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CONTENTS

Evaluation of finger millet germplasm for morpho-metric traits, seed quality parameters and against important endemic diseases in mid hills of Uttarakhand

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ABSTRACT: Finger millet is one of the most important small millet crops grown in large areas of the developing world especially in Africa and Asia. The aim of this study was to characterize 114 finger millet genotypes for their morpho-metric traits, seed quality parameters and against important endemic diseases affecting the yield in mid hills of Uttarakhand. One hundred and fourteen germplasm lines of finger millet including two checks *viz.,* PRM-1, PRM-2 were planted in augmented design with 1.0 m row length. Observations were recorded for morpho-metric traits, disease incidence and seed quality parameters.The studied qualitative traits showed significant variation among tested germplasm. A wide variation was recorded in plant height among 114 finger millet germplasm that ranged from 58.41 cm to 134.74 cm.Days to maturity ranged from 126.16 days to 161.63 days acrossthe germplasm. Seed yield of randomly selected five plants and 1000- seed weight exhibited appreciable variation in the experimental materials that ranged from 6.61 g to 97.83 g and 1.20 g to 3.20 g, respectively.Significant variation was recorded in seed quality traits also.Seed vigour index-I and II showedsubstantial variation with a range of 701.53 to 1530.57 and 0.47 to 8.24 respectively, and first count and standard germination percent of seed also showed noticeable variation with a range of 32.75 % to 61.50 % and 60.00 % to 96.00 %, respectivelywhich might be due to genetic makeup of germplasm and prevailing environmental conditions of the experimental site. Out of 114 germplasm, two lines *viz.,* IC-587952 and IC-476936 were identified as immune for all the screened endemic diseases. Thirty-two germplasm lines reported to be resistant and thirty-five germplasm lines showed moderate resistant to leaf blast disease while seventeen germplasm lines showed resistant to neck blast disease. From the present investigation, two germplasm *viz.,*IC-587952 and IC-476936 were identified for higher seed yield along with early maturity as well as resistant to all the important endemic finger millet diseases. These two identified germplasm lines from the bulk are of immense value and may be used in further breeding programme.

Key words: Finger millet, germplasm,leaf blast, neck blast, seed quality, seed vigour index

Small millets represent a diverse group of small seeded annual cereal grasses used for food, feed, and forage purpose. Finger millet (*Eleusine coracana* L.) is an important small millet crop grown in India and it can thrive under a variety of harsh environmental conditions, but nowadays, varieties of factors viz., poor soil fertility, diseases and insects-pests attack have become major constraints in production and productivity of finger millet (Rawat *et al.,* 2019). Finger millet ranks second after rice during *Kharif* season and occupies an important place in the agriculture of Uttarakhand especially in the hilly regions due to its hardy nature.

Poor seed germination and patchy seedling emergence is a problem faced by farmers due to the use of low vigour seeds, generally saved by the farmers. Ellis (1992) stated that the low seed vigour has been identified as the factor mostly responsible for poor germination and uneven seedling establishment. Seed vigour is a complex physiological trait that is necessary to ensure the rapid and uniform emergence of plants in the field (Ventura *et al.,* 2012). Rajjou *et al.* (2012) reported the economic and ecological importance of high vigour seeds for seedling establishment and sustainable crop productivity, especially under unfavorable conditions as high vigor seeds can improve seed germination and seedling emergence, increase crop yield, and reduce the cost of agriculture production. In addition, for seed germplasm conserved in gene banks around the world, seed vigour and longevity may affect the regeneration cycle of accessions stored in seed banks. But the seed vigor trait is often excluded from traditional breeding programs, which are mostly directed

towards high yield.

Finger millet is known to be least affected by biotic and abiotic stresses (Dwivedi *et al.,* 2012). However, blast and Cercosporaleaf spot diseases of finger millet are major production constraints causing heavy yield losses. Rao (1990) reported 6.75 to 87.5 per cent yield losses in finger millet due to all the three blast diseases and Nagaraja *et al*. (2007) has observed 28-36 per cent yield losses in finger millet due to all blast diseases. Yield losses up to 40 per cent and 1000 seed weight by about 21 per cent if Cercosporaleaf spot disease occurs immediately after heading has been reported by Pradganang (1994). Rath and Mishra (1975) stated that the most damaging stage of blast disease is when the pathogen attacks the neck region, which significantly reduces grain number, grain weight and increases spikelet sterility.

Genetic variability and genetic diversity are the primary pre-requisites for any crop improvement programme. Germplasm is an essential reservoir of favorable alleles for agronomic and quality traits. The characterization will serve the requirement of long term goals in plant breeding *viz.,* climate change, duplicacy of germplasm, depleting natural resources, available genetic resources adapted to present climatic conditions. Therefore, the characterization and documentation of available germplasm will be helpful to serve the near-future crop breeding programme. Keeping in view of the above problems and importance of finger millet crop in present climate change era, the present investigationswas undertaken to study morpho-metric characterization, screening against important endemic diseases and to assess seed quality traits of finger millet germplasm.

MATERIALS AND METHODS

The present investigation was conducted for two consecutive years of 2018 and 2019 at Plant Pathology Research Block (B-Block,) College of Forestry, Ranichauri, Tehri Garhwal, V.C.S.G Uttarakhand University of Horticulture and Forestry, Uttarakhand, India. The details of experimental materials used and procedures followed during investigations are presented under the following headings.

Experimental Materials

The experimental seed materials for the present investigation comprised of 114 germplasm of finger millet [*Eleusine coracana (*L.) Geartn] including two checks viz., PRM-1 and PRM-2(Table 1)were obtained from AICRP on Small Millets running at Ranichauri Centre, Uttarakhand, India.

Experimental Design and Layout

The experiment was laid out in augmented design andthe plant-to-plant distance was maintained at 10.0 cm apart by proper thinning of plants in the early growth stage. The distance between two rows was maintained 22.5 cm. The field experiments of both the seasons were carried out under conditions favoring normal crop growth and expression of all the characteristics.

Sampling procedure and observations recorded

The observations were recorded for two consecutive years by randomly selecting five plants for each germplasm and the average of the readings was calculated for the computation of the data. The observations were recorded for the following parameters.

Plant height (cm)

The plant height was recorded at the time of physiological maturity stage from the ground level to tip of ear head with the help of measuring scale. The average was expressed as plant height in centimeter.

Number of productive tillers per plant

The total number of basaltillers bearing the ear head was counted from the five randomly selected plants and their average was recorded as number of productive tillers per plant.

Peduncle length (cm)

Peduncle length was recorded from thumb finger to top most node of the main stem. The average of five

Table 1. Details of finger millet germplasm used in the present study

Sl. No.	Name of Germplasm	Source	Sl. No.	Name of Germplasm	Source
1	IC-476378	NBPGR, New Delhi	58	GEC-181	NBPGR, New Delhi
2	IC-417361	NBPGR, New Delhi	59	GEC-45	NBPGR, New Delhi
3	IC-588007	NBPGR, New Delhi	60	IC-77187	NBPGR, New Delhi
4	IC-477245	NBPGR, New Delhi	61	RM-1	Uttarkashi
5	IC-477838	NBPGR, New Delhi	62	RM-2	Uttarkashi
6	IC-477237	NBPGR, New Delhi	63	RM-3	Uttarkashi
7	IC-476986	NBPGR, New Delhi	64	RM-4	Uttarkashi
8	IC-476745	NBPGR, New Delhi	65	RM-5	Uttarkashi
9	IC-476580	NBPGR, New Delhi	66	RM-6	Uttarkashi
10	IC-587952	NBPGR, New Delhi	67	RM-7	Uttarkashi
11	IC-587979	NBPGR, New Delhi	68	RM-8	Uttarkashi
12	IC-477766	NBPGR, New Delhi	69	RM-9	Uttarkashi
13	IC-476687	NBPGR, New Delhi	70	RM-10	Uttarkashi
14	IC-477207	NBPGR, New Delhi	71	RM-11	Uttarkashi
15	IC-476846	NBPGR, New Delhi	72	RM-12	Uttarkashi
16	IC-476969	NBPGR, New Delhi	73	RM-13	Uttarkashi
17	IC-477406	NBPGR, New Delhi	74	RM-14	Uttarkashi
18	IC-477166	NBPGR, New Delhi	75	RM-15	Uttarkashi
19	IC-477302	NBPGR, New Delhi	76	RM-16	Uttarkashi
20	IC-477711	NBPGR, New Delhi	77	RM-17	Uttarkashi
21	IC-477009	NBPGR, New Delhi	78	RM-18	Uttarkashi
22	IC-476932	NBPGR, New Delhi	79	RM-19	Uttarkashi
23	IC-476936	NBPGR, New Delhi	80	RM-20	Uttarkashi
24	IC-476988	NBPGR, New Delhi	81	RM-21	Uttarkashi
25	IC-477327	NBPGR, New Delhi	82	RM-22	Uttarkashi
26	IC-477963	NBPGR, New Delhi	83	RM-23	Uttarkashi
27	IC-476707	NBPGR, New Delhi	84	RM-24	Tehri Garhwal
28	IC-476535	NBPGR, New Delhi	85	RM-25	Tehri Garhwal
29	IC-476786	NBPGR, New Delhi	86	RM-26	Tehri Garhwal
30	IC-476783	NBPGR, New Delhi	87	RM-27	Tehri Garhwal
31	IC-477323	NBPGR, New Delhi	88	RM-28	Tehri Garhwal
32	IC-477331	NBPGR, New Delhi	89	RM-29	Tehri Garhwal
33	IC-477963	NBPGR, New Delhi	90	RM-30	Tehri Garhwal
34	IC-477963	NBPGR, New Delhi	91	RM-31	Tehri Garhwal
35	IC-477157	NBPGR, New Delhi	92	RM-32	Tehri Garhwal
36	IC-476962	NBPGR, New Delhi	93	RM-33	Tehri Garhwal
37	IC-476560	NBPGR, New Delhi	94	RM-34	Tehri Garhwal
38	IC-478010	NBPGR, New Delhi	95	RM-35	Tehri Garhwal
39	IC-476866	NBPGR, New Delhi	96	RM-36	Tehri Garhwal
40	IC-476763	NBPGR, New Delhi	97	RM-37	Tehri Garhwal
41	IC-476780	NBPGR, New Delhi	98	RM-38	Tehri Garhwal
42	IC-476901	NBPGR, New Delhi	99	RM-39	Tehri Garhwal
43	IC-476567	NBPGR, New Delhi	100	RM-40	Tehri Garhwal
44	GEC-13	NBPGR, New Delhi	101	RM-41	Tehri Garhwal
45	GEC-114	NBPGR, New Delhi	102	RM-42	Tehri Garhwal
46	GEC-52	NBPGR, New Delhi	103	RM-43	Tehri Garhwal
47	GEC-3	NBPGR, New Delhi	104	RM-44	Tehri Garhwal
48	GEC-39	NBPGR, New Delhi	105	RM-45	Tehri Garhwal
49	GEC-126	NBPGR, New Delhi	106	RM-46	Tehri Garhwal
50	GEC-84	NBPGR, New Delhi	107	RM-47	Tehri Garhwal
51	GEC-70	NBPGR, New Delhi	108	RM-48	Tehri Garhwal
52	GEC-118	NBPGR, New Delhi	109	RM-49	Tehri Garhwal
53	GEC-14	NBPGR, New Delhi	110	RM-50	Tehri Garhwal
54	GEC-123	NBPGR, New Delhi	111	RM-51	Tehri Garhwal
55	GEC-58	NBPGR, New Delhi	112	RM-52	Tehri Garhwal
56	GEC-173	NBPGR, New Delhi	113	PRM-1	College of Forestry, Ranichauri
57	GEC-146	NBPGR, New Delhi	114	PRM-2	College of Forestry, Ranichauri

randomly selected plants peduncle's length recorded as an average peduncle length in centimeter.

