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

Abstract

An experiment was undertaken to evaluate the 490 finger millet (*Eleusine coracana* L.) lines (released, pre-release and breeding lines) including two check varieties *viz*., Indaf 5 (susceptible) and GPU-28 (resistant) against leaf, neck and finger blast disease at Hill Millet Research Station, Waghai, Dangs, Gujarat during *kharif*, 2018 to 2022. Among all the 490 lines, 148 lines have shown resistant reaction under high disease pressure field conditions. However, 44 germplasm lines have shown consistent susceptible reaction during all the during *kharif*, 2018 to 2022 years tested. The lines *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 ranged from 2.90 to 72.4 and 3.9 to 84.2 respectively, where it was 61.74 and 73.6 in check Indaf-5 highly susceptible reaction, respectively. In which **72.4 and 84.2 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. The resistant check variety GPU-28 exhibited resistant reaction to both neck and finger blast.

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

Introduction

Finger millet (*Eleusine coracana*), 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 cereals and millets its position in production is sixth after wheat, rice, maize, sorghum and bajra. Finger millet consumption has wide range of advantages because of its high nutritive values. Of the several fungal diseases that affect finger millet crop, blast disease caused by *Pyricularia grisea* is the most important disease. The disease was reported for the first time in India, from Tanjore delta of Tamil Nadu by McRae (1920). Since then, the disease is known to occur almost every year during rainy season in all major ragi growing areas and is perceived as is one of the major disease causing recurring yield losses in all the states of India.

The extent of damage depends on the severity and time of onset of disease. The average loss due to finger millet blast has been reported to be around 28% and has been reported as high as 80-90% in endemic areas. Finger millet blast disease is by far the most devastating, causing over 50% yield loss. According to McRae (1992) the grain loss due to blast could be over 56 per cent, while, Venkatarayan (1947) reported more than 80 per cent yield loss in Mysore. Sunil and Anilkumar (2004a) reported 3-35% loss in 1000-grain mass in head blast-affected ear heads in Bangalore. The plant is susceptible to the disease during all stages of its growth, from seedling to grain formation stage. Young seedlings are affected both in the nursery and in the field. The lesions are generally of spindle shaped, however lesions of different sizes may also be observed. In the beginning the spots have yellowish margin and grayish centre. Later, the centres became whitish grey and disintegrate. Under 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. Use of high yielding resistant/ tolerant cultivars is the most viable, environmentally safe and economical

sound which paves less expensive technique for the management of disease. Thus, it is most remunerative to farmers and thus the identification of the resistance source is a basic need in breeding for disease resistance. Therefore, the present investigation was undertaken to find out resistant as well as susceptible sources against neck and finger blast disease.

Materials and Methods

The trails were conducted against finger millet blast caused by *Pyricularia grisea* at Hill Millet Research Station, Waghai, Dangs, Gujarat during *kharif*, 2018 to 2022. The experiment was laid on a plot in Augmented Block Design, with 490 lines which was sown in two rows of 3 m length with a spacing of 22.5 x 10 m. The recommended agronomic practices and other standard packages of practices were adopted at the time of crop growth period. Five randomly selected plants were selected from each genotype for recording the observations. The genotypes of finger millet were screened under natural epiphytotic conditions and no artificial inoculation was made. According to grades exhibited, the entries were categorized as I (Immune), HR (Highly resistant), R (Resistant), MS (Moderately susceptible) and S (Susceptible) (Hittalmani, 2004). (Table 1 and 2).

Leaf blast (%) was calculated by using the following ratings (Disease rating scales 1-9 scale).

Table 1 : Standard Evaluation System (SES) scale for **Leaf blast rating (1-9 scale) (Disease rating scales)**

Score	Description	Disease Reaction
1	Small, brown, pinhead size specks without sporulating centre	Highly Resistant (HR)
2	Small (1-2 mm) roundish to elongated, necrotic grey spots with a distinct brown margin covering up to 5% leaf area	Resistant (R)
3	Typical blast lesions (≥3 mm) with sporulating center, covering 6-10 % of the leaf area	Resistant (R)
4	Blast lesions covering 11-20% leaf area	Moderately Resistant (MR)
5	Blast lesions covering 21-30% leaf area	Moderately Resistant (MR)
6	Blast lesions covering 31-40% leaf area	Susceptible (S)
7	Blast lesions covering 41-50% leaf area	Susceptible (S)
8	Blast lesions covering 51-75% leaf area	Highly Susceptible (HS)
9	Blast lesions covering >75% leaf area & plant dead	Highly Susceptible (HS)

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 I (Immune), HR (Highly resistant), R (Resistant), MS (Moderately susceptible) and S (Susceptible) (Hittalmani, 2004).

$$\textbf{Neck Blast}\ (\%) = \frac{\text{Total number of infected ears at neck region}}{\text{Total number of ears Observed}} \times 100$$

List 1. Disease reaction for neck blast

Reaction	Disease rating (%)
Immune (I)	0.0
Resistant (HR)	0.1-5
Moderately susceptible (R)	5.1-10
Susceptible (MS)	10.1-25
Highly susceptible (S)	>25

Finger blast

For recording the incidence of finger blast, three middle lines in a plot were selected. 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 I (Immune), R (Resistant), MS (Moderately susceptible), S (Susceptible) and HS (Highly susceptible) (Babu *et al*., 2013).

$$\textbf{Finger Blast}\ (\%) = \frac{\text{Total number of infected fingers}}{\text{Total number of fingers observed}} \times 100$$

Table 2: Disease reaction for finger blast.

