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Assessment of brinjal germplasms against bacterial wilt incited by *Ralstonia solanacearum*

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Brinjal cultivation in India is severely affected by the incidence of bacterial wilt caused by *R. solanacearum*. Three hundred fifteen germplasms were screened against bacterial wilt of brinjalunder field conditions. Ninety-three germplasms were identified as highly resistant, while sixty-six were classified as resistant. Sixty-four germplasms exhibited moderate resistance. On the other hand, thirty-three germplasms were deemed moderately susceptible, twenty-nine were found to be susceptible, and thirteen were categorized as highly susceptible. The AUDPC values were found to be ranging from 3505.9in highly susceptible germplasm to 10.5 in highly resistant germplasm.

Keywords : AUDPC, bacterial wilt, brinjal, *Ralstonia solanacearum*, varietal screening

INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) is a major solanaceous crop widely cultivated in tropics and sub-tropics. It is extensively grown in India withtotal area under cultivation and production is 752.8 thousand hectares and 12.77 million MTduring 2022-23 (Anonymous,2023) and is a major source of income for the small and marginal farmers. The unripe fruit of brinjal is primarily used as a vegetable for cooking purposes like curry or other savouries. The production and productivity of brinjal depends on both abiotic as well as biotic stresses. Among the biotic factors, bacterial wilt caused by *Ralstonia solanacearum* proves to be a major problem.

Bringing about severe crop losses worldwide, the disease is now receiving global profile (Allen *et al*. 2005). The disease has limited both the commercial and domestic level production. It has caused economic problems worldwide leading to serious annual losses exceeding USD 950 million (Mansfield *et al*. 2012). Brinjal cultivation in India is severely affected by the incidence of bacterial wilt caused by *R. solanacearum*(Nishat *et al*.2015) and the yield loss ranging from 11.67 to 96.67 per cent (Bainsla *et al*.2016) is recorded in India.

Typical symptoms of bacterial wilt include turning of the lower leaves to pale yellow, loss of turgidity of the young leaves, followed by drooping of the leaves (epinasty), sudden wilting of plants and brown discoloration of vascular bundles.

Management of bacterial wilt in brinjal is being attempted with use of resistant varieties, crop rotation, intercropping and organic manuring, biological management includes vascular-arbuscular mycorrhizae (VAM), bacterial endophytes, bacteriophages(Sahu*et al*. 2017), avirulent mutants of *R. solanacearum*, and genetically engineered antagonist bacteria. (Abdel-Monaim *et al*. 2014). Some bioagents such as*Psuedomonas fluorescens*, *Trichoderma* spp. (Chauhan *et al*. 2024) or integration of these strategies (Abo-Elyousr *et al*. 2014), but all have a limited success. Additionally, using chemicals has a negative impact on non-target creatures and the ecosystem. Therefore, search for resistant sources is essential so that those genes can be incorporated into the commercial cultivars.

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MATERIALS AND METHODS

The experimental material consisting of 315 germplasmsobtained from Main Vegetable Research Station (MVRS), AAU, Anandwas maintained in a homozygous state inpolyhouse at MVRS, AAU, Anand. One month old seedlings of the germplasms were transplanted in the field in last week of October 2023. The experiment was laid out in non-replicated trial. Around 10 seedlings of each germplasm were sown in a row. A susceptible check (Punjab Sadabahar) was used. Around one month after transplantation, the symptoms of wilting were observed. Observations for disease incidence was made as per the scale suggested by (Winstead and Kelman (1952)(Table1),and accordingly the categorization of the germplasm was done. Weekly observations were recorded till 135 days after transplantation. The disease incidence was calculated by the following formula :

$$\text{\% Wilt Incidence} = \frac{\textit{Number of wilted plants}}{\textit{Total number of plants}} \times 100$$

Area under Disease Progress Curve and Infection rate

Relative spread of the disease was calculated among the different varieties and using the area under the disease progress-curve (AUDPC), following the standard method (Campbell and Madden, 1990) as follows :

$$\text{AUDPC}(Y) = \sum_{i}^{n} \left[\left(X_i + X_{i+1} \right) / 2 \right] \left(t_{i+1} - t_i \right)$$

Infection rate (r) was also calculated by using the following formula :

$$(r) = \sum_{i}^{n} \left[\log \left(X_i + X_{i+1} \right) \right] 2.3 \left(t_{i+1} - t_i \right)$$

Y is the AUDPC, X_i is the disease incidence of the i^{th} observation and X_{i+1} is the disease incidence of the $i+1^{st}$ observation, t_{i+1} - $t_i$is the number of days between two observations.

Infection rate (r) and AUDPC was correlated and represented graphically.

RESULTS AND DISCUSSION

Screening of germplasms is a vital process that underpins the development of more productive, resilient, and sustainable agricultural systems. The use of resistant varieties leads to less loss of yield and less use of chemicals, which are hazardous to humans and the environment.