Days to 50 per cent flowering

The number of days to 50 per cent flowering was taken from the date of sowing to the date on which 50 per cent of plant exhibited 50 per cent flower initiation in the main ear head.

Number of fingers per ear head

The total number of fingers on the main ear head of each five randomly selected plants was counted and their average was reported as number of fingers per ear head.

Main ear head length (cm)

Main ear head length was recorded on five randomly selected plants from ear head tip to ear head joint. The average of five ear head was calculated and recorded as main ear head length in centimeter.

Finger length (cm)

The finger length was measured across the tip to base of the finger of the main ear head at physiological maturity stage. Average of five finger length reported as finger length in centimeter

Finger width (cm)

Finger width was measured across centre of main ear head finger at physiological maturity stage and average of five finger width was recorded in centimeter.

Days to maturity

Days to maturity was taken from date of sowing to the date on which 90 per cent of the plant's tillers had mature ear headi.e., the ear colour changed from green to brownish.

Seed yield (g)

The total yield of seed obtained from the threshing of harvested dried fingers of each selected plant expressed in gram.

1000 Seeds weight (g)

1000 seeds were counted randomly from each germplasm after threshing and their weight was recorded in gram with the help of electronic balance.

Disease incidence

Severity of leaf blast disease

Severity of leaf blast was rated on 1-9 scale. Following scale was used for scoring leaf blast disease in finger millet(Proceedings of 28th Annual Group Meeting of AICRP on Small Millets, Bengaluru, 2017).

Score (G)	Descriptions
1	Small brown specks of pinhead size without sporulating center.
2	Small roundish to slightly elongated, necrotic gray spots, about 1-2 mm in diameter, with distinct brown marginsis mostly found on the lower leaves.
3	Lesion type is the same as in 2 but significant numbers of lesions on the upper leaves.
4	Typical sporulating blast lesions, 3 mm or longer, infecting less than 2% of leaf area.
5	Typical blast lesions infecting 2-10% of the leaf area.
6	Blast lesions infecting 11-25% leaf area.
7	Blast lesions infecting 26-50% leaf area.
8	Blast lesions infecting 51-75% leaf area.
9	More than 75% leaf area affected.

Severity of Cercospora leaf spot disease

Severity of Cercosporaleaf spot was rated on 1-9 scale. Following scale was used for scoring Cercospora leaf spot disease in finger millet(Proceedings of 28th Annual Group Meeting of AICRP on Small Millets, Bengaluru, 2017).

Score (G)	Descriptions
1	Less than 1% leaf area affected.
2	1-3% leaf area affected.
3	4-5% leaf area affected.
4	6-10% leaf area affected.
5	11-15% leaf area affected.
6	16-25% leaf area affected.
7	26-50% leaf area affected.
8	51-75% leaf area affected.
9	76-100% leaf area affected.

Incidence of finger blast (%)

Ranges of variation of per cent incidence of finger blast in different genotypes were calculated using the following formula;

$$\text{Finger Blast (\%)} \frac{\text{Number of affected fingers}}{\text{Average number of finger x Total number of panicle}} \text{x100}$$

Incidence of neck blast (%)

Ranges of variation of per cent incidence of neck blast in different genotypes were calculated using the following formula;

$$\text{Neck Blast (\%)} = \frac{\text{Number of affected plants}}{\text{Total number of plant examined}} \text{x100}$$

Seed quality assessment

The observations for seed quality parameters were recorded using the harvested seeds under laboratory conditions for two consecutive years by randomly selecting ten seedlings in each replication and the average of the readings was calculated for the computation of the data. The observations were recorded for the following parameters.

Speed of germination

In this test, three replications of 100 seeds were taken from each germplasm and placed in the petri dish and then kept those at 25 ± 1°C in incubator. After the seed begin to germinate, they were checked daily, approximately at the same time. Normal seedlings were removed from the test when they reached a predetermined size. This procedure continued until all seeds produced a normal germinated seedling. Speed of germination was calculated by using following formula;

$$\text{Speed of germination} = \frac{n1}{1} + \frac{n2}{2} + \cdots \frac{nx}{x}$$

Where, n1, n2 and nx are the number of seed germinated on day 1 to x.

First count (%)

Four hundred seeds were taken randomly from each germplasm and replicated four times with hundred seeds in each replication. Before seeds were placed in top of the paper, seeds were treated with thiram to avoid surface contamination. Seeds were placed in top of the paper and then the samples were kept at 25±1°C in germinator. Only normal seedlings were counted on the 5th day of test period.

Standard germination (%)

Three pieces of circular filter paper were placed in a petri plate. The filter paper was moistened with distilled water and 100 seeds were arranged on the top of moist filter paper. The closed petri plate was placed in an incubator at 25°C±1 for 8 days. The seedlings were evaluated at regular intervals and normal seedlings were counted on 8th day. The percentage of normal seedling provided the germination percentage. Germination per cent was calculated as per the formula given below;

$$\text{Germination \%} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds taken}} \text{ x 100}$$

Root length (cm)

Ten normal seedlings were randomly selected on 8th day of the germination test from each replication. The length of root was measured with the help of measuring scale and mean root length was calculated.

Shoot length (cm)

The shoot length was measured with the help of scale of ten randomly selected seedlings at final count (8th day) from each replication.

Seedling length (cm)

The total length of seedling (cm) was obtained by adding shoot and root length as recorded earlier.

Seedling fresh weight (g)

Seedling fresh weight was recorded at the final count of standard germination test (8th day). Ten normal seedlings were taken randomly from each replication of germination test. The fresh weight of seedling was weighed with the help of an electronic balance and the average of the ten seedlings showed seedlings fresh weight of that germplasm. Seedling fresh weight was expressed in gram.

Seedling dry weight (g)

Ten normal seedlings used for taking fresh seedling weight were dried in the oven at 80 ± 2 °C for 24 hrs. The dried seedling were weighed on an electronic balance and expressed in gram.

Vigour Index

The seed vigour index was calculated by using the

formula suggested by Abdul -Baki and Anderson, (1973) as follows;

Vigour index-I

The seedling vigour index –I was calculated as per the following formula;

Vigour Index - I = Standard germination (%) X Seedling length (cm)

Vigour Index –II

The seedling vigour index –II was calculated as per the following formula:

Vigour Index - II = Standard germination (%) X Seedling dry weight (g)

Mean germination time (MGT)

Mean germination time (MGT) was calculated as per equation given by Yousheng and Sziklai (1985)as follow;

$$MGT = \frac{\sum Dn}{\sum n} x\ 100$$

Where, n is the number of seeds which were germinated on day and D is the number of days counted from the beginning of germination.

Time to take 50% germination (T_{50})

The time to 50% germination (T_{50}) was calculated according to the formula given by Coolbear *et al*. (1984) andmodified by Farooq *et al*. (2005) as follows:

$$T_{50} = t_i + \frac{\left(\frac{N}{2} - n_i\right)}{n_j - n_i} (t_j - t_i)$$

Where, N is the final number of germination and ni, nj are cumulative number of seeds germinated by adjacent counts at time ti and tj when ni ÂN/2 ÂNj.

Statistical analysis

The quantitative data recorded on various characters were subjected to following statistical analysis;

Analysis of variance

The data for different characters were statistically analyzed based on the model given by Cochran and Cox (1950) for Randomized Complete Block Design.

$$Yij = \mu + bi + tj + eij$$

Where,

Yij = Performance of the jth genotype in the ith block

μ = General mean

bi = Effect of i^{th} block

tj = Effect of j^{th} genotype

e_{ij} = Random error associated with j^{th} genotype and i^{th} block

RESULTS AND DISCUSSION

Analysis of variance

The analysis of variance revealed that, there is considerable genetic variability present among experimental materials (Table 2). Among the source of variations, checks contributed higher values for plant height, number of productive tillers, number of fingers on main ear head, ear head length and 1000 seed weight while test entry contributed significant variation for finger length, peduncle length, seed yield, days to maturity, 50 per cent flowering and finger width. However, checks × test entry had significant negative values for all the traits

Analysis of variance for each character was carried out as indicated below

The test of significance was carried out against the corresponding error degrees of freedom using 'F' table values given by Fisher and Yates (1963).

Source of Variation	Degree of freedom	Sum of square	Mean sum of square	F ratio
Replications	r-1	RSS	Mr = σ2e+ σ2r	Mr/Me
Treatments	t-1	TrSS	Mt= σ2e+ σ2g	Mt/Me
Error	(r-1)(t-1)	ESS	Me= σ2e	
Total	(rt-1)	TSS		

Where, r = Number of replications, t = Number of genotypes / treatments., df = Degrees of freedom, SS = Sum of squares, MSS = Mean sum of squares, σ2e = Error variance, σ2g = Variance due to genotypes, σ2r = Variance due to replications, M/ r = Mean sum of squares due to replications, M/ t = Mean sum of squares due to treatments, M/ e = Mean sum of squares due to error

except finger width, 50 per cent flowering and days to maturity.

Plant height (cm)

Significant differences were observed in plant height that ranged from 58.41 cm to 134.74 cm with an overall mean 98.83 cm (Table 3). Average maximum (134.74 cm) plant height was recorded in IC-476786 followed by GEC-52 (131.52 cm), IC-477963 (130.42 cm), GEC-114 (126.88 cm), and IC-476745 (126.48 cm) while minimum (58.41 cm) plant height was recorded in GCE-181 followed by RM-13 (66.39 cm), IC-477327 (66.58 cm), PRM-2 (69.17 cm), RM-2(72.95 cm).

