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Research Note

Genetic variability studies for yield and yield components in kodo millet (*Paspalum scrobiculatum* L.)

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Abstract

The experimental material comprised of one hundred and three germplasm accessions of kodo millet (*Paspalum scrobiculatum* L.) were evaluated to assess the genetic variability, heritability and genetic advance for fifteen yield component traits. Analysis of variance revealed that there were significant differences among the accessions for all the traits studied. The coefficient of variation at phenotypic (PCV) and genotypic (GCV) levels were high for Zn content, grain yield per plant, Fe content, number of productive tillers and thumb length. Broad sense heritability ranged from 54.18 per cent for length of the longest raceme to 97.30 per cent for days to 50 per cent flowering. High heritability coupled with high genetic advance as per cent of mean was observed for plant height, number of basal tillers, number of productive tillers, flag leaf width, inflorescence length, thumb length, Zn content, Fe content and grain yield per plant which indicates that these traits are under the influence of additive gene effects and selection may be effective for these characters.

Key words

Kodo millet, PCV, GCV, heritability, genetic advance

Kodo millet, *Paspalum scrobiculatum* L. (2n=4x=40) is an annual grain that is grown primarily in India. It is widely distributed in damp habitats across the tropics and subtropics of the world. It was domesticated around 3000 years ago in India, the only country today where it is harvested as a grain in significant quantities, mainly on the Deccan plateau (de Wet *et al.*, 1983). It is grown today from Uttar Pradesh to Bangladesh in the north and Kerala and Tamil Nadu in the south. It forms the main stay of the dietary nutritional requirements of farmers of marginal and dry lands in many parts of India. Kodo millet ranks second in area and production next to finger millet in India. In India, kodo millet occupies an area of 152.5 thousand hectares with the production and productivity of 41.2 thousand tones and 312 kg/ha, respectively (Padulosi *et al.*, 2009) and 3570 hectares of area and 6187 tonnes of production in Tamil Nadu. It matures in three to four months with yields varying from 250 to 1000 kg/ha (Hulse *et al.*, 1980) and a potential yield of 2000 kg/ha (Harinarayana, 1989). The seeds have an excellent storage life and can be stored for several years. The nutritional value of the protein has been found to be slightly better than that of foxtail millet but comparable to that of other small millets and has high anti-oxidant activity (anti-cancer) even when compared to other millets (Chandrasekara and Shahidi, 2011).

The basic information on the existence of genetic variability and diversity in a population and the relationship between different traits is essential for any successful Plant Breeding programme. Genetic improvement through conventional breeding approaches depends mainly on the availability of diverse germplasm and presence of enormous genetic variability. The characterization and evaluation are the important pre-requisites for effective utilization of germplasm and also to identify sources of useful genes. An insight into the nature and magnitude of genetic variability present in the gene pool is of immense value for starting any systematic breeding programme because the presence of considerable genetic variability in the base material ensures better chances of evolving desirable plant type. Hence, an attempt was made to estimate the extent of variation for yield contributing traits in 103 kodo millet germplasm accessions by studying the genetic parameters like phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance, which may contribute to formulation of suitable selection indices for improvement in this crop.

Fifteen yield contributing characteristics were measured to assess the magnitude of heritable variability for 103 genotypes of kodo millet. The study was conducted at Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore during *kharif*, 2015-2016. For evaluation, these germplasm accessions were grown in randomized block design with three replications. Observations regarding 13 morphological traits *viz.,* days to first flowering, days to 50 per cent flowering, plant height, number of basal tillers, number of productive tillers, flag leaf length, flag leaf width, peduncle length, inflorescence length, length of longest raceme, thumb length, thousand grain weight and grain yield per plant were recorded in three random plants in each replication and two quality traits *viz.*, Zn and Fe contents were recorded. Phenotypic and genotypic variances were estimated according to the formula given by Lush (1940). Phenotypic and genotypic coefficients of variability were computed according to the method suggested by Burton (1952) and traits were classified as having high, moderate or low range of variation as per the method suggested by Sivasubramanian and Menon (1973). Heritability in broad sense was calculated as per the formula given by Lush (1940). Range of heritability was categorized as suggested by Robinson *et al*. (1949). Genetic advance was expressed as per cent of mean by using the formula suggested by Johnson *et al.* (1955). Traits were classified as having high, moderate or low genetic advance as per the method suggested by Johnson *et al.* (1955).

