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Identification of Resistant and Susceptible Sources against Blast Diseases in Finger Millet [*Eleusine coracana* L. (Gaertn.)]

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Authors' contributions

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

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ABSTRACT

The study was undertaken to evaluate the 490 finger millet (*Eleusine coracana* L.) genotypes (released, pre-release and breeding genotypes) including two check varieties viz., Indaf 5 (susceptible) and GPU-28 (resistant) against neck and finger blast disease at Hill Millet Research Station, Waghai, The Dangs, Gujarat during kharif, 2018 to 2022. Among all the 490 genotypes,

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148 genotypes have shown resistant reaction under high disease pressure field conditions for neck and finger blast disease. However, 44 germplasm genotypes have shown consistent susceptible reaction during five years tested viz; kharif, 2018 to 2022. The genotypes viz., CFMV 2, GN-8, VL-376, PR-202 and GPU-67, showed the higher immune reaction under natural field condition. The pooled percent disease intensity of neck and finger blast diseases ranged from 2.90 to 72.4 per cent and 3.9 to 84.2 per cent respectively, in all tested genotypes including national and local checks. The resistant check variety GPU-28 exhibited resistant reaction to both neck and finger blast. In susceptible check variety Indaf-5 recorded the pooled diseases intensity of 61.74 % for neck blast and 73.6 % for finger blast. In which 72.4 and 84.2 is the highest percent pooled disease intensity of neck and finger blasts recorded in finger millet entry WN 666 which is the most highly susceptible reaction noted across five years of study in blast susceptible zone of Gujarat.

Keywords: Finger millet; screening; resistant; susceptible; leaf; neck and finger blast.

1. INTRODUCTION

"Finger millet (*Eleusine coracana L.*), is important small millet grown extensively in diverse regions of India and Africa. Among small millets, finger millet ranks first in area and production. Among all the cereals and millets its position in production is sixth after wheat, rice, maize, sorghum and bajra. Finger millet consumption has advantageously increasing because of its best nutritive values" [1]. "Among all the several fungal diseases that affect finger millet crop, blast diseases caused by *Pyricularia grisea* is the greatly affect the crop yield as it occurs in economical part of crop. The disease was reported for the first time in India, from Tanjore delta of Tamil Nadu" by McRae [2]. This disease is known to occur almost every year during rainy climatic condition in all most nachani/ragi growing regions and is perceived one of the major diseases causing successive yield losses in almost of the states in India.

"The percentage of losses depends on its infection severity and time of onset of disease on economical part of the plant. The mean losses due to finger millet blasts has been reported to be around 30% and found as high as 85-95% in endemic areas. Finger millet blast disease is the most devastating, causing more than 60% yield losses" [1]. As per McRae [2] "the grain loss in fingers due to blast could be over 56 per cent", while, Venkatarayan [3] registered "more than 80 per cent yield loss in Mysore areas". Sunil and Anilkumar [4] reported "3-35% loss in 1000-grain mass in head blast-affected ear heads in Bangalore. The crop is susceptible to the disease during all the stages of crop growth and development, from seedling to grain formation stage. Younger seedlings are more affected under both conditions *ie*. nursery and in the field condition. The lesions are generally of oval to spindle shaped, however lesions of different sizes may also be observed. At the beginning, the dots have yellowish border margin and grayish at the centre. Later, the centres became whitish grey and disintegrate more. Under hot humid conditions, olive-grey fungal overgrowth can be seen at the centre of the lesions. The fungal growth comprises of conidiophores and conidia. In the beginning the lesions are isolated and afterwards they may soon coalesce. The distal portion of the leaves beyond the lesions may hang and drop off. Area wise, use of better yielding resistant/ tolerant cultivars is the most viable, environmentally safe and economical way to which paves less expensive technique for the management of blast diseases. Thus, it is most remunerative to farmers and thus the identification of the resistance source is a basic need in plant breeding for disease resistance". Therefore, the present investigation was undertaken at Rajendrapur farm, Hill Millet research station, NAU, Waghai, Dangs which is the most susceptible zone (highest rainfall >2500 mm and higher humidity) of this state which will helpful to find out resistant as well as susceptible sources against most economical phases *viz;* neck and finger blast disease in finger millet.