Number of productive tillers

Number of productive tillers significantly differed among 114 finger millet germplasm that ranged from 2.61 to 5.02 tillers per plant with an overall mean of 4.31 tillers per plant. Highest (5.02) number of productive tillers per plants were counted in GEC-45, RM-7 and RM-10 while, lowest (2.61) number of productive tillers was counted in IC-477237 followed by RM-39 (2.98) and IC-588007 (3.01).

Peduncle length (cm)

Peduncle length showed significant differences among 114 finger millet germplasm that varied from 4.17 cm to 27.44 cm with an overall mean of 8.32 cm. The maximum (27.44 cm) peduncle length was recorded in RM-21 followed by IC-477455 (12.21 cm), GEC-114 (11.69 cm), IC-477323 (11.47 cm) and RM-27 (11.38 cm) while, minimum (4.17 cm) peduncle length was recorded in IC-477766 followed by IC-587979 (4.33 cm), RM-31 (4.60 cm), IC-476535 (4.69 cm) and GEC-70 (4.69 cm).

Days to 50 Per cent flowering

Statistically significant variations were observed among 114 finger millet germplasm for days to 50 per cent flowering that ranged from 66.58 days to 110.51 days with an overall mean of 86.93 days. Maximum (110.51) days to 50 per cent flowering was recorded in IC-476560 and GEC-126 followed by IC-417361 (108.05 days) and IC-477963 (107.51 days) while minimum (66.52) days to 50 per cent flowering was taken by RM-5 followed by RM-30 (69.87 days) GEC-181 (70.58 days) and RM-6 (70.58 days).

Number of fingers on main ear head

Number of fingers on main ear head is an important yield contributing trait that varied from 4.20 to 7.20 with an overall mean of 5.56 per ear head. Among the studied materials, IC-476745 reported highest (7.20) number of fingers on main ear head followed by IC-477245 (7.01), PRM-1 (7.00), RM-34 (6.99), RM-38 (6.99)and RM-52(6.99) while, minimum (4.20) number of fingers on main ear head was recorded in IC-477838 followed by RM-12 (4.21),

Table 2: Analysis of variance for yield and yield contributing traits of 114 finger millet germplasm

Characters	Mean Sum of Square					
Source of variation	Block	Treatments	Checks	Test entries	Check × test entries	Error
Degree of freedom	3	113	1	111	1	3
Plant height (cm)	492.06	198.86**	2208.80**	183.38**	-92.37**	0.192
Number of productive tillers	1.25	0.24**	0.71**	0.27**	-3.44**	0.048
Peduncle length (cm)	15.85	7.25**	5.01**	7.36**	-32.69**	0.015
Days to 50 per cent flowering	743.54	68.52**	2.13**	88.60**	2093.87**	0.424
Number of fingers on main ear head	3.64	0.41**	6.48**	0.43**	-8.64**	0.059
Ear head length (cm)	75.14	2.93**	19.31**	4.84**	-224.75**	0.164
Finger length (cm)	53.93	2.63**	3.86**	4.09**	-161.58**	0.056
Finger width (mm)	0.0796	0.0475**	0.0078**	0.0478**	0.0556**	0.0003
Days to maturity	1539.91	84.10**	0.07	125.93**	4474.52**	37.135
Seed yield (g)	835.28	217.29**	102.75**	242.13**	-2425.37**	3.821
1000 seed weight(g)	0.34	0.21**	1.34**	0.21**	-0.76*	0.003

RM-10 (4.42) RM-19 (4.42) GEC-84 and GEC 173 with 4.59 each.

Ear head length (cm)

Statistically significant variation was recorded for ear head length that varied from 2.94 cm to 12.20 cm with an overall mean of 6.44 cm. The longest (12.20 cm) ear head was measured in RM-41 followed by RM-47 (11.64 cm), RM-50 (11.52 cm), RM-43(11.20 cm) and RM-40 (11.00 cm), while smallest (2.94cm) ear head was recorded in IC-477327 followed by RM-13 (3.37 cm), IC-476936 (3.42 cm), GEC-3 (3.67 cm) and IC-476988 (3.82 cm).

Finger length (cm)

Finger length significantly differed among the studied finger millet germplasm that ranged from 2.51 cm to 11.10 cm with an overall mean 5.33 cm. Among 114 finger millet germplasm, RM-41 had longest (11.10 cm) finger followed RM-43 (10.00 cm) RM-42 (9.94 cm) RM-47(9.92 cm) and RM-49 (9.72 cm) while, IC-477327 had smallest (2.51 cm) finger followed by GEC-3 (2.56 cm), IC-476936 (2.83 cm) and GEC-39(2.84 cm).

Finger width (cm)

Statistically significant differences were found in finger width that varied from 0.14 cm to 0.90 cm with an overall mean of 0.59 cm. Among the studied materials, IC-477766 had maximum (0.90 cm) finger width followed by RM-26 (0.89 cm), IC-476580 (0.88 cm), RM-15 (0.88 cm), IC-477323 (0.87 cm) and IC-477455 (0.87 cm) while, IC-476986 had minimum (0.14 cm) finger width followed by RM-52 (0.21 cm), IC-476560 (0.21 cm), IC-476535 (0.22 cm), IC-477302 (0.24 cm), IC-477245 (0.24 cm) and IC-477838 (0.24 cm).

Days to maturity

Days to maturity significantly differed among 114 finger millet germplasm that varied from 126.16 days to 161.63 days with an overall mean of 141.47 days. Among the studied materials IC-587952, IC-477838 and IC-476580 had taken minimum (126.16 days) days to maturity followed by GEC-3 (127.68 days) and GEC-52 (128.68 days) while, maximum (161.63 days) days to maturity was taken by RM-17, RM-18 and RM-19 followed by IC-476378 (161.16 days) and IC-417361 (161.16 days).

Seed yield (g)

Seed yield was reported to be statistically significant among 114 finger millet germplasm that ranged from 6.61 to 97.83 g. with an overall mean of 32.77 g per five plants. The maximum (97.83 g) seed yield per five plants was recorded in IC-587952 followed by IC-476936 (80.76 g), RM-15 (77.9 g), IC-476580 (77.04 g) and IC-476986 (59.27 g) while minimum (6.61 g) seed yield per five plants was recorded in RM-2 followed by RM-39 (8.23 g) RM-22 (8.98 g) and RM-4 (10.23 g).

1000 seed weight (g)

1000 seed weight is a yield contributing trait that differed significantly among 114 finger millet germplasm and varied from 1.20 to 3.20 g with an overall mean of 2.17 g. The maximum (3.20 g) 1000 seed weight was recorded in RM-28 and IC-476866 (3.20 g) followed by RM-49 (3.10 g), IC-476936 (3.00), RM-3 (3.00 g) and RM-10 (3.00 g) while minimum (1.20 g) 1000 seed weight was recorded in IC-477245, RM-37 (1.20 g) and RM-42 (1.20 g) followed by IC-477766 (1.40 g) and RM-27(1.40 g).

A wide variation was recorded in plant height among 114 finger millet germplasm that ranged from 58.41 cm to 134.74 cm and it might be due to the different genetic makeup and genotype x environment interaction. It is usually a good index of plant vigour which may contribute towards productivity of the crops. A significant differencein plant height was also reported by Karad *et al.*(2013) in finger millet germplasm that ranged from 85.63 to 130.77 cm, while a range of plant height from 90.3 cm to 141.73 cm was reported by Suryanarayana*et al*. (2014). Bisht *et al*. (2015) also observed 83.48 cm to 144.92 cm plant height in finger millet germplasm.

Number of productive tillers is a yield contributing trait that varied from 2.61 to 5.02 per plant. Extent of variability in productive tillers per plant might be due to their various area of adaptation coupled

with environmental interaction. Haradari *et al.* (2011) also reported wide variation for number of productive tillers that ranged from 1.1 to 13.4 per plant, whereas a range of 0.80 to 2.40 for number of productive tillers per plant was reported by Goswami *et al.* (2015) in finger millet.

Genetic makeup and production environmental condition significantly influence the flowering time. Wide variation in days to 50 per cent flowering was observed among studied finger millet germplasm that varied from 66.58 days to 110.51 days. The early flowering germplasm can be used for further breeding programme for enhancing or transferring the character of interest particularly in hilly regions because the fluctuations in temperature and relative humidity influence the flowering time. Similarvariation for days to 50 per cent flowering was earlier reported by Karad *et al.* (2013) and Reddy *et al.* (2013) in finger millet. According to Strachan (2001), the environmental condition (*viz.,* temperature and moisture) is significant driver of crop flowering. Significant variation was observed for number of fingers on main ear head, ear head length, finger length and finger width across the finger millet germplasm. Number of fingers on main ear head varied from 4.20 to 7.20 and ear head length ranged from 2.94 cm to 12.20 cm. Such a large extent of variability in ear head length might be due to the diverse origin of germplasm coupled with the environmental effect. Suryanarayana *et al.* (2014) also reported the variation in ear head length that ranged from 5.60 cm to 12.87 cm in finger millet. However, the finger length mainly governed by genetic constitution of the genotype but environmental effect is also supposed to play crucial role in increasing the length of finger. The finger length varied from 2.51 cm to11.10 cm while finger width ranged from 0.14 cm to 0.90 cm across the germplasm. Karad *et al.* (2013) also reported variability in finger length that varied from 4.46 cm to 9.52 cm whereas finger length ranging from 4.00 cm to 15.4 cm was reported by Ganpathy *et al.* (2011) in finger millet.

Days to maturity is an important parameter that is used for classification of studied materials into different maturity groups. In the present study, days to maturity ranged from 126.16 days to 161.63 days across the germplasm. In our experiment, all the germplasm took more than 120 days to maturity which might be due to the early onset of winter season and reduction of day-night temperatures. Variation in days to maturity was also reported by Karad *et al.* (2013) that varied from 98 to 138.33 days while a range of 89.76 days to 114.36 days to maturity has been recorded by Ulaganathan and Nimalakumari (2014) in finger millet.

Seed yield and 1000- seed weight exhibited appreciable variation in the experimental materials that ranged from 6.61 g to 97.83 g of five plants and 1.20 g to 3.20 g respectively. A wide variation for seed yield and 1000 seed weight might be due to their genetic makeup and genotype x environment interaction. Another reason for lower yield could be due to presence of spikelet discontinuity and seed shattering while lower 1000-seed weight might be due to the seed size and improper filling of seeds. Germplasm identified for higher seed yield and 1000-seed weight showed their genetic potential to mid hills condition in Uttarakhand. Rawat *et al.* (2018) also reported as wide variation for seed yield per plant among 200 finger millet accessions. Variation in 1000-seed weight that ranged from 0.52 g to 3.73 g was reported by Dhanlakshmi *et al.* (2013) while 1.99 g to 3.31 g 1000- seed weight was recorded by Karad*et al.* (2013)in finger millet.

