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Evaluation of Green Long Pre-Breeding Lines of Brinjal (*Solanum melongena* L.) for Bacterial Wilt Resistance, Yield and Yield Attributing Traits

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A B S T R A C T

Ten pre-breeding lines of F_4 generation green long brinjal of Green Long x IIHR-3 along with their parents and checks (Arka Anand and Arka Kusumakar) were evaluated for bacterial wilt resistance after artificial inoculation and good horticultural properties. The results revealed that among 10 families of F_4 lines derived from the cross Green Long x IIHR-3 the progenies *viz.*, 12-36-164-7, 12-36-164-10, 12-36-164-11 and 12-36-164-14 showed moderate resistance to the bacterial wilt disease, whereas, 12-36-46-3, 12-36-46-6, 12-36-164-1, 12-36-170-9, 12-36-170-11 and 12-36-170-19 found to be resistance. F_4 pre-breeding lines had shown a larger extent of variation for all the traits when compared to the interfamily variation, so there is a need of further advancement of generation to attain the homozygosity. The study lead to identification of superior green round brinjal plants resistant to bacterial wilt along with good horticultural properties from $F_{3:4}$ segregating population.

Introduction

One of the most important solanaceous vegetable crop grown worldwide is brinjal or eggplant (*Solanum melongena* L.), which can be grown easily year round in tropical and sub-tropical regions except in higher altitudes where it is susceptible to frost injury. Brinjal is a rich source of vitamins and minerals, but their production is hindered by many biotic and abiotic stresses. Among biotic stresses, bacterial wilt is one of the most devastating diseases. It is caused by the gram negative bacterium *Ralstonia solanacearum* (Smith), previously known as *Pseudomonas solanacearum* (Smith) leading to yield loss ranging from 4.24 to 86.14 per cent (Sabita *et al.*, 2000). There are different sources of bacterial wilt disease resistant species have

been identified like, *S. melongena, S. torvum, S.sisymbrifolium, S. aethiopicum, S. xanthocarpum, S. toxicarum* and *S. nigrum* (Kalloo, 1994). The bacterium enters the plant through wounded roots and progressively invades the stem vascular tissues, leading to a sudden wilting. The affected stem shows vascular discoloration which may be accompanied by browning and rotting of tissues inside the vascular bundles. Even though there are various cultural, biological and chemical control measures have been suggested for the management of bacterial wilt incidence, these are found to be less effective. It is a complex interaction between the environment, pathogen strains and host plants. Even though there are various varieties in purple fruited segment of brinjal, modern technologies and voluminous literature have been reported, still there is a need to concentrate more on development of broad spectrum bacterial wilt disease resistance to select and identify stable resistant cultivars along with good horticultural properties in green long segment of Brinjal. This study was undertaken with an aim to select superior recombinant for bacterial wilt resistance from $F_{3:4}$ pre-breeding lines of Green Long x IIHR-3.

Materials and Methods

The experiment which was been conducted with the objective of estimating resistance in pre-breeding lines of green long brinjal (*Solanum melongena* L.). This experiment was conducted at College of Horticulture, ten $F_{3:4}$ pre-breeding lines of Green Long x IIHR-3 namely, 12-36-46-3, 12-36-46-6, 12-36-164-1, 12-36-164-7, 12-36-164-10, 12-36-164-11, 12-36-164-14, 12-36-170-9, 12-36-170-11 and 12-36-170-19 along with their susceptible and resistant parents *viz.,* Green Long and IIHR-3 respectively with resistant check Arka Anand and susceptible check Arka Kusumakar were evaluated in the field for bacterial wilt disease resistance and horticultural properties. The *Ralstonia solanacearum* (Smith) inoculums were prepared from the bacterial colonies obtained from freshly wilted brinjal plants as prescribed by Kelman (1954). *R. Solanacearum* (Smith) suspension of concentration1.0 $x10^6$ cfu/ml. About 5.0ml of bacterial suspension was inoculated to each of the seedling. Before inoculation, the roots were slightly damaged by inserting a sharp knife 1.0cm away from the stem then inoculums was drenched around the root zone on 21st day of sowing. Then during transplanting also seedlings were dipped in the bacterial suspension and planted in the main field. Data on death of the plants due to bacterial wilt disease incidence was taken until the end of the cropping season (four harvests). Occurrence of bacterial wilt was confirmed by conducting bacterial ooze test on wilted plants. The percentage of wilted plants in each line was calculated by using the following formula.

