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Identification of resistant sources of finger millet varieties against neck and finger blast disease

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Abstract
An experiment was undertaken to evaluate the fourteen finger millet varieties (released and prereleased) including two check varieties *viz*., Indaf 5 (susceptible) and GPU-28 (resistant) against neck and finger blast disease at Agricultural and Horticultural Research Station, Bavikere, Chikmagaluru district, Karnataka during *kharif* 2014 to 2016. Varieties *viz*., VL-149, DM-7, PR-202, GPU-76, VR-948, BR-2, TNAU-1063, RAU-8, TNAU-1066, GPU-67, OEB-532 and PPR-2885 showed the immune reaction under natural field condition. The percent disease intensity of neck and finger blast ranged from 0.00 to 28.71 and 0.00 to 33.36 respectively, where it was 28.71 and 33.36 PDI in check Indaf-5 Moderately susceptible reaction respectively. In case of finger blast, disease severity ranged from 0.00 to 24.18 percent, and it was 33.10 PDI in susceptible check Indaf-5 showed highly susceptible reaction. The resistant check variety GPU-28 exhibited resistant reaction to both neck and finger blast. With respect to yield performance, the genotype GPU-67 recorded significantly higher grain yield of 43.12 q/ha but found on par with VR-948 (42.17 q/ha) and OEB-532 (41.10 q/ha) respectively.

Keywords: Finger millet, neck blast, finger blast, *Pyricularia grisea,* Released and prereleased varieties, screening

Introduction

Finger millet (*Eleusine coracana* L.), is also known as African millet, Koracan, Ragi (in India), Bulo (Uganda), Wimbi (Swahili) and Telebun (Sudan). It is an important cereal crop for subsistence agriculture in the dry areas of Eastern Africa, India and Srilanka. India is one among the major cereal producing countries in the world. World finger millet production is 4.5 million tonne, of which about 2.5 million tonne is produced by Africa. The crop originated in Africa and has been cultivated for thousands of years in the Islands of Uganda and Ethiopia. It was introduced to India, probably over 3000 years ago. In India, it is cultivated in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Gujarat, Maharashtra and in the hilly regions of Uttar pradesh and Himachal Pradesh. Finger millet cultivation occupies a total area of 2.5 million hectares with a production of 2.2 million tonnes. Although it has not entered the international market for its nutritive value but it is one of the important cereal grain in areas of its adaptation.

Finger millet is the second most important food and fodder crop of the dry land in Karnataka. It has a high level of regional or local adaptation. Although grown under dry lands, it provides an assured harvest, thus making it indispensable in specific ecosystems. Finger millet is one of the few crops from which excellent malt can be prepared, and it is much appreciated for this characteristic. As such, the malt can be used directly, or in the preparation of various beverages and drinks (Anon., 1961) [61]. In southern Karnataka, the fodder is highly valued for feeding cattle and other ruminants. The grain is highly resistant to storage insect pests, even without any special care or attention. It is reputed to remain in good condition when stored as long as fifty years (Ayyangar, 1932) [32].

Diseases are the major constraints in economic production of finger millet. As many as 25 fungal, 4 viral, 5 bacterial and 6 nematode pathogens have been recorded on this crop . Blast (*Pyricularia grisea* (Cooke) Sacc.), foot rot (*Sclerotium rolfsii* Sacc.), smut (*Melanopsichium eleusinis* (Kulk.) Mundk. and Thirum.) and brown spot (*Helminthosprium sativum* Link.) are major important diseases in India (Nagaraja *et al*., 2007) [13], while blast and foot rot are major constraints of finger millet cultivation in Gujarat (Anon., 2010) [2]. Blast caused by *Pyricularia grisea* (Cooke) Sacc. [teleomorph: *Magnporthe grisea* (Hebert) Barr.] have been reported as the major disease, causing serious losses in finger millet.

The average loss due to blast has been reported to be around 28 to 36 percent (Nagaraja *et al* 2007) [13], and in certain areas, yield losses could be as high as 80 to 90 percent (Rao 1990) [18]. Blast affects the crop at all growth stages, but neck and panicle blast are the most destructive form of the disease (Takan *et al*. 2012) [22].

