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## Stability analysis for yield and yield contributing traits in finger millet (*Eleusine coracana* (L.) Gaertn)

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**Abstract**

Fifteen finger millet genotypes were evaluated for three environments to examine the stability of these genotypes for grain yield and its related traits. Out of fifteen genotypes GE-1680, Kanika reddy, IVT-25, Nagli Dapoli-1 (Check) recorded average stability for number of fingers per ear indicated wide adoptability of these genotypes under all environments. Genotype showing better performance under favourable performance PEH-1201, VL-149, NDS-1 (Check) for length of finger (cm). General stability for grain yield per plant found in the genotypes TNAU-1214, IVT-11. These genotype can be used for further breeding programme.

**Keywords:** Finger millet, stability analysis, environment, grain yield

**Introduction**

Finger millet (*Eleusine coracana* (L.) Gaertn.) also known as *ragi* or African millet is an annual plant widely grown as an important food crop in the arid areas of Africa and South Asia. It ranks third in importance among the millets after sorghum and pearl millet in India. It is a hardy crop that can be grown in diverse environments from almost at sea level in south India to high lands of Himalayas (altitudes of 1850 to 2300 meters) and from poor soils on hill slopes to rich soils in the Indogangetic plains. It is cultivated in tropical and rainfed area but mostly as a rainfed crop in India for its valued food grains and its adaptability to wide range of geographical areas and agro-ecological diversity, with minimal inputs, tolerant to moisture stress, produced on marginal land where other crops cannot perform and tolerant to acidic soil and termite, mostly countries in Africa and Asia. Small millets comprise of Finger millet, little millet, Foxtail millet, Kodo millet, Barnyard millet and Proso millet is an important group of dry land field crops. They have been come to be known as 'Nutricereal' in human dietary components. In India, the cropped area of a little over four million hectares planted to small millet. Finger millet occupies first place with fifty percent of the area. Recently government of India declared millets as a 'Nutricereal' crops being a rich source of minerals in almost all types of millets.

**Material and methods**

The field experiment was conducted on the field of Department of Agricultural Botany, College of Agriculture, Vasant Rao Naik Marathwada Krishi Vidhyapeeth Parbhani by taking three replications in Randomized Block Design during *Kharif*, 2017. Experimental material comprises of 13 different genotypes with 2 checks Nagli Dapoli Safed-1 and Nagli Dapoli-1 from different diverse sources of country. Thirteen different genotypes of finger millet including two checks were evaluated for three different environments D<sub>1</sub> (20 June 2017), D<sub>2</sub> (5 July 2017) and D<sub>3</sub> (20 July 2017). The environments were created by using different sowing dates. The materials was grown in randomized block design with three replications 30 cm spacing was kept between the rows while, 10 cm spacing was kept between the plants. The gross plot size was 2 m x 2 m and net plot size maintained was 1.50 x 1.60 m. All the agronomic practices were performed for better performance of the trial. The observations on Plant height (cm), days to maturity, number of tillers per plant, number of fingers per ear, length of finger (cm), grain yield per plant (g), grain yield ha (qt) and straw yield q/ha was recorded. Stability analysis was carried out using the Eberhart and Russell (1966)<sup>[4]</sup> model.

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## Results and discussion

**Table 1:** Analysis of variance for stability parameters pooled over three environments in finger millet (Eberhart and Russell 1966) [4].

Sources of variation	d. f.	Plant height (cm)	Days to maturity	No. of tillers per plant	No. of fingers per ear	Length of finger (cm)	Grain yield per plant (g)	Grain yield ha (qt)	Straw yield q/ha
Replication with environment	6	2.643**	2.891**	0.049**	0.071*	0.12**	0.157**	0.6**	3.654
Genotypes	14	176.08**	389.294**	0.445**	0.864**	3.19**	14.138**	56.107**	55.662**
Env.+ (G X E.)	30	6.377**	1.558**	0.041**	0.163**	0.08**	0.082**	0.327**	14.207*
Environments	2	82.483**	9.217**	0.537**	1.675**	0.97**	1.102**	4.348**	10.243
Genotype x environment	28	0.941**	1.011**	0.006	0.055	0.022	0.009*	0.039**	14.49*
Environments (linear)	1	164.967**	18.435**	1.074**	3.35**	1.95**	2.204**	8.697**	20.486
Genotype x environment (linear)	14	1.597**	1.842**	0.004	0.083*	0.028	0.014**	0.06*	22.777**
Pooled deviation	15	0.265	0.168	0.006	0.024	0.015	0.004	0.018	5.79
Pooled error	84	7.93	8.931	0.029	0.049	0.083	0.13	0.516	4.684