Per cent disease incidence (PDI) = Number of plants infected with bacterial wilt / Total number of plants *100

Further, genotypes were classified into five different groups as given below according to percent disease incidence as reported by Hussain *et al.,* (1952).

Results and Discussion

The evaluation results revealed that the parent Green Long and the check Arka Kusumakar were highly susceptible with bacterial wilt disease incidence of 90.28 per cent and 91.67 per cent respectively. The resistant parent and check like IIHR-3 and Arka Anand respectively showed very less disease incidence *i.e.,* 20.00 per cent and 4.16 per cent respectively (Table 2). Among 10 families of F_4 lines derived from the cross Green Long x IIHR-3 the progenies *viz.,* 12-36-164-7

(46.66%), 12-36-164-10 (30.00%), 12-36-164-11(27.50%) and 12-36-164-14 (27.50%) showed moderate resistance to the bacterial wilt disease, whereas, 12-36-46-3, 12-36-46-6, 12-36-164-1, 12-36-170-9, 12-36-170-11 and 12-36-170-19 found to be resistance to bacterial wilt with a percent disease incidence of 10.00 per cent, 20.00 per cent, 17.50 per cent, 17.50 per cent, 7.40 per cent and 12.50 per cent respectively. This may be due to the presence of polyphenolic compound or glycoalkaloids in resistant lines Vasse *et al.,* 2005. This result was in accordance with Hussain *et al.,* (2005).

Means and standard deviation of various quantitative characters for pre-breeding lines their parents and checks are presented in the Table 3 and 4 respectively. Out of ten F_4 families none of them had shown highest plant height when compared to the parent and checks among these lines highest plant height had shown in the line 12-36-170-11(51.63 cm) with a range of 37.00cm to 70.00cm and lowest was noticed in the line 12-36-164-7 (40.17 cm).

Highest mean value foe number of branches was observed in line 12-36-170-11 (7.71) with a range of 4 to 11 followed by 12-36-1164-11 (7.28) and lowest was noticed in line 12-36-46-3 (5.61). None of the pre-breeding lines showed lesser mean number of days for first flowering than the parents, but there are plants within each lines which showed early bearing habit. Higher values of standard deviation were observed for average fruit weight in all the pre-breeding lines which indicates more deviation from the mean value for this character. The wider range of variation in the fruit length, fruit breadth and average fruit weight may be due to the variation in the maturity stages of fruits harvested at each picking. The line 12-36-46-3 had shown highest mean value for average fruit weight 43.50±10.89 with a range of 24.33g to 72.00g followed by 12-36-46-6 (38.58±11.36) while, lowest was observed in line 12-36-164-7 (30.93±7.91). All the pre-breeding lines were recorded with more average number of fruits per plant and yield per plant compared to both of the parents where, highest was noticed in the line 12-36-170-19 (13.07±9.74) with a range of 2.00 to 47.00 fruits per plant and highest fruit yield per plant was found in line 12-36-164-11 (405.18±371.83g) when compared to both the parents (Table 3 and 4). A wide range of variation exists for almost all the quantitative characters in the pre-breeding lines of brinjal. These results are in accordance with Prasad *et al.,* (2006), Kumar *et al.,* (2011), Madhavi *et al.,* (2015) and Patel *et al.,* (2017).

Table.1 Disease reaction index

Disease reaction	Per cent wilt incidence
Highly resistant (HR)	Plants do not show any wilt symptom
Resistant (R)	1-20% plants wilt
Moderately resistant (MR)	21-40% plants wilt
Moderately susceptible (MS)	41-60% plants wilt
Susceptible (S)	61-80% plants wilt
Highly susceptible (HS)	More than 80% plants wilt

Table.2 Reactions of $F_{3:4}$ pre-breeding lines of Green Long x IIHR-3, their parents and checks to *Ralstonia solanacearum* (Smith)