Genetic variability studies provide basic information regarding the genetic properties of the population based on which breeding methods are formulated for further improvement of the crop. These studies are also helpful to know about the nature and extent of variability that can be attributed to different causes, sensitivity of crop to environment, heritability of the character and genetic advance.

The analysis of variance for characters under study in the present experiment showed significant differences among accessions for all the characters (Table 1), indicating the presence of adequate variability for further improvement. The estimates of mean, range, phenotypic coefficient of variation, genotypic coefficient of variation, heritability and genetic advance as percent of mean are presented in table 2.

In general, PCV was higher than GCV for all the characters studied. The values for phenotypic coefficients of variation ranged from 9.74 to 60.36 per cent. The values for genotypic coefficients of variation obtained for various yield and yield attributing characters ranged from 9.51 to 57.72 per cent. The coefficients of variation at phenotypic (PCV) and genotypic (GCV) levels were high for Zn content, grain yield per plant, Fe content, number of productive tillers and thumb length showed that the variations observed in these characters contributed markedly to the total variability. Similar results were reported by Subramanian *et al.,* (2010) in kodo millet for grain yield per plant; Plawani Panda (2015) for number of productive tillers, Zn content, Fe content and grain yield per plant in barnyard millet. Moderate PCV and GCV were observed for plant height, inflorescence length, length of the longest raceme, flag leaf width, thousand grain weight and flag leaf length. These observations are in agreement with the earlier reports of Yogeesh *et al.* (2015) for plant height in foxtail millet. The lowest PCV and GCV were recorded for days to first flowering and days to 50 per cent flowering which showed that the variability for these characters among these genotypes was meagre. These results are in accordance with Yogeesh *et al.* (2015) in foxtail millet for days to 50 per cent flowering.

Broad sense heritability ranged from 54.18 per cent for length of the longest raceme to 97.30 per cent for days to 50 per cent flowering. Days to 50 per cent flowering (97.30 %) recorded the highest heritability followed by Fe content (95.86 %), days to first flowering (93.76 %), Zn content (91.45 %), plant height (89.60 %), grain yield per plant (88.33 %), flag leaf width (87.31 %), number of basal tillers (79.13 %), inflorescence length (77.28 %), thumb length (71.05 %), number of productive tillers (68.54 %), thousand grain weight (66.07 %) and flag leaf length (64.51 %). High heritability for days to 50 per cent flowering and grain yield per plant was reported by Sreeja (2014) and plant height, inflorescence length and grain yield per plant was reported by Subramanian *et al.* (2010) in kodo millet; days to first flowering, days to fifty percent flowering, plant height, flag leaf length, flag leaf width, inflorescence length, Zn content, Fe content and grain yield per plant by Plawani Panda (2015) in barnyard millet. Heritability which is the heritable portion of phenotypic variance is a good index of transmission of characters from parents to offspring (Falconer, 1960).

