International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(3): 2967-2969

Received: 19-03-2019
Accepted: 21-04-2019

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Genetic variability, heritability and genetic advance in foxtail millet breeding lines

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Abstract
Foxtail millet is one of the nutri-cereal which is grown for food, feed and fodder. It can answer well the context of climate change through its high resilience. Variability is the main prerequisite for any crop to sustain itself and feed the growing population. Hence, variability, heritability and genetic advance of foxtail millet breeding lines was studied at Agricultural Research Station, Vizianagaram during *kharif*, 2017. Among all genotypes, SiA 3222 is the earliest which can fit in the gap between any cropping system and also can be used in contingent planning. High variability existed for panicle length, peduncle length and leaf length followed by grain yield and fodder yield. High heritability with high Genetic Advance as percent Mean was recorded for panicle length, peduncle length, leaf length, days to maturity and grain yield suggesting primarily additive nature of gene action which responds well to selection.

Keywords: Genetic variability, heritability, foxtail millet, setaria italica

Introduction

Small millets grown in India mainly constitute finger millet, foxtail millet, kodo millet, little millet, proso millet, Barnyard millet and browntop millet. Foxtail millet (*Setaria italica* (L.) P. Beauv) also known as Italian millet is important crop next to finger millet among the seven small millets. It is also known by different names such as giant setaria, german millet, chinese millet, hungarian millet. It belongs to the family Poaceae with chromosome number 2n=18. It is one of the most economically important millet crops grown for grain, which is used for human consumption and also as animal, poultry, cage birds feed and its straw is used as fodder. It is a potential crop grown mostly on poor or marginal soils in southern Europe and in temperate, subtropical and tropical Asia which feeds millions of people. It can even grow at an altitude of 2000 msl.

Foxtail millet is fairly drought tolerant but cannot tolerate water logging. It is an annual, self-pollinated nutritious food crop. Foxtail millet ranks second in the world's total production of millets. In India it is cultivated in an area of 5 lakh hectares and the production of 2.9 million tons with productivity of 600 kg per hectare (Anonymous, 2016). At present, foxtail millet is cultivated in Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, Rajasthan, Madhya Pradesh, Uttar Pradesh and north eastern states of India.

Foxtail millet grains are rich in protein, fibre, β carotene, minerals viz., calcium, iron, potassium, magnesium, zinc, antioxidants and vitamins (Rai, 2002). Millet based dietary fiber, improves glycemic control, decreases hyperinsulinemia and lowers plasma lipid concentrations in patients with type 2 diabetes (Jali *et al*., 2012) [6].

Grain yield of a crop being a complex character is influenced by many of its dependent traits and is controlled by polygenes as well as environmental influence. Knowledge on inheritance of yield and its related traits, heritability, expected genetic advance and association between various economic traits is necessary for planning successful selection procedure for evolving high yielding genotypes.

Improvements of these traits depend on the existence of variability. The variability for traits of economic importance is the basic prerequisite for any crop improvement. In order to improve grain yields breeding of high yielding varieties either through heterosis breeding or pureline selection is essential.

Materials and methods

In the present investigation, eight genotypes including one local check variety, were evaluated at Agricultural Research Station, Vizianagaram, Andhra Pradesh during *kharif*, 2017.

Genotypes were sown in a randomized complete block design (RCBD) in three replications with a spacing of 30 × 7.5 cm per each entry. Fertilizers, 40-20-0 NPK kg/ha and need based plant protection measures were taken to raise a healthy crop. Observations were recorded on days to 50% flowering, plant height, No. of productive tillers/plant, panicle length, peduncle length, leaf length, leaf width, grain yield and fodder yield.

Analysis of variance and summary statistics were calculated as per Panse and Sukathme (1967). Analysis of variance may not reveal the absolute variability and this could be accessed through standardizing the phenotypic and genotypic variances by obtaining the coefficients of variability. Hence, the components of variation such as genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) were computed as per Burton and Devane (1953) [3]. Further it is essential for selection to separate out the environmental influence from the total variability. This indicates the accuracy with which a genotype can be identified by its phenotypic performance and thus heritability in broad sense was computed as per Allard (1960) [1]. The estimates of heritability alone fail to indicate the response to selection. Therefore, the heritability estimates appeared to be more meaningful when accompanied by estimates of genetic advance. Hence the genetic advances as per cent mean (GAM) was also estimated. Heritability and genetic advancement were categorized into low, medium and high as per Johnson *et al.*, (1955) [7]. Phenotypic correlations were calculated according to Falconer (1981) [5].

Results and discussion

ANOVA table showed high significant differences among the genotypes studied for all the traits indicating presence of sufficient amount of variability (Table No. 1). The analysis of variance (ANOVA) showed highly significant differences ($P < 0.01$) among the genotypes for the entire yield and yield component traits studied (Table 1).

Summary statistics (Table No. 2) of eight genotypes studied indicated that days to 50% flowering ranged from 39 to 53 days and days to maturity ranged from 65 to 84 days respectively. Plant height varied from 117.2 to 158.8 cm with general mean of 135.9 cm. Number of productive tillers varied from 4.2 to 7.0 with general mean 5.3, Ear length ranged from 14 to 23.1 cm having general mean 18.4 cm, leaf length ranged from 30.5 to 52.5 cm having general mean 36.6 cm, leaf width ranged from 1.7 to 2.3 cm having general mean 2.0 cm and peduncle length ranged from 9.3 to 16.1 cm with general mean of 12.6 cm. Grain yield ranged from 18.6 q/ha (SiA 3222) to 28.9 q/ha (SiA 3223) while fodder yield had a wide range of 41.6 q/ha (SiA 3222) to 70.0 q/ha (SiA 3156).

