Biological Forum – An International Journal **15(1): 252-257(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Screening of Soybean Genotypes for Resistance to Root rot Disease caused by *Rhizoctonia solani* in Assam condition

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(Received: 17 November 2022; Revised: 18 December2022; Accepted: 30 December, 2022; Published: 13 January, 2023)
(Published by Research Trend)

ABSTRACT: The productivity of Soybean in Assam condition is greatly hampered by the numerous biotic factors. Frequent rainfall in the area provides a suitable environment for occurrence of numerous diseases. Among all the diseases affecting soybean, Rhizoctonia rot is worth mentioning. The wide host range of the pathogen causes difficulty in its management and so developing resistant genotypes against the pathogen is of great importance. Screening genotypes for developing resistance can help us to reduce the impact of the disease and reduce crop losses. Forty varieties received from AICRP (All India Coordinated research Project) on soybean were evaluated at Jorhat, Assam under green house and field conditions during the year 2018 and 2019 to identify sources of genetic resistance against rhizoctonia root rot disease incited by the *Rhizoctonia solani.* The fungus was isolated from diseased soybean seedlings collected from ICR farm at seedling stage, purified and maintained on PDA. Fungus inoculated soil was prepared and seeds were sown.In greenhouse experiment, out of 40 soybean varieties no varieties exhibited immune and resistant reaction, 22 varieties exhibited moderately resistant reaction, 12 varieties exhibited moderately susceptible reaction and 4 varieties exhibited highly susceptible reaction. Under the field conditions, the PDI varied from 6.2 to 24 % with highest disease severity shown by HIMSO-1689 variety.

Keywords: Rhizoctonia root rot, *Rhizoctonia solani,* Soybean, Genetic resistance.

INTRODUCTION

Soybean being a nutritious crop plays a significant role in overcoming problems of food and nutritional insecurity especially in developing countries (Sharma *et al.,* 2016). It is the most important and least expensive protein sources produced worldwide (Soystats, 2017). It has been reported that the Indian continent is the secondary center for domestication of the crop after China (Agarwal *et al.,* 2013). The crop enhances soil fertility and economizes crop production by minimizing the regular rate of nitrogen fertilizer (Rahman *et al.,* 2020). The low productivity of soybean in both national and state level is attributed to a biotic and abiotic stresses mostly comprising drought, weed, insect pest and diseases. (Borah and Saikia 2019). Disease pressure appears to be increasing as yield losses are seen to increase over time (Bandara *et al*., 2020). The diseases are caused principally by fungi or bacteria however fungal diseases mostly cause greater threat to the crop production (Borah and Deb 2020). In wet conditions, plant fungal pathogens mostly sporulate on previous years vegetation so no -till management regimes may increase disease outburst (Sharma-Poudyal *et al.,* 2017). Seed and seedling diseases which are basically soil borne cause significant problem in Assam condition (Borah, 2019). So addressing this issues are important to ensure soybean production profitability by controlling these diseases.

The crop is greatly affected by diseases such as root rot, brown spot, Soybean rust, downey mildew and stem blot which causes great loss in Soybean production in many countries. (Sallam *et al.,* 2021). *Rhizoctonia solani Kuhn* (teleomorph = Than at ephoruscucumeris Donk) is a ubiquitous soil-borne plant pathogenic fungus causing significant yield losses in most of the agriculturally important crops (Sturrock *et al.,* 2015). It is an important part of root rot/seedling disease complex reported in many soybean producing areas (Wrather *et al.,* 2003). It causes pre emergence and post emergence damping off with symptoms of seed rot root rot hypocotyl lesions and web blight (Rahman *et al.*, 2020). *R. solani* in Soybean are often associated with short soybean rotations, cropping histories that include other susceptible hosts such as dry beans (*Phaseolus vulgaris*) or poor environmental conditions for seed germination and seed emergence (Nelson *et al*., 1996). *Rhizoctonia solani* is well known and widely dispersed in soil, plant dead matter and roots causing diseases in wide range of host, including root rot in soybean (Surbhi *et al*., 2020).