Disease incidence

The disease screening is important for identification of resistant source for minimizing grain yield loss and can be incorporated in crossing programme for developing high yield with multiple disease resistant varieties. In present experiment, the endemic diseases of finger millet *viz.,* leaf blast, Cercospora leaf spot, neck blast and finger blast were recorded in one hundred and fourteen finger millet germplasm and their results are present in Table 4.

Leaf blast

The one hundred and fourteen finger millet germplasmwere screened against leaf blast, of which two lines *i.e.*, IC-587952, IC-476936 were found

immune for leaf blast while, thirty-two germplasm showed resistance and thirty five germplasm showed moderate resistance against leaf blast disease. Thirty germplasm were found to be moderately susceptible and fifteen germplasm were found susceptible to leaf blast disease.

Cercospora leaf spot

Cercospora leaf spot is one of the most destructive diseases of finger millet in hilly area and the data presented in Table 4 indicating that the only two finger millet lines *viz.,* IC-587952, IC-476936 were found immune against Cercosporaleaf spot. However, thirty-four germplasm lines were found to be moderately susceptible, forty-three germplasm were susceptible and thirty-three germplasm lines were reported to be highly susceptible for Cercospora leaf spot.

Finger blast

Results presented in the Table 4 revealed that out of one hundred and fourteen finger millet germplasm screened against finger blast, only two lines *viz.,*IC-587952, IC-476936 were found immune for finger blast. Thirteen germplasm were found moderately susceptible, eighty-seven germplasm showed susceptibility and twelve germplasm were found highly susceptible for finger blast.

Neck blast

Out of one hundred and fourteen finger millet lines that were screened against neck blast disease, only two lines *i.e.*IC-587952 and IC-476936 were found immune for neck blast while, seventeen germplasm lines showed resistant reaction against neck blast. However, sixty-four germplasm lines showed moderate susceptible reaction and thirty-one germplasm line found to be highly susceptible for neck blast.

Finger millet blast and Cercospora leaf spot aremajor production constraints causing heavy yield losses in hilly region of Uttarakhand. In present experiment, one hundred and fourteen finger millet germplasm were screened for leaf blast,Cercosporaleaf spot, finger blast and neck blast diseases, of which only two finger millet germplasm lines were found to be immune against all the endemic finger millet diseases. For leaf blast disease, thirty-two germplasm lines were found resistant and thirty-five germplasm lines found moderately resistant while remaining germplasm lines showed moderate to highly susceptibility. However, for Cercospora leaf spot, finger blast and neck blast, one hundred and twelve germplasm lines were found moderate to highly susceptible. Nagaraja and Mantur (2007)stated that the blast resistance in finger millet appears to be complex and were controlled by polygene of additive and dominance as well as interaction of gene effects while weather parameters *viz*., relative humidity exerted major influence on disease occurrence as reported by Kumar *et al.*(2016). However, the date of sowing also influenced the disease incidence because maximum disease incidence has been reported in the crop sown during second fortnight of July to first fortnight of August (Nagaraja *et al.*2017). Twenty-five finger millet varieties were screened for blast disease by Neeraja *et al*. (2016) and nine varieties were found resistant to moderately resistant to leaf blast and three were moderately resistance to both neck and finger blast.

Cercospora leaf spot is one of the most important foliar diseases in finger millet and sixty-onegermplasm were found resistant against Cercospora leaf spot in present experiment. Among the susceptible lines, Cercospora leaf spot incidence ranged from 57.14 % to 82.50 %. The higher severity of Cercopsora leaf spot in hilly region might be due to the favorable environmental conditions for the pathogens.The Cercosporaleaf spot disease is prevalent in Himalayan foot hills and mid hills of Nepal as stated by Nagaraja *et al.*(2017). The Cercosporaleaf spot is a polycyclic disease dependent on relative humidity greater than 90 per cent and temperature above 15.5 ^{o}C for disease progression (Windels *et al.,* 1998).

Seed quality assessment

Seed quality assessment is important for determining the planting value of seed lots and also used to identify which seed lots are of high quality and hopefully high vigour. Data presented in Table 5 indicated significant variation for seed quality traits.

Table 3: Mean performance of 114 finger millet germplasm for yield and its contributing traits

Sl. No.	Name of germplasm	Plant Height (cm)	Number of productive tillers plant^{-1}	Peduncle length (cm)	Days to 50 per cent flowering	Number of fingers on main ear	Ear head length (cm)	Finger length (cm)	Finger width (cm)	Days to maturity	Seed yield (g)	1000 grain weight (g)
1	IC-476378	76.66	3.41	7.73	106.05	4.60	6.42	5.25	0.64	161.16	15.62	2.40
2	IC-417361	94.74	3.21	8.11	108.05	5.81	5.74	5.17	0.32	161.16	28.72	2.00
3	IC-588007	94.82	3.01	7.83	108.05	6.01	5.04	6.21	0.82	133.16	44.00	2.40
4	IC-477245	79.52	3.21	7.11	92.05	7.01	4.00	4.07	0.24	133.16	32.10	1.20
5	IC-477838	88.44	3.21	8.09	92.05	4.20	6.84	5.13	0.24	126.16	39.04	2.40
6	IC-477237	86.50	2.61	5.27	96.05	5.81	5.94	4.23	0.86	130.16	45.33	2.00
7	IC-476986	92.50	3.61	6.33	92.05	6.41	6.26	5.59	0.14	133.16	59.27	2.00
8	IC-476745	126.48	3.41	8.51	91.05	7.20	8.94	7.65	0.36	133.16	31.58	2.40
9	IC-476580	118.64	3.21	9.39	90.05	6.81	6.34	4.55	0.88	126.16	77.04	1.70
10	IC-587952	110.84	3.21	7.51	90.05	5.60	5.04	3.95	0.36	126.16	97.83	2.40
11	IC-587979	97.48	3.41	4.33	93.05	5.20	6.06	5.13	0.40	133.16	26.11	2.00
12	IC-477766	88.04	4.21	4.17	74.05	5.81	4.76	4.45	0.90	130.16	36.95	1.40
13	IC-476687	91.94	4.41	4.99	74.05	5.20	4.12	3.09	0.56	140.16	24.27	2.00
14	IC-477207	74.32	4.61	6.85	74.05	4.81	3.84	3.17	0.32	135.16	35.99	2.40
15	IC-476846	108.12	4.21	9.31	102.05	5.01	5.90	4.69	0.26	136.16	22.77	2.90
16	IC-476969	112.10	3.81	9.45	75.05	4.60	10.50	9.11	0.32	138.16	27.88	1.70
17	IC-477406	101.00	4.61	7.19	102.05	5.41	5.42	5.01	0.56	133.16	36.09	2.00
18	IC-477166	90.28	4.61	5.83	74.05	5.01	6.06	4.43	0.84	133.16	38.04	2.00
19	IC-477302	120.08	4.81	9.05	102.05	5.20	8.34	6.21	0.24	133.16	47.01	2.00
20	IC-477711	101.92	4.81	10.33	102.05	5.81	5.04	3.43	0.84	133.16	27.25	2.40
21	IC-477009	80.82	4.61	5.53	93.05	6.01	6.08	4.03	0.34	133.16	51.46	2.10
22	IC-476932	97.90	4.41	7.83	81.05	5.01	4.00	3.05	0.44	133.16	33.35	2.00
23	IC-476936	90.68	4.21	5.61	96.05	5.81	3.42	2.83	0.46	133.16	80.76	3.00
24	IC-476988	97.26	4.41	6.59	93.05	5.20	3.82	3.27	0.86	140.16	38.25	1.80
25	IC-477327	66.58	4.41	5.15	81.05	5.41	2.94	2.51	0.84	140.16	11.86	2.00
26	IC-477963	130.42	4.61	10.23	100.05	5.20	9.14	7.01	0.76	140.16	12.86	2.40
27	IC-476707	113.88	4.81	10.69	93.05	5.41	4.92	4.37	0.74	140.16	58.74	2.40
28	IC-476535	85.28	4.81	4.69	96.05	5.41	5.34	4.17	0.22	130.16	23.88	2.40
29	IC-476786	134.74	4.60	10.93	99.51	5.39	4.77	4.64	0.49	131.68	32.82	2.10
30	IC-476783	105.04	4.80	8.23	99.51	5.59	5.03	3.98	0.25	139.68	33.06	1.50
31	IC-477323	117.74	4.20	11.47	99.51	5.59	4.49	3.50	0.87	139.68	45.99	2.10
32	IC-477455	124.34	4.00	12.21	99.51	4.80	5.11	4.28	0.87	139.68	33.38	2.10
33	IC-477331	104.14	4.60	7.41	105.51	4.99	6.43	5.70	0.43	139.68	17.43	1.80
34	IC-477963	116.24	4.80	10.99	107.51	4.99	6.07	5.10	0.25	139.68	31.80	2.50
35	IC-477157	107.64	4.60	10.51	96.51	6.39	9.41	8.18	0.85	139.68	21.38	2.50
36	IC-476962	97.94	4.80	6.77	105.51	5.59	6.31	5.32	0.47	133.68	22.64	2.10
37	IC-476560	101.28	4.60	8.19	110.51	5.19	5.63	4.14	0.21	133.68	36.92	1.50
38	IC-478010	111.48	4.60	10.11	102.51	5.39	5.49	4.30	0.83	133.68	47.85	2.10
39	IC-476866	91.84	4.60	5.89	96.51	5.99	4.57	3.76	0.83	134.68	35.52	3.20
40	IC-476763	91.34	4.40	6.87	96.51	5.19	5.07	4.41	0.47	134.68	39.76	2.50
41	IC-476780	94.64	4.40	7.03	78.51	5.59	6.29	3.90	0.35	134.68	22.82	2.50
42	IC-476901	96.70	3.60	8.35	76.51	5.19	5.55	4.42	0.47	134.68	47.47	1.50
43	IC-476567	120.26	4.40	10.83	78.51	5.19	6.17	4.22	0.81	133.68	45.28	2.50
44	GEC-13	96.26	3.40	7.45	86.51	6.19	4.87	3.96	0.85	129.68	27.73	2.50
45	GEC-114	126.88	4.00	11.69	86.51	5.19	4.07	2.90	0.27	128.68	32.26	1.50
46	GEC-52	131.52	3.80	8.15	86.51	4.80	4.67	3.00	0.83	128.68	35.42	3.00
47	GEC-3	97.30	4.20	5.79	95.51	4.99	3.67	2.56	0.47	127.68	31.17	2.10
48	GEC-39	114.94	4.40	11.37	96.51	5.59	7.07	2.84	0.33	131.68	47.43	1.60
49	GEC-126	114.14	4.40	11.01	110.51	4.99	8.75	7.44	0.85	131.68	38.09	2.10
50	GEC-84	123.86	4.20	10.67	86.51	4.59	7.21	4.24	0.41	131.68	38.95	2.50
51	GEC-70	101.02	4.80	4.69	96.51	5.80	4.49	3.48	0.77	138.68	39.21	1.50

