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REGULAR ARTICLE

Morpho - agronomic diversity in *Eleusine coracana* (L.) Gaertn landraces from Maharashtra State (India)

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Abstract

Sixty four finger millet [*Eleusine coracana* (L.) Gaertn] landraces and 2 cultivars were evaluated for yield contributing and morpho-agronomic characters. All the landraces were collected from Western Ghats zone of Maharashtra. Collected landraces were cultivated at Nashik (Maharashtra) and 5 representatives of each were evaluated for head weight, height, 1000 seed weight, tillers, panicle length, extra finger, number of grains/spikelet, number of fingers/ head, days to 50% flowering and days to maturity. Obtained data was used to determine GCV, PCV and correlation studies. A good amount of variability was found for all the selected characters. Among the characters highest GCV and PCV was recorded for tillers (54.95% and 71.38%). All the characters showed higher PCV values which indicate the influence of the environment. All the characters except height and tillers exhibited higher level of correlation. Heritability estimates ranged from 90.03 % for 1000 seed weight to lowest 44.03 % for height. 1000 seed weight exhibited high heritability coupled with low genetic advance. Obtained results revealed the existence of variability for the character studied. Present studies will be useful for selection of potential characters which could be used in the genetic improvement or selection program of Finger millets.

Key words: Finger millet, morpho-agronomic characters, PCV, GCV, correlation

Introduction

Finger millet [*Eleusine coracana* (L.) Gaertn], is one among the highly utilized millets belongs to the family Poaceae and it ranks fourth in importance in the world (Upadhyaya et al., 2007). It is an allopolyploid with chromosome number 2n=4x = 36 and evolved from a cross between two diploid species, *E. indica* (AA) and *E. floccifolia* or *E. tristachya* (BB) as genome contributors (Hiremath and Salimath, 1992). Finger millet is a nutritious food grain crop. This millet species is mainly grown in Africa and South Asia under varied agro-climatic conditions (Dida et al., 2008). In India, finger millet is produced as a staple food after bajra (*Pennesetum glaucum*) (Krishnappa et al., 2009) and is cultivating in states like Karnataka, Andhra Pradesh, Tamil nadu, Maharashtra, Orrisa, Jharkhand, Chhattisgarh and Uttarakhand (Nandini et al., 2010). It is resistant to water stress and major insect attacks, and the grains are rich in polyphenols and calcium (Chandrashekar, 2010).

Apart from its significance the cultivation of this major millet species only contributes 10 per cent of the total area (34.6 million ha) planted to millets (FAO, 2004; Upadhyaya et al., 2006). In India, finger millet cultivation goes on decreasing in recent years (www.indiastat.com) due to lack of high

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yielding varieties, use of marginal soils and replacement of land for cash crops. Finger millet is being pushed to the more marginal areas; therefore, it is believed that this would cause serious loss of genetic variation and/or genetic erosion (Auti et al., 2015).

A crucial objective of germplasm collection and preservation is the comprehension of hereditary connections inside and between the species concerned. Therefore, there is a need to investigate wide range of variability among finger millet genotypes and isolate the suitable genotype(s) that perform well under all environments (Bezaweletaw et al., 2006). Variability for different characters present in germplasm collections is important for a successful breeding program. The varietal selection is more vital in any crop improvement and this is relying upon the presence of hereditary inconstancy for yield and yield contributing characters and their heritability (Allard, 2000). Regardless of the vast materials available and the urgent need to improve finger millet unit productivity through genetic manipulation, little is known about their variability, major characters and the potential usefulness of the landraces. Hence, this study was undertaken the germplasm collection, assessment of variability, correlation among the characters and to find out best genotypes for the improvement program. Hence, this study was undertaken to assess the variability and association among finger millet landraces and to determine the genetic potential of these materials for future use in the breeding program.

