Electronic Journal of Plant Breeding, 5(1): 82-86 (Mar 2014)
ISSN 0975-928X

Research Note

Genetics and interrelationships of yield traits for enhancing productivity of little millet

V. Manimozhi Selvi*, A. Nirmalakumari and A. Subramanian
Department of Millets, Centre for Plant Breeding and Genetics,
Tamil Nadu Agricultural University, Coimbatore – 641 003.
*Email: manimozhiagri2005@gmail.com.

(Received: 17 Feb 2014; Accepted:17 Mar 2014)

Abstract

One hundred and nine little millet genotypes comprising 105 germplasm accessions and four check varieties *viz.*, CO2, CO3, CO (Samai)4 and OLM 203 were evaluated during June- September, 2012. High genotypic and phenotypic coefficients of variation were observed for panicle exertion, single plant dry matter yield, culm branches per plant, flag leaf width, single plant grain yield and number of basal tillers per plant. Moderate to high heritability values in broad sense were obtained for almost all the characters studied. Panicle exertion, single plant grain yield, single plant dry matter yield, 1000 grain weight, flag leaf width, culm branches per plant, number of basal tillers per plant and plant height possessed high heritability coupled with high estimates of genetic advance, indicating additive gene action for these characters. Hence, selection at phenotypic level for these traits would be effective. High heritability estimates accompanied by moderate genetic advance were observed for flag leaf length and days to 50 per cent flowering. Hence selection will be effective for these traits. Grain yield had significant and positive correlation with flag leaf length (0.770), peduncle length (0.272) and panicle length (0.223). Hence these traits need to be given important in yield improvement programme.

Keywords:
Little millet, Germplasm, Variability, Heritability, Correlation

Little millet (*Panicum sumatrense* Roth. ex. Roem. and Schultz.) is one of the important small grain crops that come up well in dry lands, which are characterized by high temperature, low fertile soil and poor management by resource poor farmers. According to Blatter and McCann (1935), this crop is cultivated or naturalized throughout India. It is considered to be indigenous to Indian subcontinent due to the luxuriant presence of its wild ancestor *Panicum psilopodium* throughout India. It is a self pollinated and allotetraploid crop with chromosome number of 2n = 4x = 36 belonging to the family *Poaceae* and sub family *Panicoideae*. Besides India, it is widely cultivated as, minor cereal across Nepal, Sri Lanka and western Burma. It is the first food of the year among the tribal farmers and is the staple food for millions in many parts of the world. Little millet is presently grown throughout India in about one million hectares. In Tamil Nadu, it occupies 21,231 ha of land with production of 6,502 tonnes and productivity of 777 kg/ha (Season and Crop report, 2009). It is valued for its drought tolerance, stress tolerance and nutritional value. The great merit of little millet is that it can be stored for a period of up to ten years or more without deterioration. Consequently, it has traditionally played an important role as reserve food crop. Moreover, it is considered to be free of the major pest and diseases.

In spite of these advantages, the national average grain yield of little millet is low, although it has a potential to yield up to 3 t/ha. Its low productivity has been due to lack of improved varieties, frequent drought in rainfed condition and unimproved traditional cultivation practices. Currently most of the farmers are cultivating local varieties (landraces) and so far, five improved varieties have been released in Tamil Nadu for production in place of land races. Replacement of landraces by modern cultivars generally increases the productivity of the crop and income of the farmers. Besides, little millet is being pushed to more marginal areas; so it is believed that, this would aggravate the danger of loss of genetic variation. Therefore investigating and identifying plants for the genetic variation available in the breeding materials is the first step of plant breeding and so vital for successful crop improvement program in future. Hence, this study was undertaken to assess the genetic variability, heritability, genetic advance and inter relationship of different yield and yield contributing traits and to determine the genetic potential of these materials for future use in the breeding programme.

The study material comprised 109 little millet genotypes including 105 germplasm accessions and four checks *viz.*, CO2, CO3, CO (Samai)4 and OLM 203 which were maintained at Small Millets Unit, Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. These germplasm accessions were evaluated in Augmented Block Design during June- September, 2012. Each accession was grown in single row of three m. length with a spacing of 30x10 cm. Crop management was done according to the recommended agronomic practices to have a good crop stand. Observations were recorded on five randomly selected competitive plants in each accession for 12 quantitative traits *viz.,* plant height (cm), days to 50 per cent flowering, number of basal tillers per plant, culm branches per plant, peduncle length (cm), panicle length (cm), panicle exertion (cm), flag leaf length (cm), flag leaf width (cm), single plant dry matter yield (g), 1000 grain weight (g) and single plant grain yield (g) as per the descriptors (IBPGR, 1985). The analysis of variance was carried out for all the genotypes as suggested by Federer and Raghavarao (1975) for the Augmented Block Design. The phenotypic and genotypic coefficients of variability were estimated following the procedure of Burton (1952). Heritability in the broad sense was arrived by the formulae of Allard (1960). Expected genetic advance as per cent of mean (GAM) was determined according to the method of Johnson *et al*. (1955a). Correlation was calculated as described by Falconer (1964).