In *kharif*, due to continuous, heavy rainfall, high Humidity and warm temperature, the crop is heavily infested by blast incidence. It is a major constraint to the production of finger millet, resulting in direct crop losses in Karnataka. It was found very severe in the area where neck blast and finger blast phase were occurring. 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 sources against finger blast disease.

Material and Methods

With a view to identify the resistant source against neck and finger blast diseases under natural field condition, an experiment was carried out during *kharif* 2014 to 2016. The screening was carried out at Agricultural and Horticultural Research Station, Bavikere, which is an endemic area in Chickmagaluru district of Karnataka. A set of fourteen pre-released and released finger millet varieties *viz*., VL-149, DM-7, PR-202, GPU-76, VR-948, BR-2, TNAU-1063, RAU-8, TNAU-1066, GPU-67, OEB-532 and PPR-2885 including susceptible local check variety Indaf-5 and resistant check GPU-28 were evaluated against neck and finger blast under field conditions. Each variety was sown in two rows of 3 m length with 22.5 × 10 cm spacing.

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) [20]. 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) [8].

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

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) [20]. 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) [4].

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

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) [7]. The critical difference (CD) values are given at 5 percent level of significance, wherever the 'F' test was significant.

Results and Discussion

In three consecutive years kharif seasons of 2014, 2015 and 2016 fourteen released and pre-released varieties were evaluated against blast of finger millet under natural field condition. The varieties were grouped under different degrees of resistance on the basis of disease reaction for neck blast, finger blast and the grain yield results are presented in Table 1 and 2.

Evaluation of Released & Pre-Released finger millet varieties for resistance to major diseases and yield during kharif 2014-2016

During *kharif* 2014

Fourteen released and pre-released finger millet varieties including Local check indaf-5 and GPU-28 were evaluated for neck and finger blast diseases and their yield performance under field conditions during kharif 2014. The genotypers viz., VL-149, VR-948, TNAU-1063, TNAU-1066, OEB-532 and PPR-2885 were found to be resistant to both neck and finger blast diseases. The genotypes GPU-67 recorded significantly higher grain yield of 4474.10kg/ha but found on par with VR-948 (43.41 q/ha), OEB-532 (42.96 q/ha), BR-2 (40.44 q/ha), TNAU-1063 (39.70 q/ha), GPU-76 (39.40 q/ha), PPR-2885(37.04 q/ha) and Local check variety GPU-28 (36.59 q/ha) respectively.

During *kharif* 2015

In the year 2015, fourteen released and pre-released finger millet varieties including Local check indaf-5 and GPU-28 were evaluated for neck and finger blast diseases and their yield performance under field conditions. The genotypers *viz*., VL-149, VR-948, TNAU-1063, TNAU-1066, OEB-532 and PPR-2885 were found to be resistant to both neck and finger blast diseases. The genotypes GPU-67 recorded significantly higher grain yield of 43.70 q/ha but found on par with VR-

948 (42.96 q/ha), OEB-532 (41.48 q/ha), BR-2 (40.14 q/ha), TNAU-1063 (39.40 q/ha), GPU-76 (38.96 q/ha), PPR-2885(36.29 q/ha) and Local check variety GPU-28 (36.74 q/ha) respectively.

During *kharif* 2016

Fourteen released and pre-released finger millet varieties including Local check indaf-5 and GPU-28 were evaluated for neck and finger blast diseases and their yield performance under field conditions during kharif 2016. The genotypes viz., VL-149, VR-948, TNAU-1063, TNAU-1066, OEB-532 and PPR-2885 were found to be resistant to both neck and finger blast diseases. The genotypes GPU-67 recorded significantly higher grain yield of 40.93 q/ha but found on par with VR-948 (40.15 q/ha) and OEB-532 (38.87 q/ha) respectively.

Finally three years pooled data revealed that, VL-149, VR-948, TNAU-1063, TNAU-1066, OEB-532 and PPR-2885 as resistant (R).