Genetic advance as per cent of mean ranged from 18.96 to 113.71 per cent. Zn content (113.71 %) recorded the highest genetic advance as per cent of mean followed by Fe content (64.05 %), grain yield per plant (60.80 %), number of productive tillers (36.92 %), thumb length (36.86 %), plant height (36.79 %), number of basal tillers (34.25 %), flag leaf width (30.06 %), inflorescence length (28.00 %) and peduncle length (26.36 %). Yogeesh *et al.* (2015) reported similar results for grain yield per plant, number of basal tillers and inflorescence length in foxtail millet. High genetic advance as per cent of mean indicated that these characters are governed by additive genes and selection will be rewarding for improvement of these traits. Moderate genetic advance as per cent of mean was recorded for days to 50 per cent flowering (19.53 %) followed by thousand grain weight (19.27 %), length of the longest raceme (19.15 %), flag leaf length (19.03 %) and days to first flowering (18.96 %). Similarly moderate genetic advance as per cent of mean was reported by Dagnachew Lule *et al.* (2012) for days to 50 per cent flowering in finger millet indicated that these characters are governed by non additive genes. High heritability with high genetic advance as per cent of mean was observed for plant height, number of basal tillers, number of productive tillers, flag leaf width, inflorescence length, thumb length, Zn content, Fe content and grain yield per plant**.** High heritability accompanied with high genetic advance indicates that these traits are under the influence of additive gene effects and selection may be effective for these characters. It is concluded that genetic variability present in the population is mainly used for varietal improvement of future breeding programmes.

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Table 1. Analysis of variance for 15 quantitative characters in kodo millet

Characters	Mean sum of squares	
	Treatments (df=102)	Error (df=204)
Days to first flowering	94.98**	2.06
Days to 50 per cent flowering	106.27**	0.97
Plant height (cm)	391.68**	14.58
Number of basal tillers	34.36**	2.77
Number of productive tillers	6.75**	0.89
Flag leaf length (cm)	8.58**	1.33
Flag leaf width (cm)	0.03**	0.001
Peduncle length (cm)	3.33**	0.71
Inflorescence length (cm)	12.74**	1.13
Length of the longest raceme (cm)	2.33**	0.51
Thumb length (cm)	5.53**	0.66
Thousand grain weight (g)	0.63**	0.09
Zn content (mg/100g)	13.40**	0.40
Fe content (mg/100g)	69.24**	0.98
Grain yield per plant (g)	71.23**	3.00

**Significant at 1% level

Table 2. Genetic parameters for fifteen quantitative traits in kodo millet

Characters	Range		Mean	Vp	Vg	PCV (%)	GCV (%)	h^2 (%)	GA	GA (%) of mean
	Min.	Max.								
Days to first flowering	49.00	77.00	58.15	33.03	30.97	9.82	9.51	93.76	11.10	18.96
Days to 50 per cent flowering	52.00	80.00	61.34	36.07	35.10	9.74	9.61	97.30	12.04	19.53
Plant height (cm)	36.01	86.35	59.42	140.28	125.69	19.93	18.87	89.60	21.86	36.79
Number of basal tillers	11.00	25.22	17.36	13.30	10.52	21.01	18.69	79.13	5.94	34.25
Number of productive tillers	3.83	10.73	6.46	2.85	1.95	26.15	21.65	68.54	2.38	36.92
Flag leaf length (cm)	8.99	17.14	13.52	3.70	2.41	14.32	11.50	64.51	2.56	19.03
Flag leaf width (cm)	0.57	1.62	0.70	0.014	0.012	16.71	15.62	87.31	0.21	30.06
Peduncle length (cm)	3.78	8.25	5.41	1.59	0.87	23.31	17.27	54.91	1.43	26.36
Inflorescence length (cm)	8.38	20.80	12.72	5.00	3.86	17.59	15.46	77.28	3.56	28.00
Length of the longest raceme (cm)	3.87	9.32	6.18	1.12	0.60	17.16	12.63	54.18	1.18	19.15
Thumb length (cm)	3.47	11.62	6.00	2.28	1.62	25.19	21.23	71.05	2.21	36.86
Thousand grain weight (g)	2.47	4.91	3.68	0.27	0.18	14.16	11.51	66.07	0.71	19.27
Zn content (mg/100g)	0.10	6.87	3.61	4.73	4.33	60.36	57.72	91.45	4.10	113.71
Fe content (mg/100g)	5.49	25.03	15.02	23.73	22.75	32.44	31.76	95.86	9.62	64.05
Grain yield per plant (g)	5.37	31.37	15.19	25.74	22.74	33.42	31.41	88.33	9.23	60.80