315 germplasms were screened against *R. solanacearum* causing bacterial wilt in brinjal. The incidence varied greatly within all the germplasms. Among all the germplasms, ninety-three germplasms were found to be highly resistant, having no wilted plants with a grade of 0. Sixty-six germplasms were found to be resistant, showing 1-20% plants wilted with a grade of 1. Sixty-four germplasms were found to be moderately resistant, having 21-40% plants wilted with a grade of 2. Thirty-three germplasms were found to be moderately susceptible having 41-60% plants wilted with a grade of 3. Twenty-nine germplasms were found to be susceptible having 61-80% plants wilted with a grade of 4. And thirteen germplasms were found to be highly susceptible, having more than 80% plants wilted with a grade of 5. The susceptible check, *viz*. Punjab Sadabahar was found to be highly susceptible with 100% of plants being wilted (Table2).Santhosha *et al*. (2015) screened forty brinjal genotypes against *Ralstonia solanacearum*, and observed similar results in which genotypes ranged from resistant to highly susceptible.Resistance attributed to genotypes maybe due to secondary metabolism of polyphenols and the elevated levels of steroidal glycoalkaloids in resistant plants, and structural defences like tyloses, gels, and callose also play a role in preventing further spread of *R. solanacearum* and confining it (Vasse *et al*. 2005; Planas-Marquès *et al*.2019).

In the present study, the AUDPC values were calculated for five germplasms from each class selected randomly. It was found to be the minimum (10.5) in the germplasm GPBRJ-15, GPBRJ-216, GPBRJ-99, GPBRJ-318 and GPBRJ-21 which showed highly resistant reaction and the maximum (3505.95) for GPBRJ-3 which was highly susceptible under naturally infected field conditions. Infection rate (r) of germplasm

Table 1: 0-5 scale of bacterial wilt of brinjal (**Winstead and Kelman 1952)**

Grade	Disease Reaction	% Incidence
0	Highly resistant (HR)	Plants did not show any wilt symptoms
1	Resistant (R)	1-20% plants wilted
2	Moderately resistant (MR)	21-40% plants wilted
3	Moderately susceptible (MS)	41-60% plants wilted
4	Susceptible (S)	61-80% plants wilted
5	Highly susceptible (HS)	More than 80% plants wilted

Table 2: Disease reaction of different germplasm lines of brinjal against bacterial wilt

Grade	Disease Reaction	% Incidence	Germplasm No. (GPBRJ)
0	Highly resistant (HR)	Plants did not show any wilt symptoms	7,8,10,12,15,16,18,19,21,25,26,27,29, 32,38,43,48,53,72,73,76,77,91,94,96,97,99,102,103, 105,106,108,110,114,115,116,123,125,127,129,130,135,139,141,142,146,147,149,151,161,189,201,203,207,208,210,213,216,218,222,228,232,233,235,238,240,241,247,248,254,256,259,267,268,284,286,289,290,291,309,310,313,315,317,318,320,322,326,330,331,335,336,337
1	Resistant (R)	1-20% plants wilted	2,20,23,24,34,41,42,46,57,63,65,66,75,76,80,90,93,95,112,113,117,124,126, 131,145,153,156,157,160,162,178,179,193,195,200, 202,206,209,211,212,215,219,220,221,225,227,234,239,242,243,245,249,253,255,258,262,264,276,282,283,287,293,295,297,307,311,333
2	Moderately Resistant (MR)	21-40% plants wilted	1,5,9,14,17,30,33,35,3,39,44,48,49,50,55,56,62,68,82,85,87,89,107,109,111, 118,119,121,128,134,137,138,140,143,144,152,154,158,164,167,171,172,173,174,181,182,187,188,190,192,194,196,197,198,204,205,223,226,229,230,231,237,244,250
3	Moderately Susceptible (MS)	41-60% plants wilted	4,11,13,28,31,36,40,47,54,59,64,69,70,79,88,92,100, 104,122,150,155,163,169,175,180,184,199,217,224, 236,269,272,279,323
4	Susceptible (S)	61-80% plants wilted	6,22,51,52,60,71,78,81,83,86,98,132, 133,136,165,168,170,176,183,185,191,214,246,257, 271,280,319,334
5	Highly Susceptible (HS)	More than 80% plants wilted	3,61,67,74,101,120,148,166,177,260, 265,273,277

Table 3: AUDPC and R-values of randomly selected germplasms

Genotype No	Reaction	AUDPC	R-value
15	HR	10.5	0
216	HR	10.5	0
99	HR	10.5	0
318	HR	10.5	0
21	HR	10.5	0
162	R	227.5	0.045932
293	R	574.7	0.047356
41	R	227.5	0.045932
76	R	227.5	0.045932
200	R	1095.5	0.049823
85	MR	359.10	0.012366
55	MR	1842.05	0.069348
223	MR	403.2	0.056384
121	MR	403.2	0.056384
1	MR	743.75	0.066485
13	MS	883.05	0.043261
100	MS	2105.25	0.062978
323	MS	1751.05	0.05912
150	MS	1230.95	0.041071
36	MS	1230.95	0.041071
86	S	1102.5	0.061243
334	S	1102.5	0.061243
6	S	926.8	0.060453
246	S	1321.25	0.062978
176	S	3243.45	0.065783
120	HS	1540.00	0.064444
277	HS	2935.8	0.069436
74	HS	1758.75	0.065714
61	HS	2453.15	0.068534
3	HS	3505.95	0.076342