\* and \*\* indicated significant at 5% and 1% respectively

In the present investigation, a joint regression analysis of variance (Table 1) based over three environment indicated that genotypes differed significantly for all the characters revealing the presence of sufficient variability for all the

characters among genotypes included. This gives wide scope for selection of the genotypes for a particular character and parent in the breeding programme as well.

**Table 2:** Mean performance and stability analysis of fifteen finger millet genotypes for character plant height (cm), days to maturity, number of tillers per plant and number of finger per ear

S. No	Genotypes	Plant height (cm)			Days to maturity			Number of tillers per plant			Number of finger per ear		
		Pooled mean	bi	S <sup>2</sup> di	Pooled mean	bi	S <sup>2</sup> di	Pooled mean	bi	S <sup>2</sup> di	Pooled mean	bi	S <sup>2</sup> di
1	GE-2770	119.93	0.623	-7.574	101.4	0.601	-8.453	2.978	1.179	-0.020	7.1	1.324	-0.048
2	GE-1680	103.85	1.016	-7.439	102.7	0.332	-7.997	2.4	0.720	0.013	7.2	0.975	0.007
3	MR-6	112.73	1.367	-7.538	118.2	3.052	-8.345	3.067	1.613	-0.030	8.6	2.496	0.028
4	PEH-1201	97.00	0.911	-7.49	122.4	2.831	-8.525	2.356	1.121	-0.028	6.9	1.308	-0.050
5	Kanika reddy	103.62	0.752	-7.513	125.8	1.360	-8.506	2.333	1.030	-0.026	6.9	0.989	-0.046
6	VL-149	99.71	0.262	-7.478	94.8	1.336	-8.426	2.244	0.732	-0.030	6.9	0.686	0.031
7	TNAU-1214	99.58	0.684	-7.39	126.1	-0.135	-8.477	2	1.030	-0.026	6.6	0.578	-0.042
8	IE-6350	96.20	1.063	-7.182	125.6	-0.601	-8.453	2.067	0.687	-0.028	6.2	0.562	-0.029
9	GE-361	99.13	1.416	-7.51	105.4	0.601	-8.453	2.356	0.881	-0.030	6.7	0.775	-0.040
10	IVT-25	97.37	1.009	-7.52	127.3	1.875	-8.180	1.889	0.881	-0.030	6.9	0.944	-0.033
11	VR-929	104.02	1.183	-6.398	124.0	2.206	-8.509	2.222	1.121	-0.028	6.6	0.851	-0.014
12	IVT-11	97.51	0.748	-7.573	99.1	-0.135	-8.477	1.756	1.018	-0.013	7.1	1.399	-0.049
13	VL-369	103.31	0.775	-7.544	121.3	1.875	-8.180	1.778	1.076	-0.030	6.4	-0.351	-0.022
14	NDS-1 (Check)	117.80	1.67	-5.999	119.2	0.870	-8.496	2.578	1.179	-0.020	7.0	1.491	-0.046
15	Nagli Dapoli-1 (Check)	110.58	1.521	-7.542	120.0	-1.067	-7.927	2.511	0.732	-0.030	7.1	0.973	-0.037
	General mean	104.156			115.553			2.302			7.0		
	Range	96.2-119.93			94.8-127.3			1.756-3.067			6.2-8.6		

**Table 3:** Mean performance and stability analysis of fifteen finger millet genotypes for character length of finger (cm), grain yield per plant (g), grain yield ha (qt) and straw yield q/ha

