction grades to determine their relative degree of resistance to the disease. Per cent disease incidence was assessed by the following formula (Rahman *et al.,* 2013).

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

Lits 1. Disease rating scale 0-5 for assessing the per cent disease incidence against root rot of soybean (Hoong and Susan, 1962)

Rating	Root rot incidence	Category	Reaction	Lesion
0	0.0-0.0	I	Immune	No symptoms
1	0.1-5.0	R	Resistance	<2.5mm
2	5.1-10.00	MR	Moderately resistance	2.5-5 mm
3	10.10-25.00	MS	Moderately susceptible	Greater than 5 mm
4	25.10-50.00	S	Susceptible	Lesion girdling
5	>50	HS	Highly susceptible	Plant dead

Results and Discussion

Data presented in Table 1 showed that none of the varieties/genotypes were found to be free from disease infection. However, two varieties/genotypes with PDI, namely JS-335 and NRC-86 with disease incidence 33.78% and 26.02% were considered as susceptible variety (S), nine varieties/genotypes with PDI, 48-52%namely JS-2029 (22.37%), MDS-2001 (20.62%), JS-20-116 (20.38), NRC-146 (15.94%), MACS-1520 (14.16%), JS-2069 (13.80%), RKS-45 (13.69%), RVS-18 (13.13%) and NRC-130 (12.90%) were classified as moderately susceptible (MS) with disease incidence between 12.90% to 22.37%. Seven varieties/genotypes, including NRC-148 (8.89%), JS-2098 (8.25%), NRC-127 (8.14%), JS-2034 (7.95%), MACS-1566 (7.85%), RVS-2002-4 (6.85%) and NRC-138 (6.66%) exhibited disease incidence ranging from 6.66% to 8.89% were categorized as moderately resistant (MR). Two varieties/genotypes, namely JS-9560 and RKS-48 with disease incidence 3.86% and 3.75% were considered as resistance variety (R). None of the varieties and germplasms was found immune, highly resistant, and highly susceptible. All the varieties/genotypes were categorized according to disease rating scale (0-5). Similarly, over results are in accordance with Gupta *et al.* (2018), an experiment was conducted to determine the cause of fifty-four soybean cultivars' resistance against root rot caused by *Rhizoctonia solani*. The data showed that eight entries were found resistant, twenty-two entries were categorized as moderately resistant, twenty-one entries were categories as moderately susceptible, two genotypes assigned to the susceptible group and BAUS-96 was the only entry that displayed a highly susceptible reaction. Dutta *et al.* (2023), forty soybean varieties were analysed in order to identify the sources of genetic resistance against Rhizoctonia root rot caused by *Rhizoctonia solani* in field conditions. Twelve of these exhibited a moderately susceptible reaction, twenty-two exhibited a moderately resistant reaction, and four exhibited a highly susceptible reaction. The PDIs for each variety ranged from 6.2% to 24%, with

Table 1. Evaluation of soybean varieties/genotypes to identify the resistance source against root rot caused by *Rhizoctonia solani* under artificial inoculation Conditions

S. No.	Vari./genotype	PDI Mean			Reaction
		2023	2024	Pooled	
1	JS-335	33.83 (35.52)	33.73 (35.45)	33.78 (35.48)	S
2	JS-2069	13.25 (21.31)	14.35 (22.23)	13.80 (21.78)	MS
3	JS-9560	4.02 (11.55)	3.70 (11.12)	3.86 (11.33)	R
4	JS-2034	7.80 (16.12)	8.10 (16.48)	7.95 (16.3)	MR
5	JS-20-116	19.99 (26.44)	20.77 (26.98)	20.38 (26.71)	MS
6	JS-2029	22.00 (27.88)	22.74 (28.38)	22.37 (28.13)	MS
7	JS-9305	7.83 (16.18)	8.68 (17.10)	8.25 (16.64)	MR
8	NRC-127	7.72 (16.10)	8.57 (17.00)	8.14 (16.55)	MR
9	NRC-138	6.65 (14.91)	6.67 (14.80)	6.66 (14.85)	MR
10	NRC-130	12.47 (20.64)	13.34 (21.39)	12.90 (21.02)	MS
11	NRC-146	15.60 (23.04)	16.29 (23.58)	15.94 (23.32)	MS
12	NRC-86	25.71 (30.42)	26.33 (30.84)	26.02 (30.64)	S
13	NRC-148	8.67 (17.07)	9.12 (17.47)	8.89 (17.28)	MR
14	RKS-45	13.05 (21.14)	14.33 (22.19)	13.69 (21.67)	MS
15	RKS-48	4.00 (11.50)	3.50 (10.45)	3.75 (10.99)	R
16	RVS-18	12.56 (20.73)	13.70 (21.69)	13.13 (21.22)	MS
17	RVS-2002-4	6.82 (15.10)	6.88 (15.11)	6.85 (15.11)	MR
18	MACS-1566	7.74 (16.11)	7.97 (16.28)	7.85 (16.48)	MR
19	MACS-1520	14.15 (22.05)	14.18 (22.09)	14.16 (22.08)	MS
20	MDS-2001	19.57 (26.23)	21.68 (27.70)	20.62 (26.97)	MS
	Sem±	1.061	1.164	1.080	
	CD (p=0.05)	3.049	3.346	3.104	
	CV (%)	8.674	9.301	8.727	

*Average of three replications. Figures in parentheses are angular transformed value, HR- Highly Resistant, R- Resistant, MR- Moderately Resistant, MS- Moderately Susceptible, S- Susceptible, HS- Highly Susceptible

Table 2. Categorization of different soybean varieties and germplasms according to disease reaction

S. No.	Disease Reaction	Number of varieties/ genotypes	Varieties and germplasms
1.	Immune (I)	-	-
2.	Highly Resistant (HR)	-	-
3.	Resistant (R)	1	**JS-9560**
4.	Moderately Resistant (MR)	7	NRC-148, JS-9305, NRC-127, JS-2034, MACS-1566, RVS-2002-4 and NRC-138
5.	Moderately Susceptible (MS)	10	JS-2029, MDS-2001, JS-20-116, RKS-113, NRC-146, MACS-1520, JS-2069, RKS-45, RVS-18 and NRC-130
6.	Susceptible (S)	2	JS-335 and NRC-86
7.	Highly Susceptible (HS)	-	-

HIMSO-1689 showing the most severe disease. Mandloi *et al.* (2023) to evaluate the resistance to aerial blight caused by Rhizoctonia solani, 25 early maturity and 56 late maturity soybean genotypes in Indore. Different soybean genotypes displayed varying levels of resistance to these diseases, according to the study. Of the late maturity soybean genotypes, NRC 257 and MAUS 824 had the lowest mean disease score against RAB disease. Out of all the early maturity soybean genotypes, AUKS 234 had the lowest mean disease score against RAB disease.

Conclusion

Based on disease incidence, soybean varieties/genotypes were categorized into the seven classes during the observation of *Kharif* season 2023 and 2024. Twenty genotypes/varieties of soybean were screened under artificial inoculation field conditions. None of the varieties/genotypes was found immune, highly resistant and highly susceptible. However, two soybean varieties/genotypes (JS-9560 and RKS-48) was found to be resistant, seven to be moderately resistant, nine to be moderately susceptible, and rest two were found susceptible to the disease.

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Competing Interests - Authors have declared that no competing interests exist.

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