Materials and methods

The experimental materials consisted of 64 landraces and 2 cultivars, Dapoli 1 and Dapoli safed as a control. The 64 landraces were collected from the part of western Ghats lies in Maharashtra during the year 2013-14. The control cultivars Dapoli 1 and Dapoli safed are the high yielding cultivars developed and released by Kokan Krishi Vidyapith, Dapoli, Maharashtra.

The 64 landraces and 2 controls were evaluated for 10 quantitative characters by cultivating in randomized block design during kharif season of 2015 at Karanjali region of Nashik District, Maharashtra, India. All recommended agronomic practices were performed during the cultivation. A randomized block design with 3 rows was taken for each landrace. Each row was 3 meter long spaced 30 cm apart and plant to plant distance was maintained at 15 cm. Five representative plants were labeled in each plot for recording data for 10 quantitative characters. These characters are head weight, height, 1000 seed weight, tillers, panicle length, extra finger, number of grains/spikelet, number of fingers/head, days to 50% flowering and days to maturity.

Comparison of means was done by one way ANOVA and least significant difference was determine in between the landraces and 2 released varieties. Obtained data of 64 landraces and 2 cultivars were used to estimate, mean, range, coefficient of variation (CV), Phenotypic Coefficient of variation and Genotypic Coefficient of variation by Burton, (1952). Heritability in the broad sense (H2) and Genetic Advance (GA) were estimated (Johnson et al., 1955). The correlation between yield and yield contributing characters were estimated by Goulden (1952). The estimates of phenotypic (σ^2ph) and genotypic (σ^2g) variances were worked out as per Johnson et al. (1955).

Results and discussion

The result of analysis of variance showed a good amount of variability and significant differences for all the selected characters (Table 1). Estimate range of all the characters were head weight (1.11- 17.26 g), height (37.00 – 95 cm), 1000 seed weight (1.60-3.60) g, tillers (0-7), ear length (3-10 cm), Number of grains/spikelet (3-8), Number of fingers (3-22). Morphological variations among Finger millet genotypes from different locations were reported by Tiwari et al. (2005), Bezaweletaw et al. (2007), John (2006), Prabhu et al. (2008), Sonnad et al. (2008), Kadam et al. (2009), Krishnappa et al. (2009), Kumar and Gupta (2009), Shet et al. (2010), Upadhyaya (2011), Ganapathy et al. (2011), Priyadharshini et al., 2011 and Dhamdhere et al. (2011).

Among the selected characters Tillers (71.36 CV), Head weight (42.84 CV) and Number of fingers (31.50) exhibited maximum variation (Table 2). Landraces showed significantly higher values for Head weight, 1000 SW, Head length and no. of fingers to standard varieties Dapoli 1 and Dapoli Safed (Table 3).

For all the characters PCV values were higher than GCV values (Table 4), which clearly indicates the substantial influence of environment in the expression of these traits and dependent of phenotypic characters on genotypes. PCV values for all the selected characters showed positive co-relation with the GCV values. This is due to the interaction between genotypes and environment, Genotypic coefficient of variation (GCV) measures the range of variability in crop and enables the comparison of variability present in characters. Our results were supported by previous findings (John, 2006; Kadam et al., 2009; Dhamdhere et al., 2011; Ganpathy et al., 2011; Priyadharshini et al., 2011).

High GCVs and PCVs were observed for days to 50% flowering and days to maturity (based on combined result). Highest PCV and GCV values were recorded for Tillers 71.38% and 54.95% which has also been recorded by other researchers (Ganapathy et al., 2011). In general considerable difference exists between both PCV and GCV, which indicate greater influence of environment in shaping this trait (Prabhu et al., 2008).