Mostly *Rhizoctonia* species are soil borne in nature with a wide host range. It causes significant losses on all agricultural and horticultural crops. Use of pathogen free soiless mix or fungicide seed treatment in greenhouse does not stop its incidence as it may be introduced in contaminated potting mix or by residues in the greenhouse bench (Lewis : Lumsden 2001). However the use of fungicide is currently forbidden in many countries and biological and cultural control practices are mostly preferred (Arastehfar *et al*., 2019). Chemical control poses a serious threat to the ecosystem (Ajesh *et al.,* 2021). The pathogen causes post emergence damping off, root rot, stem rot, foliar blight and can cause substantial yield loss (Doupnik 1993). It exists in groups and its cultural characteristics, hosts and virulence differ (Erper *et al.*, 2006). Keeping this background in mind the present study was conducted to screen for genotypes possessing resistance to the pathogen.

MATERIALS AND METHOD

Source of planting material. Seeds of 40 varieties were collected from AICRP on Soybean. Planting materials were generated in the sterilized soil inside the green house of Department of Plant Pathology, AAU, Jorhat. Field experiment was also carried out at ICR farm under proper care.

Method of application of *Rhizobium solani* culture. The 30 days old suspension culture of *Rhizobium solani* was mixed with the soil in the seed trays and was kept as such for one day. The seeds were then sown in the inoculated soil. The trays were moistened with water regularly for establishment of the pathogen.

Screening of seedlings against *Rhizoctonia solani:* After 2 weeks of inoculation observations of the soybean seedlings hypocotyl was made and the disease severity was scored (Faessel *et al*., 2008).

Table 1: Rating scale of hypocotyl rot symptom after 2 weeks of inoculation.

Class	Lesion size	Reaction
0	No symptom	I
1	< 2.5mm	R
2	2.5 to 5 mm	MR
3	> 5 mm	MS
4	Lesion girdling	S
5	Plant dead	HS

Screening of soybean varieties under field condition. Seeds were procured from AICRP (All India Coordinated Research Project) on Soybean, Raipur. The field experiment was laid out during Kharif season (Fig. 1) of 2018 and 2019 at the ICR farm, AAU, Jorhat. The land was sandy loam and the pH was 5.3. Tractor was utilized for the preparation of the land.

Forty varieties were screened against *R. solani*. Each test entry was sown in a plot with row-to-row distance of 45 cm and plant to plant distance of 10 cm in a randomized block design (RBD) with three replications. Culture of *R. solani* was artificially inoculated near the root zone 15 days after sowing. Observations on disease severity were recorded at weekly intervals following inoculation. The disease reaction of genotypes was recorded using the 0–5 scale of disease severity as given by Faessel *et al.* (2008). Thereafter the disease index in different genotypes was calculated using the following formula given by Wheeler (1969):

Percent disease index (PDI) =

$$\frac{\text{Sum of all ratings}}{\text{Number of ratings} \times \text{maximum grade}} \times 100$$

RESULTS AND DISCUSSION

The characteristic symptom of the disease was keenly observed during the entire crop season. *Rhizoctonia* damaged seeds and plants before or after emergence. In seedlings, a firm, rusty-brown decay, or sunken lesion on the root or the lower stem were observed which resembled Borah (2019); Bowman *et al*. (1989). Infection may either be superficial causing no observable damage or may girdle the stem and kill or stunt plants (Borah and Deb 2020). Noticeable symptoms ranges from yellowing of the leaves, dropping off and completely dried symptoms within a week after the appearance of the first symptom. Proper examination of the basal stem and main root system of the diseased plant showed extensive rotting with most of the lateral roots destroyed. The tissues break off easily. The situation becomes devastating when Sclerotia bodies were seen scattered in the pith cavity and on the outer surface of the taproot. The symptoms resembled with symptoms as described by Chattopadhya and Bhattacharya (1967), and Sinclair and Shurtleff (1975) in soybean.

Screening of varieties against *Rhizoctonia solani.* The soybean varieties were screened for resistance against Rhizoctonia rot caused by *Rhizoctonia solani*. According to the disease severity score the genotypes were classified into 5 distinct classes which are presented in the Table 2. Similar scoring methods have also been reported by Eizenga *et al.* (2002) for rice sheath blight resistance caused by *Rhizoctonia solani*.