52	GEC-118	122.14	4.00	11.05	96.51	5.39	4.87	4.00	0.47	138.68	46.53	2.50
53	GEC-14	112.84	4.00	11.35	92.51	5.59	5.81	4.88	0.85	130.68	20.41	1.60
54	GEC-123	104.56	4.60	4.99	95.51	4.80	6.21	4.56	0.47	136.68	22.62	2.10
55	GEC-58	109.02	4.60	9.35	96.51	4.80	4.81	3.70	0.69	136.68	54.05	2.50
56	GEC-173	108.22	4.00	7.85	86.51	4.59	5.27	4.30	0.67	136.68	32.91	2.10
57	GEC-146	79.21	4.82	6.78	79.58	5.61	5.59	4.33	0.86	128.63	10.44	1.90
58	GEC-181	58.41	4.42	4.94	70.58	5.61	4.31	4.11	0.64	128.63	22.33	2.90
59	GEC-45	103.59	5.02	7.76	71.58	5.02	5.79	3.91	0.66	128.63	41.52	1.90
60	IC-77187	89.59	4.82	5.04	89.58	4.61	6.21	5.67	0.46	129.63	26.96	1.90
61	RM-1	101.05	4.62	10.26	82.58	5.61	7.81	6.55	0.70	129.63	15.35	2.30
62	RM-2	72.95	4.62	9.10	79.58	5.21	6.51	5.25	0.34	129.63	6.61	1.90
63	RM-3	103.25	4.02	10.02	70.58	5.21	6.55	6.07	0.74	154.63	23.92	3.00
64	RM-4	74.13	3.42	5.96	70.58	4.82	5.43	4.59	0.74	159.63	10.23	1.90
65	RM-5	83.25	3.82	7.90	66.58	5.02	5.33	4.37	0.86	154.63	31.62	2.80
66	RM-6	95.65	4.62	6.60	70.58	5.21	6.71	5.67	0.64	154.63	20.54	1.90
67	RM-7	105.71	5.02	9.78	80.58	6.42	5.55	5.11	0.48	143.63	20.29	1.60
68	RM-8	74.03	4.42	4.98	81.58	5.61	6.19	5.17	0.66	143.63	31.75	1.90
69	RM-9	94.79	4.82	8.64	76.58	5.42	4.93	5.43	0.84	142.63	48.18	1.90
70	RM-10	80.89	5.02	6.02	71.58	4.42	4.43	4.15	0.74	139.63	28.63	3.00
71	RM-11	92.39	3.62	8.36	82.58	4.82	4.83	4.53	0.84	135.63	49.03	2.80
72	RM-12	105.15	4.82	10.76	82.58	4.21	4.21	3.81	0.38	139.63	44.13	2.90
73	RM-13	66.39	4.42	6.14	89.58	5.61	3.37	3.71	0.74	135.63	17.24	1.90
74	RM-14	101.83	4.82	10.44	88.58	5.82	6.03	4.49	0.74	135.63	17.68	2.10
75	RM-15	104.55	4.42	8.00	79.58	5.42	7.21	6.33	0.88	135.63	77.92	2.30
76	RM-16	101.47	4.42	11.00	89.58	6.21	4.35	3.81	0.42	135.63	42.57	1.90
77	RM-17	126.01	4.62	10.02	82.58	5.42	4.73	3.63	0.44	161.63	24.81	1.90
78	RM-18	106.14	4.82	10.52	79.58	5.02	5.41	4.33	0.72	161.63	13.88	1.60
79	RM-19	81.31	4.02	6.42	66.58	4.42	5.57	5.13	0.72	161.63	13.61	1.90
80	RM-20	81.29	4.82	9.76	70.58	6.02	4.65	4.45	0.82	160.63	16.51	1.90
81	RM-21	97.19	4.22	27.44	79.58	5.42	5.27	4.49	0.76	160.63	27.69	2.30
82	RM-22	101.01	4.82	9.40	88.58	5.61	6.31	4.89	0.36	159.63	8.98	1.90
83	RM-23	91.67	4.22	7.48	89.58	5.82	5.43	4.61	0.86	159.63	22.09	2.80
84	RM-24	87.95	4.42	6.76	79.58	4.82	7.69	6.77	0.36	159.63	23.96	2.70
85	RM-25	90.77	4.58	7.26	73.87	6.58	9.90	9.12	0.67	159.53	31.81	2.00
86	RM-26	93.69	4.38	7.26	85.87	5.58	7.32	4.40	0.89	159.53	44.82	2.40
87	RM-27	102.25	4.78	11.38	82.87	6.58	8.46	5.26	0.71	159.53	27.91	1.40
88	RM-28	102.69	4.58	9.66	85.87	6.39	9.72	9.60	0.75	159.53	41.66	3.20
89	RM-29	102.69	4.18	10.34	82.87	5.18	8.14	8.06	0.61	159.53	36.11	2.40
90	RM-30	88.69	4.78	7.60	69.87	6.58	5.92	5.26	0.73	159.53	57.64	2.00
91	RM-31	96.47	4.78	4.60	73.87	5.99	4.98	4.24	0.61	136.53	30.01	2.00
92	RM-32	110.29	4.18	8.56	82.87	5.18	4.28	3.34	0.33	136.53	29.28	2.40
93	RM-33	95.89	3.98	10.52	82.87	6.18	10.54	9.58	0.41	153.53	11.23	2.00
94	RM-34	100.37	3.98	9.44	82.87	6.99	9.85	9.68	0.71	153.53	13.99	1.80
95	RM-35	95.91	3.98	9.54	73.87	6.39	10.58	9.42	0.85	153.53	25.83	2.40
96	RM-36	98.65	3.38	10.78	82.87	6.79	7.06	7.96	0.81	153.53	16.28	2.00
97	RM-37	105.95	4.38	9.56	85.87	5.58	10.18	4.34	0.67	141.53	40.59	1.20
98	RM-38	81.83	4.58	8.02	82.87	6.99	9.34	8.50	0.41	141.53	22.03	1.80
99	RM-39	93.89	2.98	6.08	82.87	5.79	4.78	3.88	0.77	141.53	8.23	2.40
100	RM-40	96.09	4.18	7.52	85.87	5.58	11.00	9.08	0.47	141.53	14.72	2.00
101	RM-41	99.21	4.58	7.26	82.87	5.99	12.20	11.10	0.67	159.53	21.19	2.40
102	RM-42	109.17	4.38	9.14	82.87	5.79	10.92	9.94	0.77	159.53	23.32	1.20
103	RM-43	101.91	4.58	10.68	85.87	6.39	11.20	10.00	0.73	159.53	16.21	2.40
104	RM-44	101.77	4.38	9.34	85.87	6.39	8.38	4.40	0.35	159.53	32.47	2.80
105	RM-45	92.65	4.58	5.62	85.87	5.39	9.22	8.22	0.43	141.53	26.55	2.40
106	RM-46	104.37	4.98	9.80	82.87	5.79	8.20	6.94	0.59	141.53	33.30	2.40
107	RM-47	93.73	4.78	5.42	82.87	5.58	11.64	9.92	0.41	141.53	39.31	2.00

108	RM-48	88.47	4.78	6.44	74.87	5.18	8.20	6.98	0.77	141.53	24.75	2.00
109	RM-49	114.69	4.58	10.18	82.87	6.79	10.34	9.72	0.37	141.53	43.21	3.10
110	RM-50	106.85	4.58	10.04	82.87	5.99	11.52	9.70	0.75	159.53	38.07	2.40
111	RM-51	92.09	4.38	6.30	84.87	5.39	7.16	5.54	0.33	159.53	45.54	2.80
112	RM-52	78.03	4.58	5.38	82.87	6.99	5.66	4.52	0.21	136.53	44.86	2.40
113	PRM-1	102.41	4.81	6.16	83.03	7.00	7.72	5.86	0.36	137.06	32.41	1.59
114	PRM-2	69.17	4.21	7.75	84.06	5.20	4.62	4.47	0.42	137.25	39.58	2.41
Lowest		58.41	2.61	4.17	66.58	4.20	2.94	2.51	0.14	126.16	6.61	1.20
Highest		134.74	5.02	27.44	110.51	7.20	12.20	11.10	0.90	161.63	97.83	3.20
General Mean		98.83	4.31	8.32	86.93	5.56	6.44	5.33	0.59	141.47	32.77	2.17
SEd (±)		0.620	0.310	0.175	0.921	0.343	0.572	0.335	0.025	8.618	2.764	0.073
LSD (0.05)		1.518	0.760	0.429	2.257	0.840	1.402	0.822	0.061	21.114	6.773	0.178
C.V (%)		14.93	12.02	32.96	12.04	11.96	33.06	37.58	36.97	7.86	47.15	20.46

Table 4: Disease screening of finger millet germplasm for leaf blast, Cercospora leaf spot, finger blast and neck blast.