Reaction	Disease rating (%)
Immune (I)	0.0
Resistant (R)	1-10
Moderately susceptible (MS)	10.1-20
Susceptible (S)	20.1-30
Highly susceptible (HS)	>30

Data analysis

The data was subjected to statistical analysis by adopting Fisher's method of analysis of variance as outlined by Gomez and Gomez (1972). The critical difference (CD) values are given at 5 percent level of significance, wherever the 'F' test was significant.

Results and Discussion

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

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

During *kharif* 2018

490 lines of finger millet varieties including local (GN-8) and national check (CFMV-2 and GPU-67) along with blast resistant and susceptible lines were evaluated for neck and finger blast diseases and their yield performance under field conditions during *kharif* 2018. Among all the finger millet lines, 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 blast were 76.0% and 84.0% in entry WN 666.

During *kharif* 2019

Remaining 366 lines of finger millet varieties including local and national checks along with blast resistant and susceptible lines were evaluated for neck and finger blast diseases under field conditions and high disease pressure during *kharif* 2019. Among all the lines 95 varieties were found to be resistant reaction to both neck and finger blast disease. The neck and finger blast disease ranged from 3.7 to 64.0 % and 3.5 to 78.0 % in check where neck blast and finger blast were 64.0 % and 78.0 % in entry WN 666.

During *kharif* 2020

Remaining 271 lines of finger millet varieties local and national checks along with blast resistant and susceptible lines were evaluated for neck and finger blast diseases under field conditions and high disease pressure during *kharif* 2020. Among all the lines 76 varieties were found to be resistant reaction to both neck and finger blast diseases. The neck 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.

During *kharif* 2021

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

During *kharif* 2022

Among the 48 lines of finger millet varieties including local and national checks along with blast resistant and susceptible lines were evaluated for neck and finger blast diseases under field conditions and high disease pressure during *kharif* 2022. Among all the lines 48 varieties were found to be moderately resistant to susceptible reaction to both neck and finger blast diseases. The neck and finger blast disease ranged from 2.0 to 88.0% and 2.9 to 88.0% in checks where neck blast and finger blast were 88% in each of entry WN 666.

Field experiments conducted during *kharif*, 2018 is out of 1550 lines of which 1060 lines have shown resistant reaction under natural conditions. Among the 490 lines evaluated from *kharif* seasons (2018-2022), of which 48 varieties are consistently showing moderately resistant to susceptible reaction to both neck and finger blast diseases the resistant reaction under natural field conditions and high disease pressure. Few of them are highly susceptible in which entry WN 666 showed highly susceptible to neck and finger blast. Data regarding the incidence of neck and finger blast of these 48 consistent lines/ varieties were given in the table 3. Hence it is concluded that, under blast susceptible environmental condition, finger millet entry **'WN 666'** showed highly susceptible for neck and finger blast during the five years of evaluation of *kharif* 2018-2022.

Patro and Madhuri (2014) 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. Patro *et al* (2016) and Nagaraja *et. al.* (2016) screened 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 moderate resistance/ susceptible to neck and finger blast. Neeraja *et. al.* (2016) screened 25 finger millet varieties and reported that nine varieties were resistant to moderately resistant to leaf blast and three were moderately resistance to both neck and finger blast. Divya *et al.* (2017) screened 10 genotypes were evaluated for resistance to blast none 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. Patro *et. al.* (2018) evaluated 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. Similar results were reported by (Patro *et al.*, (2017), Chandrasekhar *et al*., (2017) and Divya *et al*., (2016).

Conclusion:

The 490 finger millet (*Eleusine coracana* L.) lines (released, pre-release and breeding lines) 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 during *kharif*, 2018 to 2022. It was concluded that, among all the 490 lines, 148 lines have shown resistant reaction under high disease pressure field conditions. However, 44 germplasm lines have shown consistent susceptible reaction during all the during *kharif,* 2018 to 2022 years tested. The lines *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 ranged from 2.90 to 72.4 and 3.9 to 84.2 respectively, where it was 61.74 and 73.6 in check Indaf-5 highly susceptible reaction, respectively. In which **72.4 and 84.2 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. The resistant check variety GPU-28 exhibited resistant reaction to both neck and finger blast.

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Table 3 : Reaction of finger millet lines 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
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