Sl. No.	Line number/Parents/Checks		Percentage wilt	Reaction	Incubation period (Days)	50% wilt on DAT
1	12-36-46-3		10.00	R	58	-
2	12-36-46-6		20.00	R	59	-
3	12-36-164-1		17.50	R	35	-
4	12-36-164-7		46.66	MS	36	-
5	12-36-164-10		30.00	MR	34	-
6	12-36-164-11		27.50	MR	34	-
7	12-36-164-14		27.50	MR	34	-
8	12-36-170-9		17.50	R	34	-
9	12-36-170-11		7.40	R	46	-
10	12-36-170-19		12.50	R	48	-
11	Green Long		90.28	HS	25	53
12	IIHR-3		20.00	R	30	-
13	Arka Anand		4.16	R	34	-
14	Arka Kusumakar		91.67	HS	21	52

R – resistant MR – moderately resistant; MS – moderately susceptible
HS – highly susceptible; DAT – Days after transplanting

Table.3 Mean and standard deviations of various quantitative characters for ten pre-breeding lines of Green Long and IIHR-3

Genotype / Characters	12-36-46-3			12-36-46-6			12-36-164-1		
		Range			Range			Range	
	Mean ± SD	Min	Max	Mean ± SD	Min	Max	Mean ± SD	Min.	Max
Plant height (cm)	46.73±11.42	29.00	75.00	45.92±8.48	32.00	65.00	42.92±8.79	24.00	65.00
No. of branches/ plant	5.61±1.84	4.00	12.00	6.36±2.43	4.00	12.00	6.15±1.97	4.00	12.00
Days to first flowering	47.00±4.63	36.00	55.00	43.32±4.64	34.00	54.00	46.23±6.38	31.00	54.00
Average fruit weight (g)	43.50±10.89	24.33	72.00	38.58±11.36	7.35	67.16	33.30±10.79	18.41	75.80
Fruit length (cm)	10.95±1.62	7.50	14.00	10.37±1.39	7.00	12.50	10.70±1.85	8.00	16.00
Fruit breadth (cm)	1.77±0.47	1.15	2.9.00	1.76±0.51	1.20	3.40	1.40±0.34	0.90	2.30
No. of fruits/plant	6.64±3.93	2.00	16.00	9.72±7.87	3.00	41.00	8.85±4.16	3.00	18.00
Yield/ plant (g)	274.91±158..35	100.00	666.00	336.74±198.72	103.00	844.00	274.14±98.89	111.00	436.00

Continued…

Genotype / Characters	12-36-164-7			12-36-164-10			12-36-164-11		
		Range			Range			Range	
	Mean ± SD	Min	Max	Mean ± SD	Min	Max	Mean ± SD	Min.	Max
	40.17±7.86	30.00	58.00	46.90±9.02	28.00	63.00	51.41±10.27	21.00	70.00
Plant height (cm)									
No. of branches/ plant	6.06±1.84	4.00	10.00	6.21±2.01	4.00	11.00	7.28±2.72	4.00	16.00
Days to first flowering	47.31±5.56	39.00	56.00	44.72±4.35	38.00	54.00	47.10±5.23	38.00	54.00
Average fruit weight (g)	30.93±7.91	18.41	48.96	38.11±7.31	26.71	50.33	35.94±10.39	22.25	71.66
Fruit length (cm)	10.37±1.54	8.30	13.75	10.26±1.74	8.00	14.50	11.12±2.08	5.00	14.25
Fruit breadth (cm)	1.29±0.23	0.95	1.86	1.50±0.24	1.10	2.06	1.48±0.29	0.95	2.00
No. of fruits/plant	8.13±1.75	5.00	11.00	8.86±4.75	3.00	20.00	9.55±3.86	4.00	16.00
Yield/ plant (g)	290.81±103.41	132.00	436.00	325.53±165.34	128.00	694.40	405.18±371.83	130.00	2160.00