Sl. No.	Name of Germplasm	Leaf blast (G)	Cercospora leaf spot (G)	Finger blast (%)	Neck blast (%)	Sl. No.	Name of Germplasm	Leaf blast (G)	Cercospora leaf spot (G)	Finger blast (%)	Neck blast (%)
1	IC-476378	3	5	16.66	7.69	39	IC-476866	4	5	23.52	9.75
2	IC-417361	3	6	22.05	6.89	40	IC-476763	4	6	26.02	7.89
3	IC-588007	4	7	23.68	9.52	41	IC-476780	5	6	30.98	4.91
4	IC-477245	3	7	24.56	3.57	42	IC-476901	5	5	26.86	5.66
5	IC-477838	3	7	20.31	3.22	43	IC-476567	4	6	22.22	11.90
6	IC-477237	3	6	23.88	3.84	44	GEC-13	3	5	25.00	12.50
7	IC-476986	4	7	27.02	10.16	45	GEC-114	4	5	19.11	6.25
8	IC-476745	5	5	27.14	9.23	46	GEC-52	5	5	25.00	15.38
9	IC-476580	3	5	19.11	8.16	47	GEC-3	5	6	19.11	6.25
10	IC-587952	0	0	0.00	0.00	48	GEC-39	3	6	23.28	10.71
11	IC-587979	3	4	26.56	7.14	49	GEC-126	3	6	28.78	3.70
12	IC-477766	4	4	23.18	8.69	50	GEC-84	4	7	30.66	12.72
13	IC-476687	4	7	29.23	3.17	51	GEC-70	4	5	24.35	5.76
14	IC-477207	5	7	28.94	7.54	52	GEC-118	5	5	17.64	9.37
15	IC-476846	3	6	25.67	12.76	53	GEC-14	5	6	26.08	9.80
16	IC-476969	3	6	30.88	3.33	54	GEC-123	4	6	22.22	8.33
17	IC-477406	4	5	22.05	6.38	55	GEC-58	5	5	22.97	8.62
18	IC-477166	5	6	28.12	5.55	56	GEC-173	4	5	26.82	11.11
19	IC-477302	5	6	28.78	8.62	57	GEC-146	3	7	21.62	8.47
20	IC-477711	3	7	31.50	9.23	58	GEC-181	5	5	27.14	12.50
21	IC-477009	3	6	22.85	3.38	59	GEC-45	5	7	28.35	17.02
22	IC-476932	4	6	24.35	9.61	60	IC-77187	4	5	23.61	15.90
23	IC-476936	0	0	0.00	0.00	61	RM-1	4	5	23.52	9.75
24	IC-476988	5	7	32.00	16.07	62	RM-2	4	7	26.02	7.89
25	IC-477327	5	7	19.11	6.25	63	RM-3	3	7	30.98	4.91
26	IC-477963	3	6	23.28	10.71	64	RM-4	4	5	26.86	5.66
27	IC-476707	3	6	28.78	3.70	65	RM-5	3	7	16.66	7.69
28	IC-476535	4	5	30.66	12.72	66	RM-6	4	5	22.05	6.89
29	IC-476786	4	5	24.35	5.76	67	RM-7	4	5	16.66	7.69
30	IC-476783	3	6	17.64	9.37	68	RM-8	4	7	22.05	6.89
31	IC-477323	5	5	26.08	9.80	69	RM-9	4	5	23.68	9.52
32	IC-477331	5	6	22.22	8.33	70	RM-10	4	7	24.56	3.57
33	IC-477963	5	6	22.97	8.62	71	RM-11	3	5	19.11	8.16
34	IC-477963	3	5	26.82	11.11	72	RM-12	4	6	26.56	8.16
35	IC-477157	5	6	21.62	8.47	73	RM-13	4	7	23.18	8.69
36	IC-476962	5	6	27.14	12.50	74	RM-14	5	6	29.23	8.69
37	IC-476560	6	5	28.35	17.02	75	RM-15	5	7	29.23	3.17
38	IC-478010	5	6	23.61	15.90	76	RM-16	6	7	28.94	7.54

Sl. No.	Name of Germplasm	Leaf blast (G)	Cercospora leaf spot (G)	Finger blast (%)	Neck blast (%)	Sl. No.	Name of Germplasm	Leaf blast (G)	Cercospora leaf spot (G)	Finger blast (%)	Neck blast (%)
77	RM-17	3	7	25.67	12.76	96	RM-36	6	6	17.64	9.37
78	RM-18	5	5	30.88	3.33	97	RM-37	6	6	26.08	9.80
79	RM-19	6	5	22.05	6.38	98	RM-38	5	7	22.22	8.33
80	RM-20	6	6	28.12	5.55	99	RM-39	6	7	22.97	8.62
81	RM-21	5	6	28.78	8.62	100	RM-40	4	5	26.82	11.11
82	RM-22	6	5	31.50	9.23	101	RM-41	3	6	21.62	8.47
83	RM-23	6	5	22.85	3.38	102	RM-42	4	7	27.14	12.50
84	RM-24	6	6	24.35	9.61	103	RM-43	3	5	28.35	17.02
85	RM-25	5	7	32.00	16.07	104	RM-44	4	6	23.61	15.90
86	RM-26	6	7	19.11	6.25	105	RM-45	4	6	23.52	9.75
87	RM-27	4	6	23.28	10.71	106	RM-46	4	6	26.02	9.81
88	RM-28	5	5	28.78	3.70	107	RM-47	3	7	30.98	10.16
89	RM-29	6	6	30.66	12.72	108	RM-48	3	7	26.86	7.14
90	RM-30	6	7	24.35	5.76	109	RM-49	3	6	22.22	6.38
91	RM-31	6	7	19.11	6.25	110	RM-50	3	7	24.35	9.16
92	RM-32	4	6	23.28	10.71	111	RM-51	3	6	23.28	10.71
93	RM-33	5	6	28.78	3.70	112	RM-52	3	7	28.78	3.70
94	RM-34	6	5	30.66	12.72	113	PRM-1	3	6	28.94	7.54
95	RM-35	5	6	24.35	5.76	114	PRM-2	4	7	25.67	12.76

The results on seed quality parameters are described below;

Speed of germination

Statistically significant difference were found in speed of germination among one hundred and fourteen finger millet germplasm and the speed of germination ranged from 12.68 to 22.21 with an overall mean 19.10. The germplasm RM-32 had maximum (22.21) speed of germination followed by IC-476560 (21.85), PRM-1 (21.77), RM-47 (21.70) and IC-476535 (21.69) while, minimum (12.68) speed of germination was recorded in germplasm IC-476378 followed by IC-477245 (15.23), RM-16 (15.32), IC-417361 (15.58) and IC-477207 (15.59) indicating the considerable variation in germination rate of finger millet germplasm.

First count (%)

First count of seed germination was recorded at the end of fifth day and the average first count varied from 32.75 to 61.50 % with an overall mean of 46.43 per cent (Table 5). Highest (61.50 %) first count was recorded in IC-477237 followed by IC-477766 (60.75 %), IC-477331 (60.00 %) and IC-477838 (59.00 %) while lowest (32.75 %) first count was recorded in RM-16 followed by RM-31 (35.25 %), RM-7 (36.25 %), RM-28 (38.00 %) and RM-21 (38.25 %).

Standard germination (%)

Number of normal seedling was counted at the end of test period and expressed as standard germination per cent. Significant variation was recorded for the standard germination per cent among one hundred and fourteen finger millet germplasm that ranged from 60.00 to 96.00 per cent with an overall average mean of 86.02 per cent.The maximum germination value of 96.00 percent was recorded in germplasm RM-22 andIC-477323 followed by RM-43 (95.75 %), GEC-118 (95.75 %) and RM-32 (95.50 %). Minimum value of 60.00 per cent standard germination was found in IC-476378 followed by IC-417361 (71.00 %), IC-477245 (72.75 %) and IC-477207 (72.75 %).

Root length (cm)

Root length plays an important role in determining whether the seedling will be able to establish successfully itself under the field conditions. A close examination of results on root length were indicating the significant variation present among studied materials that range from 4.64 cm to 8.82 cm with an overall mean value of 6.92 cm (Table 5). The

Table 5. Mean performance of 114 finger millet germplasm for different seed quality parameters

Sl. No.	Name of germplasm	Speed of germination	First count (%)	Standard germination (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)	Vigour index -I	Vigour Index -II	Mean germination Time (days)	Time taken to 50 per cent germination (T_{50})
1	IC-476378	12.68	39.00	60.00	6.92	5.12	12.04	0.21	0.01	721.39	0.69	5.01	4.72
2	IC-417361	15.58	45.25	71.00	5.38	4.62	9.99	0.12	0.07	710.42	5.32	5.38	4.58
3	IC-588007	15.61	58.75	73.00	7.64	5.06	12.70	0.22	0.02	926.69	1.64	5.63	5.24
4	IC-477245	15.23	56.00	72.75	6.23	5.00	11.23	0.14	0.02	816.75	1.49	6.60	5.90
5	IC-477838	16.62	59.00	79.25	7.30	4.65	11.96	0.22	0.02	946.47	1.69	5.41	5.14
6	IC-477237	16.38	61.50	74.25	7.30	5.31	12.61	0.15	0.01	935.43	1.00	5.78	5.16
7	IC-476986	15.74	51.50	75.25	5.59	4.04	9.63	0.12	0.01	724.64	0.47	5.91	5.47
8	IC-476745	15.95	50.00	75.00	7.08	4.49	11.57	0.19	0.02	866.38	1.57	5.88	4.13
9	IC-476580	17.51	41.50	79.50	6.55	4.57	11.11	0.17	0.02	884.13	1.65	5.44	4.93
10	IC-587952	15.82	47.50	75.00	6.78	7.64	14.43	0.17	0.02	1082.26	1.50	5.88	4.45
11	IC-587979	17.28	43.75	75.00	6.60	6.27	12.80	0.13	0.02	957.81	1.82	5.88	3.96
12	IC-477766	18.56	60.75	83.25	6.55	4.63	11.18	0.13	0.02	931.67	1.59	5.71	5.05
13	IC-476687	16.06	45.75	74.75	6.94	5.35	12.29	0.17	0.02	919.75	1.72	5.85	4.18
14	IC-477207	15.59	50.50	72.75	6.64	4.30	10.94	0.20	0.01	794.40	0.96	5.60	4.27
15	IC-476846	16.04	52.00	75.00	5.18	4.18	9.35	0.12	0.02	701.53	1.48	5.88	5.15
16	IC-476969	16.63	53.00	75.75	7.98	6.28	14.25	0.18	0.03	1080.57	1.91	5.97	5.05
17	IC-477406	17.61	45.50	82.75	6.82	4.56	11.38	0.13	0.02	940.96	1.82	5.85	3.60
18	IC-477166	16.73	44.50	74.00	7.27	5.54	12.80	0.16	0.01	946.78	0.78	6.01	4.05
19	IC-477302	16.27	43.75	72.75	7.01	5.00	12.01	0.23	0.02	873.64	1.21	5.60	4.82
20	IC-477711	18.07	58.50	82.75	6.53	5.27	11.80	0.22	0.03	974.84	2.03	5.86	4.51
21	IC-477009	16.90	42.25	79.50	6.43	5.08	10.01	0.24	0.02	794.40	1.35	5.44	3.41
22	IC-476932	16.87	51.50	74.50	6.82	5.01	11.83	0.21	0.01	880.89	0.94	6.11	4.85
23	IC-476936	15.97	46.75	75.00	6.42	4.41	10.83	0.18	0.02	812.36	1.15	6.18	4.46
24	IC-476988	16.25	56.00	75.25	6.66	5.24	11.90	0.17	0.02	893.24	1.11	5.91	4.75
25	IC-477327	17.13	42.50	79.00	6.97	5.63	12.60	0.19	0.02	994.70	1.67	5.38	3.40
26	IC-477963	19.63	50.25	86.25	7.17	4.58	11.75	0.17	0.02	1014.25	1.79	6.28	3.83
27	IC-476707	19.96	49.75	87.50	6.56	5.67	12.23	0.17	0.02	1070.29	1.75	6.44	3.68
28	IC-476535	21.69	56.00	93.00	7.42	4.65	12.07	0.13	0.02	1122.45	1.77	5.13	3.95
29	IC-476786	21.68	52.00	92.00	6.34	4.95	11.28	0.17	0.02	1038.14	2.12	6.11	3.60
30	IC-476783	19.85	41.50	93.50	7.75	5.43	13.18	0.20	0.01	1232.55	1.25	6.05	2.80
31	IC-477323	21.08	47.75	96.00	7.42	4.27	11.69	0.12	0.02	1122.52	1.90	5.95	3.09
32	IC-477455	20.29	48.00	94.50	6.65	3.80	10.45	0.18	0.03	987.21	2.39	5.32	3.18
33	IC-477331	19.63	60.00	89.25	7.36	4.76	12.12	0.13	0.02	1083.36	1.96	5.66	4.80
34	IC-477963	19.00	49.75	85.25	7.19	5.65	12.83	0.16	0.01	1094.28	0.89	5.16	3.77
35	IC-477157	20.12	49.50	88.50	6.94	4.57	11.51	0.23	0.02	1019.91	1.46	5.57	3.57
36	IC-476962	21.06	55.00	91.75	7.02	3.68	10.70	0.21	0.02	982.48	1.14	6.17	3.92
37	IC-476560	21.85	52.00	94.75	6.69	4.76	11.45	0.12	0.07	1084.62	8.24	6.21	3.45
38	IC-478010	20.37	53.00	93.25	7.47	5.66	13.13	0.22	0.02	1224.28	2.10	6.27	3.65