S. No	Genotypes	Length of finger (cm)			Grain yield per plant (g)			Grain yield ha (qt)			Straw yield q/ha		
		Pooled mean	bi	S <sup>2</sup> di	Pooled mean	bi	S <sup>2</sup> di	Pooled mean	bi	S <sup>2</sup> di	Pooled mean	bi	S <sup>2</sup> di
1	GE-2770	7.47	1.415	-0.071	11.45	1.205	-0.126	22.902	1.217	-0.504	76.837	6.307	-1.666
2	GE-1680	7.22	0.783	-0.082	8.00	1.089	-0.128	16.009	1.099	-0.510	72.26	3.345	-1.744
3	MR-6	8.96	1.749	-0.045	14.78	0.646	-0.132	29.453	0.551	-0.466	74.951	1.370	4.663
4	PEH-1201	6.76	0.990	-0.086	9.22	1.409	-0.131	18.440	1.420	-0.519	66.592	2.793	-3.523
5	Kanika reddy	6.64	1.324	-0.079	7.24	0.598	-0.127	14.471	0.598	-0.496	64.719	1.998	-4.383
6	VL-149	7.24	1.150	-0.032	8.06	1.144	-0.129	16.111	1.155	-0.512	64.19	0.355	-4.399
7	TNAU-1214	5.89	0.956	-0.077	11.36	0.934	-0.131	22.716	0.938	-0.516	73.329	-0.697	-3.633
8	IE-6350	6.09	0.956	-0.077	8.29	0.864	-0.129	16.573	0.867	-0.508	73.2	0.576	-4.408
9	GE-361	4.62	-0.252	-0.011	8.94	1.042	-0.131	17.871	1.050	-0.520	72.267	2.270	-4.260
10	IVT-25	6.43	1.140	-0.086	6.29	0.547	-0.128	12.582	0.548	-0.504	66.246	-1.337	-3.565
11	VR-929	6.27	0.898	-0.084	11.96	1.251	-0.131	23.916	1.261	-0.518	76.436	-3.897	-4.403
12	IVT-11	5.84	1.048	-0.083	10.59	0.935	-0.129	21.182	0.945	-0.511	73.894	-1.683	-3.761
13	VL-369	6.07	0.415	-0.072	10.92	1.641	-0.132	21.831	1.652	-0.521	69.511	3.172	-4.203
14	NDS-1 (Check)	7.29	0.990	-0.086	8.76	1.004	-0.132	17.511	1.010	-0.521	64.187	0.959	-4.407
15	Nagli Dapoli-1 (Check)	7.96	1.439	-0.085	9.52	0.690	-0.110	19.044	0.687	-0.426	69.931	-0.547	-3.465
	General mean	6.72			9.69			19.374			70.570		
	Range	4.62-8.96			6.29-14.78			12.582-29.453			64.19-76.84		

**Pooled stability analysis for plant height (cm)**

The population means was found to be 104.156 cm for fifteen finger millet genotypes over three environments. All genotypes showed non-significant 'S<sup>2</sup>di' values. The genotypes GE-1680, Kanika reddy, VR-929 and VL-36 showed unit 'b' values and least deviation from regression with higher pooled means over population mean indicating average stability for the character.

However the genotypes MR-6, NDS-1 (Check) and Nagli Dapoli-1 (Check) showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes GE-2770 showed b values less than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated above average stability.

Stability analysis data revealed that the population mean for plant height was recorded as 104.156. Genotypes GE-1680 and VR-929 showed more stable genotypes under all kinds of environments. However, the genotypes MR-6, NDS-1 (check) and Nagli Dapoli-1 (Check) showed better performance under favourable environments showing below average stability. Only one genotype that is GE-2770 recorded above average stability showing better performance under poor environment. These results are related to the results of Rasal (1992)<sup>[8]</sup> observed in pearl millet and Suryawanshi *et al.* (1991) in pearl millet.

**Pooled stability analysis for days to maturity**

The population means was found to be 115.553 days for fifteen finger millet genotypes over three environments. All genotypes showed non-significant 'S<sup>2</sup>di' values. The genotypes MR-6, PEH-1201 Kanika reddy, VR-929, IVT-25, VR-929 and VL-369 showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes TNAU-1214, IE-6350, NDS-1 (check) and Nagli Dapoli-1 (Check) showed b values less than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated above average stability.

Data on stability analysis for days to maturity was recorded as 115.553 for all genotypes over three environments. None of the genotypes recorded average stability. The genotypes MR-6, PEH-1201, Kanika reddy, VR-929, IVT-25, VR-929 and VL-369 were found to be suitable for better environments which showed below average stability, while the genotypes TNAU-1214, IE-6350, NDS-1 (check) and Nagli Dapoli-1 (Check) recorded above average stability and indicating performance for poor environment. These results are in accordance with the results shown by Suryawanshi *et al.* (1989) in pearl millet.