2. MATERIALS AND METHODS

The experiment were conducted against finger millet blast caused by *Pyricularia grisea* at Hill Millet Research Station, Waghai, Dangs, Gujarat in blast susceptible zone of Gujarat during *kharif*, 2018 to 2022. The experiment was laid in Augmented Block Design, with 490 genotypes which was sown in three rows of 3.5 m length with a spacing of 30 x 10 cm. The recommended cultivation practices and other regular packages

of practices were adopted at time to time of crop growth period. Only randomly selected five plants were used from each genotype for recording the data. The genotypes of finger millet were screened under natural epiphytotic conditions and no artificial inoculation was made in crop stand. As such the climatic conditions are reported to be in blast susceptible zone of Gujarat. According to grades, the entries were categorized as I (Immune), HR (Highly resistant), R (Resistant), MS (Moderately susceptible) and S (Susceptible) [5]. (Table 1 and 2).

2.1 Neck Blast

"For recording the incidence of finger millet neck blast, the total numbers of healthy panicles and total numbers of blast infected panicles were counted in the dough stage at each five random sites of 1 x 1 sq mt area and percent incidence was calculated by using the following formula as adopted by Ravikumar (1988). The maximum grades out of recorded observations were considered as final reaction of the respective entry. According to grades exhibited, the entries were categorized as below" by Hittalmani [5].

Neck Blast (%) = Total no. of infected ears at neck region/ Total no. of ears Observed *100

Table 1. Standard Evaluation Systems (SES) disease rating scales for neck blast

Reaction	Disease rating (%)
Immune (I)	0.00
Resistant (HR)	0.1-5.0
Moderately susceptible (R)	5.10-10.0
Susceptible (MS)	10.10-25.0
Highly susceptible (S)	>25.00

2.2 Finger Blast

"For recording the incidence of finger blast, three middle genotypes in a plot were selected. The total numbers of healthy fingers and total numbers of blast infected fingers were recorded from each variety. Counting of healthy and blast infected finger, was done at dough stage and percent finger blast incidence was calculated by using the following formula as adopted by Ravikumar (1988). The maximum grades out of recorded observations were considered as final reaction of the respective entry. According to grades exhibited, the entries were categorized as below" by Babu et al. [6].

Finger Blast (%) =Total no. of infected fingers/ Total no. of fingers observed *100

Table 2. Standard Evaluation Systems (SES) disease rating scales for finger blast

Reaction	Disease rating (%)
Immune (I)	0.00
Resistant (R)	1.0-10.0
Moderately susceptible (MS)	10.10-20.0
Susceptible (S)	20.10-30.0
Highly susceptible (HS)	> 30.0

3. RESULTS AND DISCUSSION

In five successive *kharif* seasons (2018-2022) 490 genotypes were evaluated out of 1550 genotypes against blast of finger millet under completely natural field condition with high disease pressure of blast susceptible field plot. The genotypes were grouped under different degrees of resistance on the basis of disease reaction for neck blast and finger blasts in finger millet.

3.1 Evaluation of finger millet genotypes for resistance to major diseases during *kharif*, 2018-2022

3.1.1 During *kharif* 2018

The 490 genotypes of finger millet varieties including local (GN-8) and national check (CFMV-2 and GPU-67) along with the blast resistant and susceptible genotypes were studied for neck and finger blast diseases and their yield performance under natural field conditions during *kharif* 2018. Out of 490 finger millet genotypes, 124 varieties have shown resistant reaction under natural conditions and high disease pressure. The neck and finger blast disease ranged from 3.6 to 76.0 % and 2.8 to 84.0 % in check where neck blast and finger blasts were 76.0% and 84.0% in entry WN 666.

3.1.2 During *kharif* 2019

Rest of the 366 genotypes of finger millet varieties including local and national checks along with blast resistant and susceptible genotypes were studied for neck and finger blast diseases under natural field conditions and high

disease pressure during *kharif* 2019. Out of 366 genotypes, 95 varieties were found resistant to both neck and finger blast diseases. The neck blast and finger blast disease ranged from 3.7 to 64.0 % and 3.5 to 78.0 % in check where neck blast and finger blasts were 64.0 % and 78.0 % in entry WN 666.