Continued…

Genotype	12-36-164-14			2-36-170-9			12-36-170-11			12-36-170-19		
		Range			Range			Range			Range	
Characters	Mean ± SD	Min.	Max	Mean ± SD	Min.	Max	Mean ± SD	Min.	Max	Mean ± SD	Min.	Max
Plant height (cm)	47.30±8.71	28.00	65.00	50.26±6.55	33.00	60.00	51.63±7.33	37.00	70.00	49.46±6.98	36.00	62.00
No. of branches/ plant	6.93±1.88	4.00	12.00	7.03±1.49	4.00	9.00	7.71±1.53	4.00	11.00	7.07±1.84	4.00	11.00
Days to first flowering	45.33±6.22	31.00	54.00	47.81±4.79	40.00	55.00	47.43±5.70	38.00	54.00	45.25±6.20	30.00	54.00
Average fruit weight (g)	32.98±10.23	11.44	56.00	35.65±9.79	16.66	70.23	32.49±7.57	12.07	46.53	34.07±10.051	12.20	53.50
Fruit length (cm)	10.23±2.51	4.10	14.80	11.48±1.87	5.00	14.50	11.33±1.40	8.50	13.80	10.89±2.35	5.10	15.10
Fruit breadth (cm)	1.65±0.37	1.06	2.65	1.57±0.38	1.05	2.40	1.56±038	0.90	2.35	1.51±0.41	0.95	2.66
No. of fruits/plant	9.78±7.21	3.00	39.00	9.90±6.33	3.00	30.00	11.83±6.33	3.00	22.00	13.07±9.74	2.00	47.00
Yield/ plant (g)	275.95±110.31	135.20	482.20	345.13±221.34	100.00	966.00	377.51±221.34	132.80	739.60	385.44±207.60	107.00	956.80

SD – Standard deviation

Table.4 Mean and standard deviations of various quantitative characters for parents and checks

Parent/ check	Plant height (cm)	Number of branches	Days to first flowering	Average fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Number of fruits/plant	Yield /plant (g)
Green Long	47.80±1.92	7.20±0.44	40.2±1.78	34.53±2.38	11.93±0.43	2.10±0.10	4.40±0.54	151.10±12.00
IIHR-3	58.40±3.36	8.40±0.54	37.8±1.78	43.00±1.46	12.75±0.43	1.54±0.14	5.20±0.54	223.27±14.75
Arka Anand	59.60±3.05	9.20±0.84	36.80±1.48	33.16±0.89	14.63±0.45	2.88±0.24	11.00±0.71	364.49±18.97
Arka Kusumakar	55.60±1.67	8.00±1.22	36.60±1.14	27.02±1.81	11.50±0.73	2.85±0.22	9.00±1.00	242.10±18.49

Table.5 Quantitative characters of selected individual plants in $F_{3:4}$ segregating population

Entry No.	Plant height (cm)	No. of branches	Days to 1st flowering	Fruit length (cm)	Fruit breadth (cm)	Total No. of fruits/ plant	Average fruit weight (g)	Yield / plant (g)
12-36-46-3-32	65.00	7.00	45.00	10.50	1.30	9.00	24.33	219.00
12-36-46-3-35	52.00	8.00	42.00	12.75	1.80	12.00	41.98	503.80
12-36-46-6-4	51.00	9.00	43.00	11.50	1.60	5.00	46.60	233.00
12-36-46-6-10	46.00	12.00	43.00	11.00	1.20	15.00	39.97	599.60
12-36-46-6-37	45.00	6.00	45.00	9.73	1.40	4.00	50.75	203.00
12-36-170-9-15	55.00	6.00	44.00	10.52	1.85	30.00	32.20	966.00
12-36-170-9-19	52.00	9.00	43.00	13.00	1.46	15.00	33.93	509.00
12-36-170-9-30	58.00	9.00	44.00	12.60	1.40	13.00	31.33	407. 40
12-36-170-11-1	55.00	7.00	45.00	12.00	1.10	16.00	25.53	408.60
12-36-170-11-11	53.00	10.00	41.00	13.60	1.16	22.00	32.96	725.20
12-36-170-11-14	55.00	7.00	38.00	10.80	1.60	20.00	27.75	555.00
12-36-170-19-19	46.00	7.00	45.00	15.10	1.70	22.00	34.33	755.40
12-36-170-19-26	58.00	9.00	46.00	11.47	1.93	33.00	28.99	956.80

Considering both bacterial wilt resistance reaction and various quantitative characters the superior plants in the resistant lines12-36-46-3, 12-36-46-6, 12-36-170-11, 12-36-170-9 and 12-36-170-19-26 were selected for further evaluation in $F_{4:5}$ generation (Table 5).

Further evaluation and selection of superior plants from the segregating generation will lead to the development of bacterial wilt resistant green long brinjal varieties having good horticultural properties.

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