Ravikumar *et al*.(1990) [19] evaluated 316 genotypes of finger millet over four seasons under natural environmental conditions, the mean neck and finger blast incidence was higher in the post rainy season. Over season a number of genotypes showed zero incidence for neck blast. However none was completely free from finger blast, while 7 genotypes GE75, GE669, GE866, GE1309, GE1319, GE1407 and GE1409 showed resistance to both neck and finger blast.

Somasekahara et al. (1991) [21] screened 25 finger millet cultivars for their resistant to blast under natural conditions and reported that none of the cultivar was resistant to leaf blast but HPB IE 11-1 had small sized lesion when scored for neck and finger blast, IE 1012 was completely immune to infection, and cultivars HPB IE 11-1, Indaf 15, MR 1, MR 2 and MR 3 had less than 5 percent infection.

Jain et al. (1994) [11] evaluated 21 genotypes of finger millet during 1987, 1988 and 1989 for stability of resistance to neck and finger blast diseases (*P. grisea*). The response of genotypes to neck and finger blast was genetically controlled. Genotypes VL 145, VL 149, PR 1158-9, GPU 16 and RHRN82-1/84 had stable resistance, while HR 8-19-1 and PR 202 exhibited moderate resistance and stability for both the diseases.

Muyonga *et al*. (2000) [12] screened 5 finger millet varieties for blast disease tolerance. Among them, the variety Sirare was more tolerant to blast disease than variety P224 and Nyaikuro, while Gulu-E and Ikhulule were moderately tolerant.

Jain and Yadava (2001) [9] screened 52 genotypes of finger millet for blast resistance in two consecutive years. Genotypes MR6, GE1348, 1370, 1417, 1420,2821, 3022, 3024, 3057, 3058, 3080, IE 1012 and I-8 IE were found resistant, while VL 231, 171, 174, GPU 25, GE 1036 and 3484 were found moderately resistant.

Assessed 66 genotypes of finger millet for blast resistance. Among them, 9 entries *viz*., GE 2400, 4913, 4914, 4915, 4929, 4966, 5102, 5126 and 5148 were completely free from infection and recorded “0” disease grade, as many as 36 entries recorded 0.1 to 2.0 percent incidence in both the seasons and proved as a good resistance. However, 16 entries showed moderate incidence (2.1 to 10.0%) of neck and finger blast, while only two entries recorded a disease grade of 4 (10.1 to 25.0 percent incidence). Two susceptible checks viz., KM 229 and KM 230 showed more than 25 percentblast, while K7 recorded more than 50 percent blast.

Jain and Yadava (2004) [10] screened 40 genotypes of finger millet for blast resistance in two consecutive years to determine the mechanism of resistance. Genotypes, GE-3022, GE-3024, E-3058, GE-3060, and MR-6 showed consistency of resistance against leaf, neck, and finger blast in the two years of the experiments.

Nagaraja and Mantur (2007) [13] screened 75 finger millet germplasm entries under natural conditions, 01-12 entries were free from the neck and finger blast incidence, some 28, 23, 33 and 16 numbered entries were resistant showing less than 2.00 percent incidence of both neck and finger blast. However, entries GE 5183, 5203, 5205, 5209, 5212, 5215, 5218, 5227 and 5230 showed constant resistance reaction.

Gupta and Jain (2010) [6] screened 38 finger millet cultivars at Reva and Dindori location of Madhya Pradesh and found that three cultivars namely BR-1, L-76 and KMR-204 showed resistant reaction, while 10 cultivars were moderately resistant to all three blast (leaf, neck, finger blast) infection at both the locations.

Barnwal (2012) [5] screened 8 finger millet cultivars under favourable environmental conditions against blast isease and stated that the cultivar OEB 225 had the lowest neck blast incidence (2.5%) and finger blast (12.1%) with the highest grain yield (27.4 q/ha), followed by GPU 67, while other cultivars A 404, JWM, 1, GPU 45, OEB 244, IE 7 and PR 202 showed moderately resistant reaction against neck blast.