Heritability gives the data on the magnitude of inheritance of characters, while hereditary progress is useful in defining suitable selection procedures. The data on heritability alone may not help in directing characters for authorizing determination. Nevertheless, the heritability evaluates in conjunction genetic advance will be more dependable. Height character exhibited higher GV (36.46), PV (82.80) and GA (8.25) The phenotypic correlation (rp) among traits is influenced by genotypes and environment. Genotypic correlation (rg) is usually attributed to pleiotropy (Falconer, 1975), whereas environmental correlation (re) is entirely due to environment and is not heritable and stable. 1000 seed weight exhibited high heritability (90.03 %.) coupled with low genetic advance (0.79), this indicated dominant and epistemic gene for these traits. Highest Genetic Advance (GA) was recorded for Height (8.25) and lowest GA was recorded for 1000 SW (0.16), similar results were reported by Bezaweletaw et al. (2006) for Ethiopian germplasm. Relationship of heritability and genetic advance also give an idea about the type of gene action (Ganapathy et al., 2011). Likewise, positive associations of grain yield per plant with 1,000-grain weight were reported by (Dhagat et al., 1972). Value of genetic advance will suggest the type of gene action involved the expression of various polygenetic inheritances and characters (Singh and Narayanan, 1993).

Among the characters highest GCV and PCV was recorded for tillers (54.95% and 71.38%). All the characters showed higher PCV values which indicate the influence of the environment. All the characters except height and tillers exhibited higher level of correlation. Heritability estimates ranged from 90.03% for 1000 seed weight to lowest 44.03% for height. 1000 seed weight exhibited high heritability coupled with low genetic advance.

We found a major contribution in heritability of characters by analyzing the total phenotypic variation in population. Higher heritability and low genetic advance indicating the influence of dominant and epistemic gene or these traits. Heritability is an important concept in quantitative genetics, particularly in selective breeding of crops. Similar findings were reported previously (Yücel et al., 2006; Anbessa et al., 2006). Increased heritability was reported previously by Ganapathy et al. (2011) for the traits Fingers/ Head and Panicle length. There is previous report about high heritability and genetic advance for traits like days to maturity and grain yield per plant (Bezaweletaw et al., 2006).

According to Sonnad et al. (2008) the trait grain yield per plant showed moderate genotypic and phenotypic coefficients of variability with high heritability and genetic advance and it is controlled by additive gene action and less influenced by environment. Kadam et al. (2009) found that PCV and GCV were high for plant height, days to 50 per cent flowering, flag leaf blade length, inflorescence length and yield. Heritability and genetic advance was high for leaf blade length, basal tillers and plant height.

Both additive and dominance genetic variation with a preponderance of the latter in the expression of time to 50% flower, plant height and dry fodder weight per plant while only dominance genetic variation was operative in the expression of number of tillers per plant, number of fingers per ear and grain weight per plant (Krishnappa et al., 2009). Kumar and Gupta (2009) concluded that phenotypic variability was higher for all the traits except days to 50 and 90% flowering, seed hardness and protein content, which showed similar magnitude of genotypic variability. Maximum difference between phenotypic and genotypic variability was observed for number of seeds per main ear. Shet et al. (2010) observed high PCV and GCV values for grain yield per plant, finger width and plant height and days to 50% flowering whereas low to moderate for all other characters.

Dhamdhere et al. (2011) reported that genotypic coefficient of variation was the major component of total variation. However, PCV was invariably higher than GCV for most of the characters studied. Ear weight, straw weight and total biomass showed high heritability and high genetic advance while grain yield exhibited moderate heritability and high genetic advance. Plant height, number of tillers per plant, leaf number per plant and finger number showed low heritability.

Characters such as number of grains, fingers/head, panicle length and 1000 seed weight showed significant correlation to head weight (0.056, 0.053, and 0.329). These characters can be used as most preferable characters for yield at the time of selection from long back to recent times. Similar results were obtained by Dessalegn (2011), which showed positive co-relation among number of fingers per ear and finger length with yield component for Ethiopian landraces. While 1000 seed weight showed significant co-relation with tillers, number of grains, days to flowering and days to maturity.