**Pooled stability analysis for number of tillers per plant**

Pooled data presented in Table 2 indicated 2.302 population mean for fifteen genotypes over three environments studied. All genotypes showed non-significant 'S<sup>2</sup>di' values. The genotypes GE-2770, PEH-1201, Kanika reddy and NDS-1 (Check) showed unit 'b' values and least deviation from regression with higher pooled means over population mean indicating average stability for the character. However the genotypes MR-6 showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes GE-1680, GE-361 and Nagli Dapoli-1 (Check) showed b values less than 1 and non-significant 'S<sup>2</sup>di' with

higher pooled means with over the general mean indicated above average stability.

Tillering capacity of finger millet is one of the important trait playing role in maximization of yields. In present investigation Population mean for number of tillers per plant was found to be 2.302. The genotypes GE-2770, PEH-1201, Kanika reddy and NDS-1 (Check) recorded average stability indicated wide adaptability of these genotypes under all environments. However, the genotypes MR-6 was found to be suitable for better environment which showed below average stability. The genotypes GE-1680, GE-361 and Nagli Dapoli-1 (Check) recorded above average stability showing better performance under poor environment. Suryawanshi *et al.* (1991) reported that Significant G x E (Linear) component for number of tillers per plant.

**Pooled stability analysis for number of fingers per ear**

Pooled data presented in Table 2 indicated 7.0 population mean for fifteen genotypes over three environments studied. All genotypes showed non-significant 'S<sup>2</sup>di' values. The genotypes GE-1680, Kanika reddy, IVT-25 and Nagli Dapoli-1 (Check) showed unit 'b' values and least deviation from regression with higher pooled means over population mean indicating average stability for the character. However the genotypes GE-2770, MR-6, PEH-1201, IVT-11 and NDS-1 (check) showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes VL-369 showed b values less than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated above average stability.

Stability analysis showed population mean as 7 for number of fingers per ear. The genotypes GE-1680, Kanika reddy, IVT-25 and Nagli Dapoli-1 (Check) were found to be more stable genotypes for number of fingers per ear as they exhibited average stability over three environments and these genotype can perform well under any kind of environments for traits. However the genotypes GE-2770, MR-6, PEH-1201, IVT-11 and NDS-1 (check) were found to be suitable for better environment which showed below average stability. While the genotypes VL-369 recorded above average stability showing better performance under poor environment. Similar kind of results were also reported by Suryawanshi *et al.* (1989), Rasal (1992)<sup>[8]</sup>, Anarse *et al.* (2000)<sup>[11]</sup> in pearl millet.

**Pooled stability analysis for length of finger (cm)**

The population means was found to be 6.72 cm for fifteen finger millet genotypes over three environments. All genotypes showed non-significant 'S<sup>2</sup>di' values. The genotypes PEH-1201, VL-149 and NDS-1 (check) showed unit 'b' values and least deviation from regression with higher pooled means over population mean indicating average stability for the character.

However the genotypes GE-2770, MR-6 and Nagli Dapoli-1 (Check) showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes GE-1680 showed b values less than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated above average stability.

For increasing yield of finger millet length of finger (cm) is important yield contributing traits. Population mean for length of finger (cm) over all three environments studied was 6.72 cm. The genotypes PEH-1201, VL-149 and NDS-1 (check) showed average stability which indicated that these genotypes

were more stable and can perform well under in any kind of environments, while the genotypes GE-2770, MR-6 and Nagli Dapoli-1 (Check) were found to be suitable for better environment which showed below average stability. While the genotype GE-1680 recorded above average stability showing better performance under poor environment. Patil (2006) [7] in finger millet and Rasal (1992) [8] also noticed similar kind of results in pearl millet.

#### Pooled stability analysis for grain yield per plant (g)

Pooled data presented in Table 3 indicated 9.69 population mean for fifteen genotypes over three environments studied. All genotypes showed non-significant 'S<sup>2</sup>di' values. The genotypes TNAU-1214 and IVT-11 showed unit 'b' values and least deviation from regression with higher pooled means over population mean indicating average stability for the character. However the genotypes GE-2770, VR-929 and VL-369 showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes MR-6 showed b values less than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated above average stability.

