Madras Agric. J., 98 (1-3): 18-21, March 2011
https://doi.org/10.29321/MAJ.10.100232

Genetic Variability and Trait Relationships in Finger Millet (*Eleusine coracana* (L.) Gaertn.) Hybrids

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Twenty one hybrids along with seven parents of finger millet were evaluated for genetic variability, nature and magnitude of association among the yield traits and their direct and indirect effects on grain yield. In the present investigation, values of phenotypic coefficients of variability were greater than genotypic coefficients of variability for all the traits studied. High PCV and GCV were recorded for number of productive tillers per plant and moderate PCV and GCV for longest finger length, seed protein content and harvest index indicated large extent of genetic variability for these traits in the material. High heritability along with high genetic advance (% of mean) observed for plant height, number of productive tillers per plant, number of fingers per ear head, longest finger length, seed protein content, harvest index and single plant grain yield, indicating involvement of additive gene action for these traits and phenotypic selection based on these traits in the segregating generations would likely to be more effective. Grain yield had positive correlation with number of productive tillers, finger length and harvest index. On the basis of path analysis, harvest index had high positive direct effect on grain yield and number of productive tillers and finger length had moderate direct effect and revealed true relationship of these traits with grain yield and hence direct selection for these traits would be rewarding for yield improvement.

Key words: Finger millet, variability, heritability, correlation, path analysis.

Among millets, finger millet has an unique place and is the only millet which has been able to touch an average productivity level of more than 1.5 tonne per hectare. The crop has a wide range of seasonal adaptation and is grown in varying soil and temperature conditions. It can be grown throughout the year if moisture is adequate and if temperature is above 15°C. It has adopted to conditions prevailing from sea level to an altitude of 3000 m. India is the major producer of finger millet in Asia as well as in the world. It is important staple millet after pearl millet (*Pennisetum glaucum*) in India. It is cultivated mostly as a rainfed crop in India under diverse production environments. Finger millet, a C_4 plant, is an important grain crop in the southern states of India. It is a hardy crop with minimum disease and pest problems and assures reasonable economic return from adverse growing conditions (John Joel *et al.*, 2005).

Exploitation of genetic variability existing in the working germplasm is the first principle in the improvement of any crop. Analysis and utilization of available genetic diversity is a short-term strategy for developing improved cultivars for meeting immediate requirement of the farmers and the end-users. The finger millet crop has a wide range of variation for its character. In development of improved varieties, recombination breeding occupies a predominant position in finger millet improvement programmes (Priyadharshini *et al.*, 2010).

In addition, assessment of variability present in any crop species is the essential pre-requisite for formulating an effective breeding programme. The existing variability can be used further to enhance the yield level of the cultivars following appropriate breeding strategies. Estimation of genetic variability alone does not give a clear indication of the possible improvement that can be achieved through selection and it should be used in conjunction with heritability and genetic advance.

Since yield is a complex trait, knowledge on the association of the different yield components with grain yield and interrelation among themselves is necessary. A study through correlation coefficients on the genotypic values provides dependable basis for selection. Correlation in conjunction with path analysis would give a better insight into cause and effect relationship between different pairs of characters (Venkatesan *et al.,* 2004).

Selection of superior genotypes based on yield as such is difficult due to the integrated structure of plant in which most of the characters are interrelated and being governed by more number of genes. This

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necessitates a thorough knowledge on the nature of relationship prevalent between contributory characters and grain yield and the extent of genetic variability. Therefore, the present investigation aims to assess the variability together with the relative contribution of different yield attributes to grain yield and their interrelationship by estimating correlation, path analysis, coefficients of variability, heritability and genetic advance in finger millet.

Materials and Methods

The materials used in the present study consists of seven parents *viz*., CO 9, RIL 156, TNAU 1039, GPU 45, PRM 801, VL 149 and CO (Ra) 14 and crossed in half diallel mating design with parents during *summer*, 2009. The 21 hybrids along with seven parents were evaluated in Randomized Complete Block Design with three replications by adopting a spacing of 30x10 cm at Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore during *kharif*, 2009. The observations on days to 50 per cent flowering, plant height (cm), number of productive tillers per plant, number of fingers per ear head, longest finger length (cm), thousand grain weight (g), seed protein content (%), harvest index (%), single plant dry fodder yield (g) and single plant grain yield (g) were recorded. Standard statistical procedures were used for the analysis of variance, genotypic and phenotypic coefficients of variation (Burton, 1952), heritability (Lush, 1940), genetic advance, correlation (Johnson *et al.*, 1955) and path analysis (Dewey and Lu, 1959).

Results and Discussion

Analysis of variance revealed significant differences between the genotypes for all the characters studied (Table 1). The estimates on genotypic co-efficient of variation, phenotypic co-efficient of variation, heritability, genetic advance and genetic advance as per cent of mean for the traits under study are furnished in table 2.