Gowda (1997) and Daba (2000) have recoded significant and positive associations of grain yield per plant with days to maturity. Dhanakodi (1988) and Daba (2000) recorded significant co-relation of ear length with plant height and finger number with ear length. As expected, height and tillers did not show any significant correlation to yield contributing characters. While Ganapathy et al. (2011) has noted moderate co-relation for the same characters. Height showed no significant correlation to any one of the 8 characters except panicle length. Tillers did not show any significant correlation to any other characters except Panicle length and Extra finger showed significant correlation to head weight and these characters may be critically studied and emphasized for selection. Panicle length showed a negative significant correlation with days to 50% flowering. One reason for this may be the increased number of flowers in the long Panicle. Days to 50% flowering showed strong correlation to days to maturity and probably the highest in all the data analyzed.

Table 1. Mean, minimum and maximum values, standard deviation and coefficient of variation of agronomic traits of landraces.

	Head weight	Height	1000 seed weight	Tillers	Ear length	Extra finger	Number of grains	Number of fingers
Minimum	1.11	37.00	1.60	0.00	3.00	0.00	3.00	3.00
maximum	17.26	95.00	3.60	7.00	10.00	4.00	8.00	22.00
mean	6.40	66.63	2.36	1.59	6.40	0.67	5.12	6.76
SD	2.74	9.10	0.42	1.14	1.43	0.72	1.06	2.13
CV	42.84	13.66	17.88	71.36	22.33	107.02	20.67	31.50

Table 2. Least significant difference of agronomic traits of landraces.

Sl. No.	Landraces	Head weight	Height	1000 seed weight	Tillers	Head length	Extra finger	Number of grains	Number of fingers
1	Dapoli 1	3.55	80.20	1.94	3.20	6.68	1.60	4.20	5.80
2	Dapoli safed	7.28	63.00	2.24	2.00	6.84	0.80	4.80	6.20
3	Badgi w	6.98*	65.80*	2.08	2.00	6.84	1.00	5.40	7.80*#
4	hattipada	7.54*	75.80#	1.82#	2.00	7.58	0.80	5.60	7.20
5	vangni	7.73*	71.40	2.46*	0.40*#	8.84*#	0.60	5.20	9.80*#
6	rajbari 1	5.53	60.60*	1.72#	1.40*	6.66	0.00	5.20	6.80
7	Rajbari 2	5.04	63.20*	1.82#	1.20*	7.88*	0.00	5.40	7.20
8	Vangni 1	5.68	68.40*	2.28*	1.60*	7.26	0.00	5.20	6.40
9	jale 1	2.55#	64.40*	1.72#	1.40*	7.02	0.20	4.60	6.00
10	Jale 2	3.96#	70.80	1.82#	1.60*	6.16	0.00	4.40	6.20
11	Badgi r	4.81	67.60*	1.98#	1.40*	7.72	0.00	4.20	6.20

Table 2 Contd..