Increasing the performance of genotypes starts as per plant once breeder get a single plant by means of mutation breeding or by means of selection. This traits further evaluated by different approaches and stable genotypes could be identified. In present investigation general stability for grain yield per plant (g) was found in the genotypes TNAU-1214 and IVT-11 showed average stability. However the genotypes GE-2770, VR-929 and VL-369 showed better performance under favourable environments showing below average stability. Only one genotype MR-6 showed above average stability. Similar results were also recorded by Dahiya *et al.* (1987) [3] and Suryawanshi *et al.* (1991) in pearl millet

#### Pooled stability analysis for grain yield per ha (qt)

Pooled data presented in Table 3 indicated 19.374 population mean for fifteen genotypes over three environments studied. All genotypes showed non-significant 'S<sup>2</sup>di' values. The genotypes TNAU-1214 and IVT-11 showed unit 'b' values and least deviation from regression with higher pooled means over population mean indicating average stability for the

character. However the genotypes GE-2770, VR-929 and VL-369 showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes MR-6 showed b values less than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated above average stability.

Performance of genotypes yield per hectare is the combined effect of different yield contributing traits. In the present investigation followed by further population mean for yield per hectare over three environments was 19.374 quintals per hectare. The genotypes TNAU-1214 and IVT-11 exhibited average stability. These genotype can perform in all kinds of environment means timely sown, late sown and very late sown i.e. 20<sup>th</sup> July. These genotype could be better identified for the Marathwada region. The genotypes GE-2770, VR-929 and VL-369 were found to be promising for favourable environments showing below average stability. Only one genotype MR-6 showed above average stability. These results are in accordance with the results reported by Jawale *et al.* (2017) [6] in finger millet. Bhamre (1986) [6] and Dahia *et al.* (1987) [3] in bajra and Hawlador (1991) [5] in foxtail millet.

#### Pooled stability analysis for straw yield q/ha

Pooled data presented in Table 3 indicated 70.570 population mean for fifteen genotypes over three environments studied. All genotypes showed non-significant 'S<sup>2</sup>di' values. However the genotypes GE-2770, GE-1680, MR-6 and GE-361 showed b value greater than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated below average stability. While the genotypes TNAU-1214, IE-6350 VR-929 IVT-11 showed b values less than 1 and non-significant 'S<sup>2</sup>di' with higher pooled means with over the general mean indicated above average stability. Stability analysis data revealed that the population mean for straw yield q/ha was recorded as 70.570 quintals. None of the genotypes showed average stability. The genotypes GE-2770, GE-1680, MR-6 and GE-361 exhibited better performance under favourable environments showing below average stability. While the genotypes TNAU-1214, IE-6350 VR-929 IVT-11 showed above average stability. Similar kind of results was also reported by Rasal (1992) [8].

**Table 4:** The genotypes showing different stability for different characters

S. No.	Characters	Average stability	Below average stability	Above average stability
1	Plant height (cm)	GE-1680, VR-929	MR-6, NDS-1 (check), Nagli Dapoli-1 (Check)	GE-2770
2	Days to maturity	None	MR-6, PEH-1201, KANIKA REDDY, IVT-25, VR-929, VL-369	TNAU-1214, IE-6350, NDS-1 (Check), Nagli Dapoli-1 (Check)
3	No. of tillers per plant	GE-2770, PEH-1201, Kanika reddy, NDS-1 (Check)	MR-6	GE-1680, GE-361, Nagli Dapoli-1 (Check)
4	No. of fingers per ear	GE-1680, Kanika reddy, IVT-25, Nagli Dapoli-1 (Check)	GE-2770, PEH-1201, IVT-11, NDS-1 (Check)	VL-149
5	Length of finger (cm)	PEH-1201, VL-149, NDS-1 (Check)	GE-2770, MR-6, Nagli Dapoli-1 (Check)	GE-1680
6	Grain yield per plant (g)	TNAU-1214, IVT-11	GE-2770, VR-929, VL-369	MR-6
7	Grain yield ha (qt)	TNAU-1214, IVT-11	GE-2770, VR-929, VL-369	MR-6
8	Straw yield q/ha	None	GE-2770, GE-1680, MR-6, GE-361	TNAU-1214, IE-6350, VR-929, IVT-11

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