In general, for all the traits studied, the phenotypic co-efficients of variation were higher than the genotypic co-efficients of variation. The values for genotypic co-efficients of variation obtained for various yield and yield attributing characters ranged from 7.71 to 22.07 per cent. The highest GCV was observed for number of productive tillers (22.07%). Moderate GCV was observed for longest finger length (17.33%) followed by seed protein content (14.18%) and harvest index (11.94%). The lowest GCV was recorded for thousand grain weight (9.49%), days to 50 per cent flowering (8.21%) and single plant dry fodder yield (7.71%).

The values for phenotypic co-efficients of variation ranged from 7.83 to 23.02 per cent. The highest magnitude of phenotypic co-efficient of variation was observed for number of productive tillers (23.02%). Moderate PCV was recorded for longest finger length (17.87%) followed by seed protein content (14.19%) and harvest index (12.00%). The lowest phenotypic co-efficient of variation was recorded for thousand grain weight (9.92%), days to 50 per cent flowering (8.24%) and single plant dry fodder yield (7.83%).

High PCV and GCV were recorded for number of productive tillers per plant. The traits finger length, seed protein content and harvest index had moderate PCV and GCV values. Similar results in finger millet were reported by John (2006) and Satish *et al.* (2007). The genotypic and phenotypic coefficients of variation indicated the extent of variation of variability for different traits.

The genotypes under study showed high heritability values for all the characters under study. Seed protein content (99.82%) recorded highest heritability followed by days to 50 per cent flowering (99.28%) and harvest index (98.13%). Similar results were reported in finger millet by Kadam (2008). Since heritability is also influenced by environment, the information on heritability alone may not help in pin pointing characters for enforcing selection.

Table 1. Analysis of variance for yield and yield attributing traits in finger millet

Source	Mean square										
	Degrees of freedom	Days to 50 % flowering	Plant height (cm)	No.of productive tillers per plant	No. of fingers per ear head	Longest finger length (cm)	Thousand grain weight (g)	Seed protein content (%)	Harvest index (%)	Single plant dry fodder yield (g)	Single plant grain yield (g)
Replication	2	0.33	8.67	0.04	0.04	0.01	0.01	0.003	0.27	0.27	0.06
Genotype	27	97.53**	518.98**	6.22**	2.89**	4.33**	0.22**	5.18**	60.87**	13.42**	10.72**
Error	54	0.23	7.79	0.18	0.16	0.09	0.007	0.003	0.21	0.14	0.16

Nevertheless, the heritability estimates in conjunction with predicted genetic advance will be more reliable (Johnson *et al.,*1955).Genetic advance as per cent of mean ranged from 15.63 to 43.57. Number of productive tillers (43.57%) recorded the highest genetic advance followed by longest finger length (34.62%), seed protein content (29.18%) and harvest index (24.46%). Moderate genetic advance was recorded for number of fingers per ear head (19.94%) followed by thousand grain weight (18.71%) and days to 50 per cent flowering (16.86%).

High heritability along with high genetic advance (% of mean) were observed for plant height, number of productive tillers per plant, number of fingers per ear head, longest finger length, seed protein content,

Table 2. Variability parameters for grain yield and yield attributing traits in finger millet

Traits	Mean	Range		GCV(%)	PCV (%)	h_2(%) broad sense	GA as per cent of mean
		Maximum	Minimum				
Days to 50 per cent flowering	69.33	81.00	61.33	8.21	8.24	99.28	16.86
Plant height (cm)	111.66	133.50	80.73	11.69	11.95	95.63	23.55
Number of productive tillers per plant	6.43	10.07	4.22	22.07	23.02	91.87	43.57
Number of fingers per ear head	8.69	10.57	7.20	10.99	11.93	84.80	20.84
Longest finger length (cm)	6.86	9.17	4.10	17.33	17.87	94.02	34.62
Thousand grain weight (g)	2.81	3.33	2.37	9.49	9.92	91.60	18.71
Seed protein content (%)	9.27	11.97	7.33	14.18	14.19	99.82	29.18
Harvest index (%)	37.67	46.01	30.02	11.94	12.00	98.93	24.46
Single plant dry fodder yield (g)	27.28	30.58	23.50	7.71	7.83	96.88	15.63
Single plant grain yield (g)	16.57	20.11	13.12	11.33	11.58	95.73	22.83

harvest index and single plant grain yield in the present investigation. Similar results were obtained in finger millet by Shet *et al.* (2009). High genetic advance indicated that these characters are governed by additive genes and selection will be rewarding for improvement of these traits.