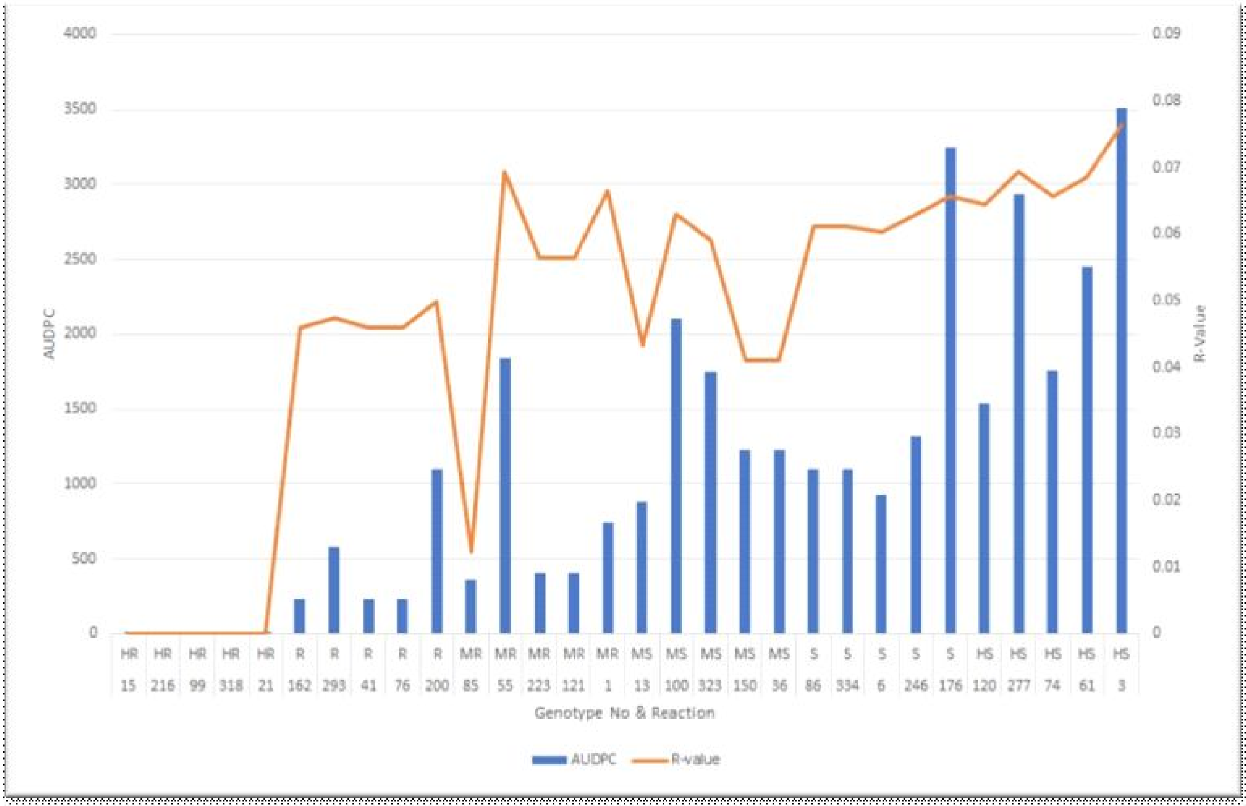

Fig. 1: Disease progression (AUDPC) and infection rate (R-value) of the selected genotypes

with different disease reactions showed a wide variation (Table3). Infection rate varied greatly among the screened varieties and germplasm which ranges between 0.0 for highly resistant germplasms to 0.076342 for the susceptible germplasm GPBRJ-6. Hence, the result indicated that, both AUPDC and infection rate followed the same trend according the disease reaction (Fig.1).

According to the findings of Nikuze (2024), who evaluated 47 African eggplant accessions for resistance, disease incidence varied between 5.6% and 66.8%. Notably, none of the accessions exhibited complete resistance to the bacterial pathogen. The area under disease progress curve (AUDPC) values ranged from 38.5 in accession RV100455, which demonstrated resistance, to 472.5 in accession RV100386, indicating a higher level of susceptibility.

Additional research is required to assess the resistance levels of the germplasms across different agro-climatic zones of the country and to examine the consistency of their resistance to various strains of *R. solanacearum*.

CONCLUSION

The current study highlights the variability in resistance to bacterial wilt among 315 brinjal germplasm accessions screened under field conditions. The identification of 93 highly resistant and 66 resistant accessions provides a valuable foundation for developing bacterial wilt-resistant cultivars, potentially reducing dependence on chemical management strategies. The results indicate a strong correlation between disease severity and both AUDPC values and infection rates, supporting their use as reliable indicators in resistance screening. While several accessions exhibited notable resistance under field conditions, further multi-location trials are essential to assess the stability and durability of resistance across varying environmental conditions and against diverse strains of *R. solanacearum*. The utilization of these resistant lines in breeding programs could significantly contribute to sustainable brinjal production and enhanced food security.

DECLARATION

Conflict of interest. Authors declare no conflict of interest.

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