3.1.3 During *kharif* 2020

Remaining 271 genotypes of finger millet varieties local and national checks along with blast resistant and susceptible genotypes were studied for neck and finger blast diseases under natural field conditions and high disease pressure during *kharif* 2020. Out of 271 genotypes, 76 varieties were found resistant to both neck and finger blast diseases. The neck blast and finger blast disease ranged from 1.9 to 66.0% and 2.2 to 82.0 % in check where neck blast and finger blast were 66.0 % and 82.0 % in entry WN 666.

3.1.4 During *kharif* 2021

Out of 195 genotypes of finger millet varieties including local and national checks along with blast resistant and susceptible genotypes were studied for neck blast and finger blast diseases under natural field conditions and high disease pressure during *kharif* 2021. Among 195 genotypes, 147 genotypes were found moderately resistant to both neck blast and finger blast diseases. The neck blast and finger blast disease ranged from 2.2 to 68 % and 3.7 to 89.0 % in check where neck blast and finger blasts were 68% and 89% in entry WN 666.

3.1.5 During *kharif* 2022

Among the remaining 48 genotypes of finger millet varieties including, local and national checks along with blast resistant and susceptible genotypes were studied for neck and finger blast diseases under natural field conditions and at high disease pressure during *kharif* 2022. Among all the genotypes 48 varieties were found to be moderately resistant to susceptible to both neck and finger blast diseases. The neck and finger blast diseases ranged from 2.0 to 88.0% and 2.9 to 88.0% in tested genotypes and checks, where the maximum neck blast and finger blast were 88% recorded in entry WN 666.

Field experiments conducted during *kharif*, 2018 is out of 1550 genotypes of which 1060 genotypes have shown resistant reaction under natural conditions. Among the 490 genotypes evaluated from *kharif* seasons (2018-2022), of which 48 varieties are consistently showing moderately resistant to susceptible reactions both neck blast and finger blast diseases under natural field conditions and high disease pressure during *kharif* seasons. Few of them are highly susceptible in which entry WN 666 showed highly susceptible to neck and finger blast. Hence it is concluded that, under blast susceptible environmental condition, finger millet entry **'WN 666'** showed highly susceptible for neck blast and finger blasts during the five years of evaluation of *kharif* 2018-2022.

Data regarding the incidence of neck and finger blast of these 48 consistent genotypes were given in the Table 3.

Patro and Madhuri [7] evaluated “32 finger millet genotypes among them, two were susceptible to neck blast and moderately resistant to finger blast, 14 were moderately resistant and 13 were susceptible to both neck and finger blast”. Divya et al*.* [8] screened “10 genotypes were evaluated for resistance to blast and none of the genotypes were found free from disease incidence. Minimum percentage of neck blast severity was recorded in VL 379 (14.82%), while the minimum finger blast severity (13.70%), was recorded in GPU 45”. Nagaraja et. al. [9] evaluated “12 elite finger millet cultivars among them, GE 4449 and GPU 28 were reported to be resistance to leaf blast and GE 4440, GE 4449 and GPU 28 were moderately susceptible to neck and finger blast”. Neeraja et. al. [10] screened “25 finger millet varieties and reported that nine varieties were resistant to moderately resistance to leaf blast and three were moderately resistance to both neck and finger blast”. Patro et. al. [11,12] studied “30 varieties of finger millet in which five varieties are found to be highly resistant and nineteen varieties are resistant whereas VR 708 recorded as highly susceptible to leaf blast”.

“The present disease incidence of neck blast ranged from 11.65 (WN 550) to 84.13 (VL 352) where it was 91.11 in susceptible line WN 666. In case of finger blast, it was ranged from 12.55 to 88.58, which is highest in WN 666 (88.58) followed by VL 389 (80.67) whereas the incidence was 90.20 in susceptible check” [13,14,8].