The 40 genotypes screened for their resistance against *Rhizoctonia solani* in greenhouse condition did not showed immune reaction as all were seen to be affected by the pathogen. No single genotypes among the 40 genotypes showed complete resistant reaction against the pathogen. Among the 40 genotypes, 22 genotypes showed moderately resistant reaction. They were PS1637, JS21-71, MACS1566, SL1191, HIMSO1688, PS24, RSC11-17, MAUS734, Dsb33, NRC138, PS1347, NRC139, SL1171, MAUS732, NRC148, RVSM2011-35, VLS97, NRCSL2, KDS1009, BAUS100, BRAGG, JS335. Among the genotypes screened for their resistance against Rhizoctonia rot were DS3109, NRC146, JS21-72, PS1637, AUKS176, GJS3, KS113, RVS2011-10, TS59, RVS2007-4, KDS1073, JS9305 were found to be moderately susceptible. Among the genotypes screened 4 were found to be susceptible to the pathogen *Rhizoctonia solani*. They were namely DS3110, MACS1620, SL958, CAUMS1. The highly susceptible genotypes screened for resistance against Rhizoctonia rot are RSC11-15, HIMSO 1689.

In the field condition, disease severity was recorded on weekly intervals and the disease index was calculated. The PDI values ranged from 6.2-24 among the genotypes (Table 3). The highest value of PDI was shown by HIMSO-1689 while the lowest value by SL1171. The disease index, lesion length mostly varies with host tested (Shamim *et al.*, 2014). Similar association of Rhizoctonia on Soybean crops has also been reported by Singh *et al.* (1974).

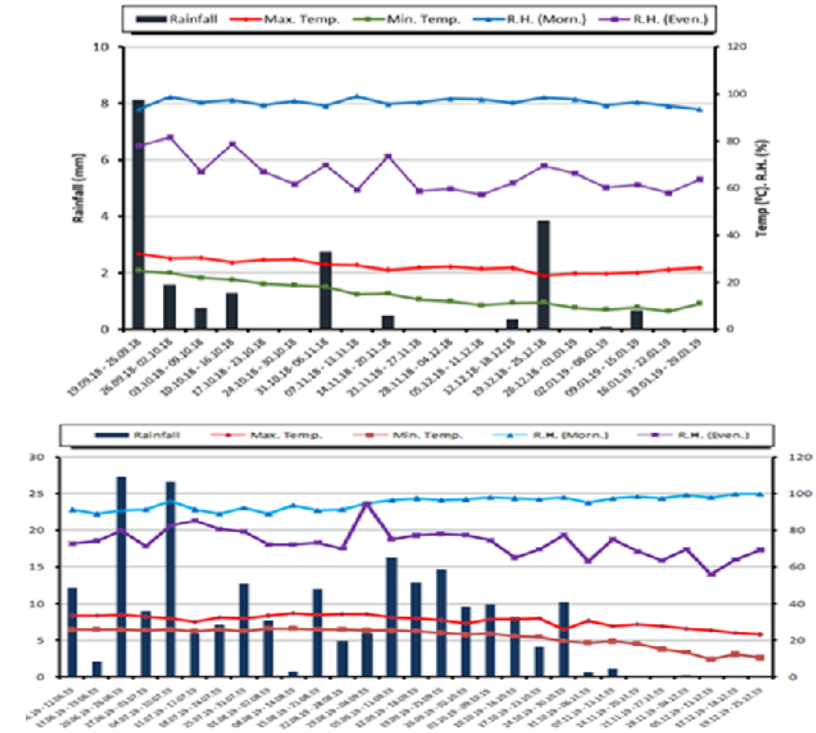

Fig. 1. Weekly meterological data during the crop growth period.

Table 2: Screening of soybean varieties under green house condition.

Genotypes	Lesion size due to Rhizoctonia rot	Reaction
DS3109	5.32mm	MS
NRC146	5.78mm	MS
PS1637	2.56mm	MR
JS21-71	2.60mm	MR
MACS1566	2.78mm	MR
SL1191	2.68mm	MR
HIMSO1688	2.80mm	MR
PS24	2.93mm	MR
RSC11-17	3.28mm	MR
MAUS734	3.45mm	MR
Dsb33	3.78mm	MR
NRC138	3.68mm	MR
JS21-72	6.25mm	MS
PS1637	6.80mm	MS
AUKS176	6.33mm	MS
PS1347	2.78mm	MR
GJS3	6.34mm	MS
NRC139	2.58mm	MR
DS3110	Lesion girdling	S
SL1171	2.76mm	MR
MACS1620	Lesion girdling	S
MAUS732	2.79mm	MR
KS113	5.78mm	MS
SL958	Lesion girdling	S
NRC148	3.02mm	MR
RSC11-15	Plant dead	HS
RVS2011-10	5.46mm	MS
HIMSO1689	Plant dead	HS

CAUMS1	Lesion girdling	S
RVSM2011-35	2.56mm	MR
VLS97	2.59mm	MR
TS59	5.69mm	MS
RVS2007-4	5.66mm	MS
KDS1073	5.42mm	MS
NRCSL2	2.78mm	MR
KDS1009	2.92mm	MR
BAUS100	3.01mm	MR
BRAGG	3.43mm	MR
JS9305	5.78mm	MR
JS335	2.78mm	MS

Table 3: Screening of soybean varieties under field condition.