Estimates of genotypic and phenotypic coefficients of variation: Genetic variability studies provide the basic information regarding the genetic properties of the population based on which breeding methods are formulated for further improvement of the crop (Joshi *et al.,* 2007). Analysis of variance revealed significant differences among all the genotypes. As shown in Table 1, high genotypic and phenotypic coefficients of variation were depicted by panicle exertion, single plant dry matter yield, culm branches per plant, flag leaf width, single plant grain yield and number of basal tillers per plant. Generally, the phenotypic coefficients of variation estimates were higher than the genotypic coefficients of variation showing that the apparent variation was not only due to genotypes but also due to the influence of environment. However the difference between phenotypic coefficients of variation and genotypic coefficients of variation was less for characters such as days to 50 per cent flowering and 1000 grain weight. This implied that the environmental role was less for the expression of these characters which would facilitate direct phenotypic selection. Similar findings were reported by Bezaweletaw *et al.* (2006) and Dagnachew Lule *et al*. (2012) in finger millet.

Estimates of heritability in broad sense and expected genetic advance: Heritability which is the heritable portion of phenotypic variance is a good index of transmission of characters from parents to offspring. In this study, heritability estimates ranged from moderate (53.9 per cent for peduncle length) to high (98.1 per cent for 1000 grain weight). High heritability estimates for 1000 grain weight, days to 50 per cent flowering, flag leaf width, single plant dry matter yield, plant height, single plant grain yield, panicle exertion, number of basal tillers per plant, flag leaf length and culm branches per plant were observed. Likewise, the heritability values were moderate for panicle length (54.5 per cent) and peduncle length (53.9 per cent). Earlier, Nirmalakumari *et al.* (2010) also observed high estimate of heritability for grain yield in little millet.

High values (31.15 to 74.54) of GAM were observed for number of basal tillers per plant, 1000 grain weight, culm branches per plant, single plant grain yield, flag leaf width, single plant dry matter yield and panicle exertion. Intermediate estimates of 14.04 and 20.16 per cent GAM were obtained for days to 50 per cent flowering and plant height respectively. These results are in conformity with the findings of Savitha *et al.* (2013) in finger millet.

Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimate alone (Johnson *et al*., 1955b). High heritability accompanied with high genetic advance was observed for panicle exertion, single plant grain yield, single plant dry matter yield, 1000 grain weight, flag leaf width, culm branches per plant, number of basal tillers per plant and plant height. This indicated that selection will be effective for the traits like peduncle length and panicle length recorded moderate heritability and low genetic advance. Hence direct phenotypic selection for their improvement will not be fruitful. Similar results were also reported by Nirmalakumari *et al.* (2010) and Reddy and Reddy (2012) in little millet.

Correlation among characters: The phenotypic correlation analysis indicated that days to 50 per cent flowering had positive and significant association with plant height (0.375). It reveals that late flowering coincides with tall plant genotypes. Number of basal tillers per plant expressed negatively significant correlation with plant height (-0.203) and negative and significant association with days to 50 per cent flowering (-0.332). Culm branches per plant showed negative and significant correlation with days to 50 per cent flowering (-0.341) and plant height (-0.653). From this data, it is inferred that the plants with more number of basal tillers and culm branches are characterized by early flowering and short stature. These unique characters may be useful to screen lodging resistant genotypes. Positive and significant associations were observed between panicle length and plant height (0. 562) and peduncle length (0.362). But a negatively significant association was recorded for panicle length with culm branches (-0.353). Panicle exertion had strong positive association with plant height (0.264). Similarly, flag leaf length had significant and positive association with peduncle length (0.311) and panicle length (0.237).

Flag leaf width expressed a significant and positive correlation with plant height (0.695), days to 50 per cent flowering (0.357), panicle length (0.297) and panicle exertion (0.264). The plants with optimum number of basal tillers and culm branches directly correlated with high peduncle length, panicle length and flag leaf length. This will lead to increase in number of grains per panicle. Well developed flag leaf act as an efficient source for grain development at maturity phase. Positive and significant correlations were observed between single plant dry matter yield and plant height (0.444), panicle length (0.339) and flag leaf width (0.378). But negative association between single plant dry matter yield and culm branches per plant. Similarly, 1000 grain weight had positive and significant association with number of basal tillers per plant and culm branches per plant. Grain yield per plant had positive associations with peduncle length (0.272), panicle length (0.223) and flag leaf length (0.770).