Table 3. Reaction of finger millet genotypes against blast disease resistance during *kharif* seasons (2018-2022)

S.No.	Variety	Neck Blast incidence (%)							Finger blast incidence (%)						
		2018	2019	2020	2021	2022	Pooled	R	2018	2019	2020	2021	2022	Pooled	R
1	WN 505	16.5	18.8	12.7	13.7	11.2	14.8	MS	15	32	51	21	14	26.6	S
2	WN 551	16.7	14.8	13.5	12.8	13	14.1	MS	25	24	38	19	41	29.4	S
3	WN 557	13.2	21.5	12.2	13.5	13.2	14.7	MS	23	32	22	38	32	29.4	S
4	WN 559	14.3	15.2	13.1	12.9	13.4	14.2	MS	25	54	18	42	11	30	S
5	WN 602	14.1	12.4	12.5	16.8	13.5	13.86	MS	39	32	21	32	26	30	S
6	WN 605	16.5	18.8	12.7	13.7	11.2	14.58	MS	21	23	31	29	34	27.6	S
7	WN 608	15.0	18.0	19.0	10.0	9.0	18.2	MS	32	25	17	31	28	26.6	S
8	WN 611	14.3	14.9	12.9	12.1	13.6	13.5	MS	23	27	28	36	35	29.8	S
9	WN 615	14.8	14	13.9	14.3	14	14.2	MS	21	22	23	28	29	24.6	S
10	WN 617	12.9	13.1	14.1	13.7	12.9	13.3	MS	26	29	29	21	36	28.2	S
11	WN 619	14.7	13.4	12.7	13.9	12.9	13.5	MS	34	27	30	30	24	29	S
12	WN 621	12.6	15.1	13.2	12.9	15.5	13.86	MS	23	34	29	32	30	29.6	S
13	WN 628	15.2	14.3	13.3	15.8	13	14.32	MS	28	23	36	31	28	29.2	S
14	WN 631	14.1	12.4	12.5	16.8	13.5	13.86	MS	39	48	12	22	25	29.2	S
15	WN 633	16.5	18.8	12.7	13.7	11.2	14.58	MS	26	30	26	33	32	29.4	S
16	WN 634	16.8	24.8	18.5	18.8	18	19.38	MS	29	49	30	27	18	30.6	S
17	WN 645	15.2	20.5	18.2	16.5	18.2	17.72	MS	45	32	14	28	20	27.8	S
18	WN 651	16.6	18	17.9	18.6	18.5	17.92	MS	33	31	22	30	32	29.6	S
19	WN 655	16.8	18.3	18.4	19.8	15.6	17.78	MS	34	28	42	19	23	29.2	S
20	WN 659	15.8	12.8	16.8	15.6	18.9	15.98	MS	31	29	31	22	31	28.8	S
21	WN 663	12.6	15.1	13.2	12.9	15.5	13.86	MS	29	28	29	26	30	28.4	S
22	WN 666	**76**	**64**	**66**	**68**	**88**	**72.4**	**HS**	**84**	**78**	**82**	**89**	**88**	**84.2**	**HS**
23	WN 668	6.2	5.8	5.2	3.5	6.5	5.4	R	21	32	29	38	32	30.4	S
24	WN 669	14.1	12.9	12	16.5	14.5	14	MS	30	28	37	27	23	29	S
25	WN 675	16.5	18.8	12.7	13.7	11.2	14.5	MS	33	27	27	36	26	29.8	S
26	WN 676	16.7	14.8	13.5	12.8	13	14.1	MS	29	32	16	29	30	27.2	S
27	WN 677	34	27	30	30	24	29	HS	23	28	22	29	29	26.2	S
28	WN 679	23	34	29	32	30	29.6	HS	28	39	26	34	22	29.8	S
29	WN 682	28	23	36	31	28	29.2	HS	22	28	39	27	32	29.6	S
30	WN 683	39	48	12	22	25	29.2	HS	20	28	29	28	29	26.8	S
31	WN 685	26	30	26	33	32	29.4	HS	23	26	32	28	36	29	S