Sr. No.	**Variety**	**PDI**	**Reaction**
1.	**DS3109**	12.8	MS
2.	**NRC146**	14.8	MS
3.	**PS1637**	6.4	MR
4.	**JS21-71**	9	MR
5.	**MACS1566**	9.6	MR
6.	**SL1191**	8.8	MR
7.	**HIMSO1688**	8.4	MR
8.	**PS24**	8	MR
9.	**RSC11-17**	8.4	MR
10.	**MAUS734**	9	MR
11.	**Dsb33**	9.4	MR
12.	**NRC138**	8.2	MR
13.	**JS21-72**	15	MS
14.	**PS1637**	14.2	MS
15.	**AUKS176**	14.4	MS
16.	**PS1347**	7.8	MR
17.	**GJS3**	11.6	MS
18.	**NRC139**	9.8	MR
19.	**DS3110**	17.8	S
20.	**SL1171**	6.2	MR
21.	**MACS1620**	19	S
22.	**MAUS732**	9.4	MR
23.	**KS113**	11.6	MS
24.	**SL958**	18.4	S
25.	**NRC148**	9.8	MR
26.	**RSC11-15**	23.2	HS
27.	**RVS2011-10**	11.4	MS
28.	**HIMSO1689**	24	HS
29.	**CAUMS1**	16.8	S
30.	**RVSM2011-35**	10	MR
31.	**VLS97**	7.4	MR
32.	**TS59**	11.8	MS
33.	**RVS2007-4**	14.4	MS
34.	**KDS1073**	12.8	MS
35.	**NRCSL2**	9.6	MR
36.	**KDS1009**	6.6	MR
37.	**BAUS100**	8.2	MR
38.	**BRAGG**	9.6	MR
39.	**JS9305**	10	MR
40.	**JS335**	13.8	MS

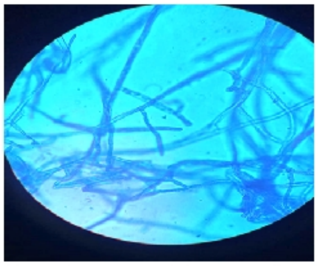

Plate 1. Microscopic view of the pathogen.

Plate 2: Suspension culture of the pathogen.

Plate 3. Pure culture on PDA slants.

Plate 4. Soybean plants infected with *Rhizoctonia solani* in field condition.

Plate 5. Sterilized soil preparation.

Plate 6. Mixing of suspension culture in sterilized soil.

Plate 7. Soybean plants dying after showing rotting symptoms.

Plate 8. Plant showing rotting symptoms in hypocotyls.

Plate 9. Hypocotyl of a plant with 2.5-5 mm lesion.

Plate 10. Hypocotyl of a plant with >5 mm lesion.

Plate 11. Hypocotyl of a plant with lesion girdling.

Plate 12. Hypocotyl of a dead plant.

CONCLUSION

As a conclusion, from this experiment it was noted that both field and greenhouse screening showed similar results. None of the genotypes was found immune or resistant to the pathogen. Only 22 genotypes namely PS1637, JS21-71, MACS1566, SL1191, HIMSO1688, PS24, RSC11-17, MAUS734, Dsb33, NRC138, PS1347, NRC139, SL1171, MAUS732, NRC148, RVSM2011-35, VLS97, NRCSL2, KDS1009, BAUS100, BRAGG, JS335 however showed moderate resistance against the pathogen. Later, findings of root rot genes for resistance from above sources may help to develop new soybean cultivars with improved root rot resistance.

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How to cite this article: Priyankee Dutta, Munmi Borah and Prasanta Kumar Goswami (2023). Screening of Soybean Genotypes for Resistance to Root rot Disease caused by *Rhizoctonia solani* in Assam condition. *Biological Forum – An International Journal, 15*(1): 252-257.