In the present study, at genotypic level, number of productive tillers, finger length and harvest index recorded significant positive correlation with grain yield. All other characters recorded non significant association with the grain yield (Table 3). Similar results were reported by Krishnappa *et al*. (2009)

Table 3 . Genotypic Correlation coefficients between grain yield and yield component traits in finger millet

TRAITS	FLOW	PH	PT	FNG	FLTH	TGWT	PRO	HI	DFYP	GYP
FLOW	1	0.44**	-0.032	-0.147	0.215	0.416*	-0.289	-0.181	0.107	-0.177
PH		1	0.394*	0.304	0.513**	0.053	-0.121	0.065	-0.161	0.122
PT			1	0.632**	0.487**	-0.299	-0.083	0.807**	-0.787	0.840**
FNG				1	0.392*	-0.187	0.124	0.663**	-0.706	0.773**
FLGTH					1	-0.036	-0.066	0.303	-0.295	0.337
TGWT						1	-0.441	-0.156	0.252	-0.218
PRO							1	-0.181	0.097	-0.126
HI								1	-0.938	0.971**
DFYP									1	-0.928
GYP										1

*Significant at P=0.05, **Significant at P=0.01.

FLOW- Days to 50 per cent flowering **PH**- Plant height
PT- Number of productive tillers per plant
FNG- Number of fingers per ear head
FLTH- Longest finger length
TGWT- Thousand grain weight
PRO- Seed protein content
HI- Harvest Index
DFYP- Single plant dry Fodder yield
GYP- Single plant grain yield

and Mishra *et al.* (2008) for number of productive tillers and harvest index. Basavraraja and sheriff (1991) reported for finger length.

Regarding the inter correlation between yield attributes, days to 50 per cent flowering had significant positive association with plant height and thousand grain weight. The trait plant height was positively and significantly inter correlated with days to 50 per cent flowering, number of productive tillers per plant and finger length. Number of fingers per ear head had positive inter correlation with plant height, number of productive tillers, finger length and harvest index

In the present study, path analysis on grain yield revealed that harvest index had high positive direct effect and number of productive tillers and finger length had moderate direct effect and this revealed the true relationship of these traits with grain yield and hence direct selection for these traits would be rewarding for yield improvement (Table 4). Hence, direct selection for these traits could be practiced to reduce the undesirable effect of other component traits studied. Similar results were reported by Chunilal *et al.* (1996) for harvest index and Bezaweletaw *et al*. (2006) for productive tillers.

Regarding the indirect effect, number of fingers per ear head had positive and high indirect effect through harvest index. Finger length had positive and moderate indirect effect through harvest index. The residual effect value of 0.192 showed that the characters included in the study were sufficient to formulate the selection indices for the improvement of grain yield.

Table 4. Direct (diagonal, bold) and indirect effects of nine characters on grain yield per plant at genotypic level in finger millet

Traits	FLOW	PH	PT	FNG	FLTH	TGWT	PRO	HI	DFYP	GYP
FLOW	0.010	-0.018	-0.005	-0.023	-0.003	-0.013	0.004	-0.124	-0.004	-0.177
PH	0.004	-0.040	0.066	0.048	-0.007	-0.002	0.002	0.044	0.007	0.122
PT	0.000	-0.016	0.268	0.099	-0.007	0.009	0.001	0.552	0.032	0.840**
FNG	-0.001	-0.012	0.106	0.257	-0.006	0.005	-0.001	0.494	0.030	0.773**
FLGTH	0.002	-0.021	0.082	0.065	-0.014	0.001	0.001	0.207	0.012	0.337
TGWT	0.004	-0.002	-0.050	-0.027	0.000	-0.031	0.006	-0.107	-0.010	-0.218
PRO	-0.003	0.005	-0.014	0.012	0.001	0.014	-0.013	-0.124	-0.004	-0.126
HI	-0.002	-0.003	0.136	0.114	-0.004	0.005	0.002	0.685	0.038	0.971**
DFYP	0.001	0.006	-0.132	-0.116	0.004	-0.008	-0.001	-0.642	-0.041	-0.928

Residual effect 0.192 *Significant at P=0.05, **Significant at P=0.01

FLOW - Days to 50 per cent flowering
PH- Plant height
PT- Number of productive tillers per plant
FNG- Number of fingers per ear head
FLTH- Longest finger length
TGWT- Thousand grain weight
PRO- Seed protein content
HI- Harvest Index
DFYP- Single plant dry Fodder yield
GYP- Single plant grain yield

Conclusion

Variability study indicated that the materials in the present investigation possessed high variability for number of productive tillers while moderate variability was observed for finger length, seed protein content, harvest index, single plant grain yield and plant height. The traits number of productive tillers per plant, longest finger length and harvest index showing high heritability with genetic advance along with high correlation and path analysis. So, it could be inferred that these traits had to be accounted for direct selection for the improvement of yield.

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Received: November 8, 2010; Accepted: March 20, 2011