S.No.	Variety	Neck Blast incidence (%)							Finger blast incidence (%)						
		2018	2019	2020	2021	2022	Pooled	R	2018	2019	2020	2021	2022	Pooled	R
32	WN 689	29	49	30	27	18	30.6	HS	40	30	20	10	40	28	S
33	WN 696	45	32	14	28	20	27.8	HS	25	27	27	27	12	23.6	S
34	WN 701	33	31	22	30	32	29.6	HS	27	28	35	28	30	29.6	S
35	WN 709	34	28	42	19	23	29.2	HS	32	15	22	35	32	27.2	S
36	WN 715	31	29	31	22	31	28.8	HS	28	29	32	31	30	30	S
37	WN 726	34	27	30	30	24	28	HS	29	31	28	29	30	29.4	S
38	WN 731	16.8	24.8	18.5	18.8	18	19.38	HS	28	30	27	30	29	28.8	S
39	WN 749	15.2	21.5	16.2	15.5	16.2	16.92	MS	28	34	29	27	28	29.2	S
40	TNAU 1066	16.8	16	16.9	18.3	18	17.2	MS	37	28	25	31	29	30	S
41	RAU 8	16.9	18.1	18.1	19.7	12.9	17.14	MS	33	37	25	31	20	29.2	S
42	Indaf 5	**55.5**	**52.4**	**63.5**	**63.6**	**73.7**	**61.74**	**HS**	**69**	**73**	**69**	**77**	**80**	**73.6**	**HS**
43	GPU 28	**3.6**	**4.9**	**2.6**	**3.1**	**4.2**	**3.6**	**R**	**3.2**	**3.5**	**2.6**	**5.0**	**4.8**	**4.3**	**R**
44	GPU 67	**2.7**	**4.2**	**3.9**	**2.7**	**6.4**	**4.0**	**R**	**4.0**	**3.8**	**4.7**	**3.7**	**2.9**	**4.0**	**R**
45	PR 202	**2.7**	**3.4**	**2.8**	**3.7**	**2.8**	**3.3**	**R**	**5.5**	**5.0**	**3.7**	**4.0**	**5.0**	**4.4**	**R**
46	VL 376	**3.4**	**5.6**	**3.9**	**2.5**	**3.0**	**3.8**	**R**	**3.2**	**3.5**	**2.6**	**5.0**	**4.8**	**4.3**	**R**
47	GN 8	**4.8**	**3.7**	**1.9**	**2.2**	**4.0**	**3.2**	**R**	**7.2**	**5.3**	**2.2**	**6.3**	**2.9**	**5.0**	**R**
48	CFMV 2	**4.2**	**3.7**	**2.5**	**3.1**	**2.0**	**2.9**	**R**	**2.8**	**3.9**	**2.6**	**7.4**	**4.2**	**3.9**	**R**

R=Resistant, MS = Moderately Susceptible, S=Susceptible, HS=Highly Susceptible,
SC- Susceptible CHECK (Indaf 5) & RC- Resistant CHECK (GPU-28)

4. CONCLUSION

The 490 finger millet (*Eleusine coracana* L.) genotypes (released, pre-release and breeding genotypes) including two check varieties *viz*., Indaf 5 (susceptible) and GPU-28 (resistant) against leaf, neck and finger blast disease were evaluated at Hill Millet Research Station, Waghai, Dangs, Gujarat in blast susceptible zone of Gujarat during *kharif*, 2018 to 2022. Among all the 490 genotypes, 148 genotypes have shown resistant reaction under high disease pressure field conditions. However, 44 germplasm genotypes have shown consistent susceptible reaction during all the during *kharif,* 2018 to 2022 years tested. The resistant check variety 'GPU-28' exhibited resistant reaction to both neck and finger blast under in blast susceptible zone of Gujarat. The genotypes *viz*., CFMV 2, GN-8, VL-376, PR-202 and GPU-67 showed higher immune reaction under natural field condition. The pooled percent disease intensity of neck and finger blast diseases ranged from 2.90 to 72.4 per cent and 3.9 to 84.2 per cent respectively, in all the 1550 tested genotypes including national and local checks. In susceptible check variety 'Indaf-5' recorded the pooled diseases intensity of 61.74 % for neck blast and 73.6 % for finger blast. In which 72.4 and 84.2 the highest percent pooled disease intensity of neck and finger blast recorded in WN 666 which is the most highly susceptible reaction noted across five years of study.

5. RECOMMENDATION

The highest percent pooled disease intensity against the neck blast and finger blast diseases recorded in entry WN 666 which is the most highly susceptible reaction noted across five years of study in blast susceptible zone of Gujarat.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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