39	IC-476866	20.83	49.50	94.00	6.72	4.51	11.23	0.14	0.02	1055.07	1.93	6.31	3.31
40	IC-476763	20.06	47.25	92.00	7.59	6.53	14.12	0.22	0.02	1298.80	1.96	6.11	3.21
41	IC-476780	21.28	53.75	94.75	7.40	6.60	14.00	0.15	0.01	1326.38	1.28	5.31	3.63
42	IC-476901	21.14	51.00	94.50	5.82	3.49	9.31	0.12	0.01	879.45	0.59	5.32	3.39
43	IC-476567	21.56	51.25	94.50	6.88	4.63	11.51	0.21	0.01	1087.41	1.18	5.32	3.42
44	GEC-13	19.42	41.75	84.50	7.68	5.99	13.66	0.18	0.02	1153.76	1.29	5.07	3.24
45	GEC-114	20.91	49.00	92.25	6.58	4.53	11.11	0.17	0.02	1024.46	1.36	5.04	3.40
46	GEC-52	20.26	47.75	92.00	6.72	4.47	11.19	0.19	0.02	1028.03	1.94	5.55	3.29
47	GEC-3	21.62	49.75	95.25	7.80	6.61	14.41	0.17	0.02	1372.28	1.98	5.41	3.28
48	GEC-39	19.32	43.00	85.25	7.39	4.58	11.97	0.17	0.02	1020.25	1.70	5.16	3.16
49	GEC-126	18.70	42.75	84.25	6.69	4.60	11.29	0.13	0.02	951.12	2.05	5.23	3.19
50	GEC-84	20.37	46.00	91.50	7.79	5.77	13.56	0.13	0.02	1240.57	1.74	5.24	3.15
51	GEC-70	17.70	39.25	83.75	6.81	5.41	12.21	0.17	0.02	1022.92	1.93	5.97	2.98
52	GEC-118	21.00	46.00	95.75	7.69	5.40	13.09	0.21	0.02	1253.26	1.20	5.47	3.00
53	GEC-14	19.98	45.75	85.75	6.72	6.43	13.15	0.12	0.07	1127.07	7.09	5.22	3.34
54	GEC-123	20.50	43.50	93.75	7.67	6.45	14.11	0.22	0.02	1322.74	2.11	5.22	2.91
55	GEC-58	20.65	46.25	92.00	8.61	6.41	15.02	0.14	0.02	1381.35	1.89	5.61	3.16
56	GEC-173	17.74	38.75	78.50	7.69	4.64	12.33	0.22	0.02	967.71	1.67	5.32	3.11
57	GEC-146	21.02	45.50	93.75	6.58	4.64	11.22	0.15	0.01	1051.93	1.27	5.22	3.04
58	GEC-181	21.50	47.00	94.50	5.72	4.57	10.29	0.12	0.01	972.57	0.59	5.22	3.12
59	GEC-45	20.64	46.00	92.50	6.74	4.52	11.26	0.19	0.02	1053.57	1.94	5.07	3.10
60	IC-77187	19.34	45.00	86.25	7.56	6.44	14.00	0.17	0.02	1206.82	1.79	5.28	3.28
61	RM-1	17.91	40.00	83.00	6.81	5.71	12.52	0.17	0.02	1039.22	1.66	5.88	3.08
62	RM-2	18.98	42.75	85.75	6.72	6.49	13.21	0.13	0.02	1132.42	2.08	5.22	3.11
63	RM-3	19.49	43.25	87.50	7.28	5.57	12.85	0.13	0.02	1124.68	1.67	5.44	3.10
64	RM-4	17.79	41.75	80.25	7.13	5.50	12.63	0.17	0.02	1014.73	1.86	5.54	3.29
65	RM-5	17.32	38.75	79.00	7.35	5.77	13.12	0.20	0.01	1038.24	1.05	5.38	3.10
66	RM-6	18.73	40.00	84.75	6.40	5.46	11.86	0.12	0.02	1005.15	1.68	5.10	2.96
67	RM-7	17.04	36.25	78.50	7.28	5.41	12.69	0.18	0.03	995.63	1.98	5.32	2.92
68	RM-8	16.58	38.75	75.00	6.75	4.58	11.33	0.13	0.02	850.49	1.66	5.88	3.29
69	RM-9	17.84	40.25	79.00	7.66	6.39	14.05	0.16	0.01	1109.01	0.83	5.38	3.20
70	RM-10	20.81	45.00	94.50	6.72	5.30	12.02	0.23	0.02	1136.07	1.55	5.31	2.97
71	RM-11	20.10	44.25	89.25	6.51	5.45	11.95	0.22	0.03	1066.60	2.19	5.66	3.09
72	RM-12	21.52	47.75	93.50	7.59	6.42	14.01	0.24	0.02	1309.56	1.59	5.19	3.19
73	RM-13	20.86	47.75	93.00	6.75	5.28	12.03	0.21	0.01	1119.34	1.17	5.13	3.20
74	RM-14	20.26	45.25	92.00	7.82	6.58	14.40	0.18	0.02	1324.13	1.41	5.67	3.07
75	RM-15	21.57	48.50	95.00	6.71	5.66	12.37	0.17	0.02	1174.61	1.40	5.05	3.18
76	RM-16	15.32	32.75	74.00	7.52	6.47	14.00	0.19	0.02	1035.73	1.55	5.75	2.82
77	RM-17	18.86	44.25	83.75	6.61	5.47	12.08	0.17	0.02	1012.02	1.74	5.97	3.31
78	RM-18	20.88	47.75	92.75	7.65	6.28	13.93	0.17	0.02	1291.72	1.86	5.15	3.21
79	RM-19	17.68	42.50	83.75	7.88	6.10	13.99	0.13	0.02	1173.18	2.03	5.97	3.22
80	RM-20	20.73	44.50	93.00	5.79	4.55	10.33	0.13	0.02	961.13	1.77	5.13	3.00
81	RM-21	16.35	38.25	75.75	6.11	5.76	11.87	0.17	0.02	899.41	1.75	5.97	3.17

82	RM-22	21.23	46.25	96.00	5.79	4.52	10.31	0.20	0.01	989.47	1.27	5.51	3.01
83	RM-23	19.71	43.25	92.50	6.85	6.08	12.92	0.12	0.02	1194.66	1.83	5.07	2.93
84	RM-24	17.67	39.50	81.75	7.55	6.58	14.13	0.18	0.03	1155.15	2.06	5.52	3.04
85	RM-25	21.24	50.00	93.50	6.64	4.63	11.27	0.13	0.02	1053.83	2.06	5.19	3.35
86	RM-26	19.10	40.75	85.00	6.69	5.36	12.05	0.16	0.01	1022.70	0.89	5.13	3.00
87	RM-27	20.52	45.25	93.00	7.53	6.77	14.29	0.23	0.02	1329.39	1.53	5.13	3.07
88	RM-28	16.59	38.00	75.00	5.92	5.39	11.31	0.21	0.02	847.68	0.97	5.88	3.18
89	RM-29	20.46	45.50	92.50	6.67	5.65	12.31	0.12	0.07	1138.56	8.14	5.07	3.07
90	RM-30	19.54	45.25	88.00	7.52	5.70	13.21	0.22	0.02	1163.10	1.98	5.55	3.28
91	RM-31	16.62	35.25	76.50	6.96	5.55	12.51	0.14	0.02	956.62	1.57	5.07	2.91
92	RM-32	22.21	49.50	95.50	6.63	5.67	12.30	0.22	0.02	1174.59	2.03	5.44	3.26
93	RM-33	20.98	46.25	93.25	7.60	6.06	13.65	0.15	0.01	1273.34	1.26	5.16	3.11
94	RM-34	19.88	45.25	86.75	6.71	6.25	12.96	0.12	0.01	1124.08	0.54	5.35	3.29
95	RM-35	21.57	48.75	92.50	6.68	5.55	12.23	0.21	0.01	1130.87	1.16	5.07	3.30
96	RM-36	18.95	43.25	83.25	6.79	4.63	11.42	0.18	0.02	951.32	1.27	5.67	3.28
97	RM-37	20.69	44.50	93.25	7.61	5.76	13.37	0.17	0.02	1246.41	1.38	5.16	2.98
98	RM-38	17.98	38.75	82.50	7.73	6.77	14.49	0.19	0.02	1195.57	1.73	5.82	2.99
99	RM-39	21.31	45.75	93.75	6.85	4.90	11.75	0.17	0.02	1101.78	1.95	5.22	3.04
100	RM-40	19.71	44.50	91.00	7.75	6.11	13.85	0.17	0.02	1257.60	1.83	5.88	3.05
101	RM-41	18.76	40.00	85.50	5.64	4.89	10.53	0.13	0.02	901.41	2.07	5.19	2.94
102	RM-42	19.21	44.00	84.25	5.77	4.66	10.43	0.13	0.02	878.50	1.61	5.04	3.27
103	RM-43	21.61	49.75	95.75	6.75	4.68	11.43	0.17	0.02	1094.14	2.20	5.97	3.23
104	RM-44	19.49	44.75	84.50	6.71	5.79	12.50	0.21	0.02	1056.15	1.05	5.06	3.34
105	RM-45	20.70	46.75	93.25	6.71	4.73	11.45	0.12	0.07	1067.14	8.19	5.16	3.13
106	RM-46	19.67	43.75	86.00	6.66	5.44	12.10	0.22	0.02	1040.78	1.94	5.25	3.20
107	RM-47	21.70	48.50	94.00	7.63	5.66	13.29	0.14	0.02	1249.38	1.93	5.25	3.24
108	RM-48	18.83	38.25	89.50	7.65	6.71	14.36	0.22	0.02	1285.58	1.89	5.69	2.72
109	RM-49	20.64	46.50	93.00	8.82	7.64	16.45	0.15	0.01	1530.57	1.25	5.13	3.13
110	RM-50	21.47	47.50	93.75	5.72	5.65	11.37	0.12	0.01	1065.55	0.59	5.22	3.16
111	RM-51	18.56	42.50	85.00	4.64	4.33	8.96	0.21	0.01	763.12	1.07	5.13	3.23
112	RM-52	21.12	48.25	94.25	6.16	6.28	12.44	0.18	0.02	1172.40	1.44	5.29	3.19
113	PRM-1	21.77	50.00	93.25	6.77	5.76	12.53	0.17	0.02	1168.46	1.38	5.16	3.35
114	PRM-2	20.18	50.00	92.00	7.38	6.62	14.01	0.19	0.02	1288.48	1.93	5.27	3.45
Highest		22.21	61.50	96.00	8.82	7.64	16.45	0.24	0.07	1530.57	8.24	6.60	5.90
Lowest		12.68	32.75	60.00	4.64	3.49	8.96	0.12	0.01	701.53	0.47	5.01	2.72
General mean		19.10	46.43	86.02	6.92	5.38	12.29	0.17	0.02	1058.48	1.81	5.53	5.53
SEd (±)		0.78	4.27	2.12	0.30	0.27	0.46	0.02	0.01	46.01	0.21	0.27	0.58
LSD (0.05)		1.53	8.40	4.16	0.59	0.52	0.91	0.04	0.01	90.53	0.42	0.52	1.15
CV (%)		5.76	13.00	3.48	6.09	6.98	5.34	17.69	33.58	6.15	16.70	3.48	22.62