12	kengpada	5.27	72.40	2.08	1.60*	8.46*#	0.00	4.80	6.80
13	Kumbhale 2	4.96	73.20	1.88#	0.60*#	5.22*#	1.00	5.20	6.60
14	Umbremal	7.26*	63.80*	1.86#	0.80*	7.58	0.80	5.40	7.20
15	khokari 1	3.14#	75.60#	2.88*#	1.20	5.72#	0.80	3.60	4.40#
16	karanjul 1	10.35*#	73.20	3.18*#	0.80*	8.14*#	0.60	4.40	8.60*#
17	karanjul W	10.06*#	71.60	2.68*#	2.00	7.70	1.00	6.20	8.00*#
18	Bubli 1	10.79*#	67.60*	2.92*#	1.40*	8.68*#	0.20	5.40	8.60*#
19	Umbarpada	10.04*#	72.40	2.48*#	0.80*	7.92*	1.40	5.20	9.80*#
20	Ghotul	6.60*	75.80#	2.48*#	1.60*	6.48	1.00	6.40	6.20
21	valutzira	4.32#	57.40*	2.02	0.20*#	4.50*#	0.00	4.20	5.60
22	Suryagad	3.23#	57.20*	2.02	2.00	4.38*#	0.80	4.20	4.80
23	Dolakha	7.46*	61.40*	2.44*	3.40#	6.02	0.60	6.20	6.20
24	Suryamal 1	5.53	70.20	2.12	1.40*	6.04	1.00	6.20	5.40
25	Suryamal w	7.54*	63.80*	2.28*	0.00*#	6.92	1.00	4.80	7.00
26	Oshora 1	9.26*	67.80*	2.12	1.60*	7.18	0.80	6.40	7.60*
27	Gomghar 1	8.08*	70.40	2.96*#	1.80*	7.66	0.80	7.40	6.60
28	Pulachiwadi	5.14	68.00*	2.66*#	0.20*#	5.64#	0.00	6.20	5.60
29	Kasa Budruk	5.22	64.60*	2.76*#	2.40	4.78*#	1.00	6.00	5.40
30	Gonde khurd	7.40*	63.40*	2.58*#	1.80*	6.10	0.80	5.80	7.20
31	Kushansheth	2.08#	63.00*	2.42*	1.20*	3.58*#	0.00	3.20	3.60*#
32	varanganpada	8.73*	64.60*	2.32*	2.20	7.42	0.00	6.40	7.00
33	Bhendi pada	9.01*	75.40#	2.46*	1.40*	7.46	0.80	6.60	7.60*
34	Pavakheda	6.27*	60.80*	2.32*	1.80*	5.72#	0.00	6.20	5.40
35	Chandgad 1	10.33*#	50.60*#	3.02*#	3.00	7.48	0.80	5.80	9.20*#
36	Chandgad 6W	11.45*#	53.00*	2.98*#	2.00	4.72*#	1.60	7.20	7.80*#
37	Panhala W2	9.40*	54.00*	2.42*	2.20	4.16*#	1.00	6.40	7.00
38	panhala 2	7.69*	62.00*	2.42*	1.60*	5.06*#	1.00	6.20	5.80
39	panhala w	7.16*	61.60*	2.26*	1.60*	4.36*#	0.00	5.40	6.20
40	Tawandi Ghat 1	7.38*	73.20	3.04*#	5.80*#	4.34*#	0.00	5.80	6.80
41	Haloli 1	11.70*#	70.40	2.54*#	1.40*	6.32	0.80	6.60	8.80*#
42	Gavase	5.07	57.80*	2.36*	3.00	6.32	0.00	4.60	8.40*#
43	Aalur	7.38*	78.00#	2.58*#	1.60*	4.30*#	1.60	4.80	8.80*#
44	Malkapur 1	8.01*	79.00#	2.52*#	2.20	7.28	0.80	5.80	7.60*
45	Shahuwadi 1	10.34*#	52.60*	1.74#	1.20*	5.42#	3.60	4.40	18.80*#
46	Uttur	10.02*#	74.00	3.38*#	1.80*	7.00	0.80	6.20	5.40
47	Kerli 1	6.92*	68.60	2.74*#	1.60*	6.88	0.80	4.80	6.20
48	shendi	3.96#	74.20	2.08	1.40*	7.66	1.60	3.60	6.40
49	Manher 1	3.65#	71.80	2.16*	1.00*	7.82	0.00	4.20	5.60
50	Ak3	3.49#	61.40*	2.76*#	2.40	7.16	0.00	4.20	5.40
51	randha 2	5.50	71.60	1.96#	1.00*	7.02	1.00	4.40	5.80
52	Khadki khurd	6.69*	72.00	2.36*	0.80*#	6.96	2.00	4.20	6.20
53	Palavni	4.26#	73.40	2.12	2.00*	7.08	0.00	4.40	6.40
54	Sukondi	3.20#	59.60*	2.46*#	3.60#	7.06	1.00	4.00	5.80
55	Palgad	4.28#	61.60*	2.68*#	0.40*#	5.36#	0.00	4.40	5.40
56	Picchaddoli	7.25*	67.80*	2.24*	2.20	7.38	0.80	5.60	6.80
57	Vijaypur	5.50	60.00*	1.88#	1.40*	6.04	0.00	4.20	5.20
58	Rampur	4.13#	64.80*	2.18*	1.60*	5.96	0.80	3.80	5.40
59	Shivgaon 1	5.48	71.00	3.46*#	2.60	6.00	1.00	5.00	6.40
60	shirale 1	4.99	69.20	2.72*#	0.20*#	7.00	1.00	4.80	6.60
61	Bhavtipada	3.92#	58.20*	2.08	0.40*#	6.94	0.60	4.20	5.40
62	Vadkhut 1	6.00	70.20	2.28*	1.20*	5.00*#	1.00	4.60	5.60
63	Payarpada	5.57	66.00*	2.28*	0.80*#	6.70	0.00	4.00	6.40
64	Awalkhed	4.60#	58.80*	1.98#	1.00*	4.82*#	0.00	3.60	6.60
65	karachiwadi	4.76#	65.00*	2.36*	0.60*#	4.38*#	0.60	4.60	5.40
66	Jambhulpada	3.95#	61.20*	1.88#	1.20*	3.74*#	0.60	5.20	5.80