Patro *et al.* (2013) [17] evaluated 16 pre-released and released varieties of finger millet and reported that GPU 28 as immune to blast pathogen and nine varieties were resistant to all three forms of blast disease. Patro *et al* (2016) [16] and Nagaraja *et al* (2016) [14] 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) [15, 16] screened 25 finger millet varieties and reported that nine varieties were resistant to leaf blast and three were moderately resistance to both neck and finger blast.

Table 1: Reaction of released and Pre-released finger millet varieties against blast disease resistance during *kharif* season (2014, 2015 and 2016).

Varieties	Neck blast disease incidence (%)					Finger blast disease incidence (%)				
	2014	2015	2016	Pooled	Disease Reaction	2014	2015	2016	Pooled	Disease Reaction
VL-149	0.00	0.00	0.00	0.00	I	0.00	0.00	0.00	0.00	I
DM-7	5.60	6.38	6.85	6.28	MS	8.57	10.37	10.40	8.90	R
PR-202	4.86	5.74	5.63	5.41	MS	8.03	8.63	9.43	7.88	R
GPU-76	4.74	5.26	5.58	5.19	MS	6.63	6.78	7.06	6.42	R
VR-948	0.00	0.00	0.00	0.00	I	0.00	0.00	0.00	0.00	I
BR-2	4.87	5.73	5.93	5.51	MS	5.99	5.92	7.34	6.19	R
TNAU-1063	0.00	0.00	0.00	0.00	I	0.00	0.00	0.00	0.00	I
RAU-8	5.51	6.14	6.54	6.06	MS	5.03	6.75	8.83	6.67	R
TNAU-1066	0.00	0.00	0.00	0.00	I	0.00	0.00	0.00	0.00	I
GPU-67	3.76	4.77	6.16	4.90	R	6.60	8.05	8.81	7.09	R
OEB-532	0.00	0.00	0.00	0.00	I	0.00	0.00	0.00	0.00	I

PPR-2885	0.00	0.00	0.00	0.00	I	0.00	0.00	0.00	0.00	I
Indaf-5 (susceptible check)	28.25	29.35	28.53	28.71	S	33.56	31.78	34.67	33.36	S
GPU-28 (resistant check)	3.98	4.17	3.56	2.57	R	5.24	5.93	4.72	5.07	R

R- Resistance, MS- Moderately Susceptible, S- Susceptible, HS- Highly Susceptible

Table 2: Evaluation of release and re-released finger millets varieties against blast resistance and their yield performance during *kharif* seasons (2014, 2015 and 2016).

Varieties	Grain yield (q/ha)			
	2014	2015	2016	Pooled
VL-149	32.44	34.67	31.65	32.92
DM-7	32.15	32.00	29.48	31.21
PR-202	32.89	37.19	34.32	34.80
GPU-76	39.41	38.96	36.10	38.16
VR-948	43.41	42.96	40.15	42.17
BR-2	40.44	40.15	37.23	39.28
TNAU-1063	39.70	39.41	36.69	38.60
RAU-8	31.56	31.26	28.54	30.45
TNAU-1066	30.67	31.85	29.43	30.65
GPU-67	44.74	43.70	40.94	43.13
OEB-532	42.96	41.48	38.87	41.10
PPR-2885	37.04	36.30	33.63	35.66
Indaf-5 (susceptible check)	31.41	30.81	27.90	30.04
GPU-28 (resistant check)	36.59	36.74	34.02	35.79
S.Em ±	311.11	251.85	79.00	81.11
C.D.(0.05)	933.33	785.18	229.64	256.31

Conclusions

Fourteen genotypes that recorded a blast incidence of 0.0 to 33.36 percent should prove as good resistance sources for utilization in breeding. In a low value crop like ragi, breeding for horizontal resistance is very useful. Screening of genotypes/varieties against neck and finger blast of finger millet are very important because among 14 six genotypes showed immune and seven showed resistant to the most devastating blast disease. These genotypes may be released after screening again under artificial condition. They may also consider as donor for breeding programme of blast resistance in southern transition zone of Karnataka. Resistant varieties found in present study may be used in breeding programme. The effective management measures should also be developed and suggested for the control of blast.

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