longest (8.82 cm) root was recorded in germplasm RM-49 followed by GEC-58 (8.61 cm), IC-476969 (7.98 cm) RM-19 (7.88 cm) and RM-14 (7.82 cm) while smallest (4.64 cm) root length was recorded in germplasm RM-51 followed by IC-476846 (5.18 cm), IC-417361 (5.38 cm), IC-476986 (5.59 cm) and RM-41 (5.64 cm).

Shoot length (cm)

Statistically significant variation was observed in shoot length among experimental finger millet germplasm that varied from 3.49 cm to 7.64 cm with an overall mean of 5.38 cm. The higher value (7.64 cm) for shoot length was recorded in germplasm RM-49 and IC-587952 followed by RM-27 and RM-38 (6.77 cm each) while lower value (3.49 cm) for shoot length was recorded in IC-476901 followed by IC-476962 (3.68 cm), IC-477455 (3.80 cm), IC-476986 (4.04 cm) and IC-476846(4.18 cm).

Seedling length (cm)

Seedling length significantly differed among all the studied finger millet germplasm and average seedling length ranged from 8.96 to 16.45 cm with an overall mean of 12.29 cm. The maximum value (16.45 cm) for seedling length was recorded in RM-49 followed by GEC-58 (15.02 cm), RM-38 (14.49 cm), IC-587952 (14.43 cm) and GEC-3 (14.41 cm) while, minimum value (8.96) for seedling length was recorded in germplasm RM-51 followed by IC-476901 (9.31 cm), IC-476846 (9.35 cm), IC-476986 (9.63 cm) and IC-417361 (9.99 cm).

Seedling fresh weight (g)

A close examination of Table 5 showed statistically significant differences among tested finger millet germplasm for seedling fresh weight that ranged from 0.12 to 0.24 g with an overall general mean of0.17 g. The fresh weight of 0.24 g was recorded in RM-12 and IC-477009, followed by RM-27, IC-477302 and RM-10 with 0.23 g fresh weight each. Whereas minimum seedling fresh weight of 0.12 g was recorded in IC-417361, IC-476986, IC-476846, IC-476560 and IC-476901.

Seedling dry weight (g)

Seedling dry weight showed significant differences among all the tested germplasm that varied from 0.01 g to 0.07 g with an overall mean of 0.02 g. The seedling dry weight of 0.07g was recorded in IC-417361, RM-45, RM-29, GEC-14 and IC-476560 while 0.01 g seedling dry weight was observed in RM-49, RM-50, RM-51, RM-33, RM-34, RM-35, IC-476780, IC-476901, IC-476567, IC-477963and IC-476783.

Vigour index-I

Seedling vigour index I is a product of standard germination per cent and seedling length (cm) is an important seed quality parameter. Results showing considerable genetic variability for vigour index I that ranged from 701.53 to 1530.57 with an overall mean of 1058.48. The maximum (1530.57) value for vigour index –I was calculated for RM-49 followed by GEC-58 (1381.35), GEC-3 (1372.28), RM-27 (1329.39) and IC-476780 (1326.38) while minimum (701.53) vigour index I was recorded in (IC-476846) followed by IC-417361 (710.42), IC-476378 (721.39) and IC-476986 (724.64).

Vigour index –II

Seedling vigour index II is a product of standard germination per cent multiplied by seedling dry weight (g) that ranged from 0.47 to 8.24 with an overall mean 1.81. The maximum (8.24) value for vigour index –II was calculated in IC-476560 followed by RM-45 (8.19), RM-29 (8.14), GEC-14 (7.09) and IC-417361(5.32) while minimum (0.47) vigour index II was recorded in IC-476986 followed by RM-34 (0.54), IC-476901 (0.59), GEC-181 (0.59) and RM-50 (0.59).

Mean germination time (Days)

Early germination is an indication of vigours seed lot and statistically significant variation was recorded in mean germination time among one hundred and fourteen finger millet germplasm that varied from 5.01 to 6.60 days with an overall mean 5.53 days. The lowest mean germination time of 5.01 days was taken by IC-476378 followedby RM-42(5.04 days), GEC-114 (5.04 days), RM-15(5.05 days) and RM-44 (5.06 days) while highest mean germination time of 6.60 days was taken by IC-477245 followed by IC-476707 (6.44), IC-476866

(6.31days), IC-477963(6.28 days) and IC-478010(6.27 days).

Time taken to 50 % germination (T_{50})

Completion of 50 % germination by various germplasm in a very short duration showed their ability to quick germination and indicated their vigour level. Results presented in the Table 5 showed significant variation for time taken to 50 per cent germination that varied from 2.72 days to 5.90 days with an overall mean of 5.53 days. The lowest (2.72) number of days to 50 per cent germination was taken by RM-48 followed by IC-476783 (2.80 days), RM-16 (2.82 days), RM-31 and GEC-123 (2.91 days each) whereas maximum(5.90) days to 50 % germination was taken by IC-477245 followed by IC-588007 (5.24 days), IC-477237 (5.16 days) and IC-476846 (5.15 days).

Testing of seed quality is important for determining the planting value of seed lots and used to identify which seed lots are of high quality and hopefully of high vigour. Higher value of first count indicates the vigour level of seed lots because high vigour seed germinates at faster rate than less vigour seed lots. Maximum value was found in IC-477237(61.50 %) and minimum value was found in RM-16(32.75 %). Germination test is used for estimation of planting value of seed lot (s). Germination per cent ranged from 96.00 to 60.00 per cent which indicated that a wide variability was present among the tested materials. The difference might be due to the genetic makeup of each germplasm, presence of degree of seed dormancy and seed coat. Wide range of variability in standard germination percentage that varied from 23.00 to 86.00 per cent was also reported by Krishnanappa *et al*. (2001) and 44.25 per cent to 93.75 per cent of seed germination was found by in Kumar *et al*. (2015).

Shoot length is an index of seedling vigour which may contribute towards better growth and development of seedling while root length contributes toward better establishment of seedling under abiotic stress conditions. Shoot length ranged from 3.49 cm to 7.64 cm and root length varied from 4.64 cm to 8.82 cm across the tested germplam. However, seedling length ranged from 8.96 cm to 16.45 cm was recorded in studied finger millet germplasm. The significant variation in seedling traits might be due to the different genetic constitution and differential bio membrane metabolism of diverse germplasm. Krishnappa *et al.* (2001) also reported a range of 5.50 cm to 6.40 cm and 13.60 cm to 20.70 cm of root and seedling length respectively. Seedling fresh weight varied from 0.12g to 0.24g and seedling dry weight from 0.01 g to 0.07 g across the tested germplasm. Seedling weight significantly correlated with seedling length of a germinated seed because with an increase in length of seedling there seems a sharp rise in fresh weight. Variation in germplasm not only affected the vigour of the seed but also possesses a proportional relationship with the fresh weight of seedling due to its effects on the rate as well as mobilization efficiency of food reverse transfer from the endosperm to the growing axis. Similar finding was also reported byKumar *et al*. (2015) for seedling weight that ranged from 0.20 g to 0.38 g.

Maximum vigour index-I was found in RM-49 (1530.57) and minimum in IC-476846 (701.53). Germination per cent and seedling length were the major factors for deciding the vigour index-I which showed significant variation among all germplasm while vigour index II ranged from 0.47 to 8.24 among tested germplasm which indicated the survival and growth rate of seedling after germination. However, early germination is an indication of vigours seed lot and significant influence of germplasm on mean germination time was recorded among 114 finger millet germplasm which ranged from 5.01 days to 6.60 days. Whereas shorter duration taken by a seed lot for completing 50 per cent germination showed the ability of seeds to quickly germinate and an indicator of seed quality that varied from 2.72 days to 5.90 days. Variation in mean germination time and time to 50 per cent germination might be due to the mixture of seeds from whole plant, position of seeds on mother plant and the presence of degree of seed dormancy. Variation for mean germination and days to 50 per cent germination was also reported by Patil *et al.* (1999) and Krishnappa *et al. (*2001) in finger millet.

CONCLUSION

Based on the results obtained from present investigation, it may be concluded that the information generated in the present investigation on morpho-metric traits, seed quality assessment and diseases screening can be used for isolating trait specific germplasm. However, most of the traits did not show direct contribution in the seed yield but indirect contribution was observed among yield contributing trait therefore these yield contributing traits are required for selection. However, two germplasm *i.e.*IC-587952 (97.83 g) and IC-476936 (80.76 g) were identified for higher seed yield along with early maturity as well as resistant to all the important endemic finger millet diseases. These two identified germplasm lines from the bulk are of immense value and may be used for further breeding programme.

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