*Significant difference from released variety Dapoli1 at probability 0.01%
Significant difference from released variety Dapoli safed at probability 0.01%
Bold values are significantly higher than dapoli1 and dapoli safed variety at probability 0.01%.

Table 3. Estimates of range, mean, genetic components of variance, heritability and genetic advance of *Elucine* genotypes evaluated.

Characters	Range	Mean	GV (σ^2_g)	PV (σ^2_p)	GCV %	PCV %	Heritability (H^2) %	GA	GAM %
Head wt (gm)	1.11-17.26	6.39	5.13	7.53	35.40	42.86	68.21	3.85	60.23
Height (cm)	37.00-95.00	66.63	36.46	82.80	9.06	13.66	44.03	8.25	12.39
1000 seed wt (gm)	1.60-3.60	2.36	0.16	0.18	17.07	17.99	90.03	0.79	33.36
Tillers	0.0-7.00	1.59	0.77	1.29	54.95	71.38	59.26	1.39	87.14
ear length	3.00-10.00	6.40	1.55	2.06	19.48	22.43	75.41	2.23	34.84
No. of Grains/spike	3.00-8.00	5.12	0.86	1.12	18.16	20.70	77.01	1.68	32.83
No of fin	3.00-22.0	6.76	3.61	4.51	28.10	31.41	80.03	3.50	51.78

Table 4. Correlation coefficient between 10 quantitative characters.

Character	HEIGHT	1000 SW	TILLERS	PANICLE LN	EXTRA FIN	GR/SPIKELET	FIN/HEAD	D TO 50% F	DTM
HEAD WT	-0.01	0.329**	0.074	0.184**	0.285**	0.506**	0.503**	0.225**	0.181**
HEIGHT		0.098	-0.032	0.207**	0.037	-0.021	-0.106	-0.048	0.004
1000 SW			0.208**	0.015	0.044	0.284**	-0.019	0.171**	0.109*
TILLERS				-0.053	0.029	0.163**	0.025	-0.025	-0.046
PANICLE LN					-0.044	0.077	0.170**	-0.178**	-0.094
EXTRA FIN						0.05	0.460**	0.180**	0.100
GR/SPIKELET							0.139*	0.217**	0.171**
FIN/HEAD								0.178**	0.158**
D TO 50% F									0.828**

**Correlation is significant at the 0.01 level (2- tailed), *Correlation is significant at the 0.05 level (2- tailed)

Conclusions

It can be concluded that, collected germplasm showed considerable amount of variability good amount of variability was found for all the selected characters. All the characters except height and tillers exhibited higher level of correlation. All the characters showed higher PCV values which indicate the influence of the environment. Higher heritability of all studied characters are due to less effect of non-genetic factors causing variation. This ensures the potential in the landraces to offer a particular character of interest. This could be used in the genetic improvement or selection of finger millet.

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Author contributions

All authors contributed equally in the study and preparation of article. All authors approved the final version of the manuscript for publication.

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