The success of genetic improvement in any character depends on the nature of variability present for that character and precise selection of relevant genotype. Hence, an insight into the magnitude of variability present in the gene pool of a crop is of utmost importance to a plant breeder for starting judicious plant breeding programme. Regardless of the magnitude, all characters expressed wide range of variability. From the above discussion, a conclusion could be arrived that, panicle exertion, single plant grain yield, single plant dry matter yield, 1000 grain weight, flag leaf width, culm branches per plant, number of basal tillers per plant and plant height recorded high heritability and genetic advance. From this, it is inferred that selection for these traits at phenotypic level may be useful for yield improvement in little millet. The correlation analysis clearly indicated apart from selection for grain yield per plant, indirect selection of peduncle length, panicle length and flag leaf length could be applied to enhance the productivity of little millet under rainfed condition. Hence, simultaneous selection of traits like short statured plant with optimum number of basal tillers and culm branches, but having high peduncle length, panicle length and flag leaf length would be more suitable for high grain yield with lodging resistance.

Acknowledgement

The authors would like to acknowledge PPV & FRA, Ministry of Agriculture, GOI, New Delhi and the Project coordinator, ICAR – Small Millets for funding the research work.

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Electronic Journal of Plant Breeding, 5(1): 82-86 (Mar 2014)
ISSN 0975-928X

Table 1. Estimate of mean, variance, coefficients of variability, heritability and genetic advance as per cent of mean (GAM) for 12 quantitative traits of little millet

Character	Mean	Coefficient of variability (%)			Heritability in broad sense (%)	Genetic advance	GAM (%)
		PCV	GCV	ECV			
Plant height (cm)	130.6	12.47	11.73	4.21	88.6	26.33	20.16
Days to 50 % flowering	54.7	7.72	7.48	1.88	94.0	7.68	14.04
No. of basal tillers/plant	8.0	25.40	22.33	12.12	77.2	2.49	31.15
Culm branches/ plant	4.9	54.07	42.22	33.78	60.9	2.02	41.22
Peduncle length (cm)	11.3	13.30	9.77	9.02	53.9	0.90	7.96
Panicle length (cm)	32.2	10.90	8.04	7.35	54.5	2.15	6.68
Panicle exertion (cm)	2.4	119.3	109.1	48.41	83.5	4.11	171.25
Flag leaf length (cm)	25.7	19.81	16.34	11.20	68.0	4.85	18.87
Flag leaf width (cm)	0.9	36.85	35.14	11.11	90.9	0.56	62.22
Single plant dry matter yield (g)	34.1	46.96	44.01	16.39	87.8	25.42	74.54
1000 grain weight (g)	2.2	18.18	18.01	2.49	98.1	0.79	35.90
Single plant grain yield (g)	8.9	35.41	33.41	12.00	88.5	5.98	57.07

Table 2. Estimates of phenotypic correlation coefficients for 12 quantitative traits of little millet

Character	Plant height (cm)	Days to 50 % flowering	No.of. basal tillers	Culm branches	Peduncle length (cm)	Panicle length (cm)	Panicle exertion (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Single plant dry matter yield(g)	1000 grain weight (g)	Single plant grain yield (g)
Plant height(cm)	1.000											
Days to 50 % flowering	0.375**	1.000										
No. of basal tillers	-0.203*	-0.332**	1.000									
Culm branches	-0.653**	-0.341**	0.190	1.000								
Peduncle length(cm)	0.008	-0.080	-0.035	0.139	1.000							
Panicle length(cm)	0.562**	0.189	-0.070	-0.353**	0.362**	1.000						
Panicle exertion(cm)	0.264**	-0.052	-0.087	-0.212*	-0.011	0.017	1.000					
Flag leaf length(cm)	-0.057	-0.142	0.097	0.029	0.311**	0.237*	-0.071	1.000				
Flag leaf width(cm)	0.695**	0.357**	-0.400**	-0.678**	-0.152	0.297**	0.264**	-0.087	1.000			
Single plant dry matter yield(g)	0.444**	0.133	0.037	-0.311**	-0.071	0.339**	0.185	0.083	0.378**	1.000		
1000 grain weight(g)	-0.601**	-0.396**	0.229*	0.602**	0.133	-0.145	-0.248*	0.188	-0.694**	-0.150	1.000	
Single plant grain yield(g)	0.006	-0.152	0.182	0.073	0.272**	0.223*	-0.149	0.770**	-0.117	0.111	0.110	1.000

*,** significant at 5 and 1 % probability level respectively