In the present study foxtail millet genotypes exhibited high PCV and GCV (Table No. 3) for peduncle length, panicle length and leaf length specifying higher variability for these traits. Grain yield and fodder yield, days to 50% flowering, plant height, No. of productive tillers/plant, and leaf width are supposed to have moderate variability as GCV and PCV values are between 10 to 20%. The values of PCV and GCV varied from 12.9 (No. of productive tillers per plant) to 38.5 (Peduncle length) and 9.39 (days to 50% flowering) to 36.46 (Peduncle length) respectively. Panicle length and leaf length had very narrow difference between PCV and GCV values which shows that major portion of PCV was contributed by GCV and this provides higher scope for improvement as these traits are determined by the genotype rather than by the environment.

In the present study, most of the traits *viz.*, Panicle length, Leaf length and Peduncle length, showed the high estimates of broad sense heritability indicating the truthfulness of high GCV values obtained and effectiveness of selection. Similar results were reported earlier by Nirmalakumari and Vetriventhan (2010), Prasanna *et al.*, (2013); Brunda *et al.*, (2017) [2, 9]. In general population with more variations are expected to have high heritability compared to uniform population. The narrowness of difference between PCV & GCV and also high estimates of broad sense heritability can be mainly attributed to uniform environmental conditions in the experimental fields (Dabholkar, 1999) [4]. As the present was taken up with utmost care in maintaining uniform environmental conditions, the PCV & GCV observed can be attributed to studying genetically diverse genotypes for that particular traits.

High heritability and high GAM were recorded for panicle length, peduncle length, plant height, days to maturity, leaf length and grain yield which suggests mostly the additive nature of gene action for these traits which respond to simple selection procedures like pure line selection or mass selection. These results are in consonance with those obtained by previous workers (Nirmalakumari, 2008; Nirmalakumari and Vetriventhan, 2010; Prasanna *et al.*, 2013; Brunda *et al.*, 2017) [2, 9, 8].

Table 1: ANOVA of eight fox tail millet genotypes.

Source of Variations	df	Mean Squares									
		Days to 50% flowering	Days to Maturity	Plant Height (cm)	No. of Prod. Tillers	Panicle Length (cm)	Leaf Length (cm)	Leaf width (cm)	Peduncle Length (cm)	Grain Yield (q/ha)	Fodder Yield (q/ha)
Treatments	7	74.48**	156.85**	620.56*	3.98**	26.64*	146.21*	0.17	19.19*	54.64**	270.53**
Replications	2	0.67	0.88	62.80	0.41	3.84	17.28	0.10	9.49	8.62	35.86
Error	14	2.05	4.49	136.19	0.78	8.10	33.08	0.07	3.25	6.03	89.33

*significant at 5% level & ** significant at 1% level

Table 2: Mean values and summary statistics of eight fox tail millet genotypes.

S. No	Entry	Days to 50% flowering	Days to Maturity	Plant Height (cm)	No. of Prod. Tillers	Pnicle Length (cm)	Leaf Length (cm)	Leaf width (cm)	Peduncle Length (cm)	Grain Yield (q/ha)	Fodder Yield (q/ha)
1	PPSS – 7	49.3	79.3	136.00	4.33	14.03	31.0	2.0	14.4	25.8	50.2
2	Suryanandi	42.3	69.0	131.83	5.17	17.73	30.5	1.7	15.8	24.0	63.2
3	SiA – 3222	39.3	64.7	117.20	4.17	15.83	35.7	2.1	12.4	18.6	51.7
4	SiA – 3085	48.3	81.0	150.17	7.00	20.83	34.3	1.8	10.5	28.4	65.4
5	SiA – 3223	52.7	84.3	158.83	7.00	23.07	52.5	2.3	9.3	28.9	63.7

6	Prasad (C)	43.7	72.7	140.83	4.50	20.67	38.0	2.0	16.1	20.4	41.6
7	SiA – 3156	48.0	76.0	134.67	5.33	18.73	37.7	1.9	11.0	28.4	70.0
8	Suryanandi L	39.0	66.0	117.83	4.50	16.63	33.3	2.3	11.7	19.5	60.0
	Mean	45.3	74.1	135.9	5.3	18.4	36.6	2.0	12.6	24.3	58.2
	Minimum	39.0	64.7	117.2	4.2	14.0	30.5	1.7	9.3	18.6	41.6
	Maximum	52.7	84.3	158.8	7.0	23.1	52.5	2.3	16.1	28.9	70.0
	CD (5%)	2.51	3.71	20.44	1.54	4.98	10.07	0.47	3.16	4.3	16.2
	CV (%)	3.16	2.86	8.59	16.8	15.4	15.7	13.3	14.3	10.1	16.6

Table 3: Genetic parameters of eight fox tail millet genotypes

S. No		Days to 50% flowering	Days to Maturity	Plant Height (cm)	No. of Prod. Tillers	Panicle Length (cm)	Leaf Length (cm)	Leaf width (cm)	Peduncle Length (cm)	Grain Yield (q/ha)	Fodder Yield (q/ha)
1	GCV	9.39	14.26	13.48	10.97	35.99	23.91	11.88	36.46	16.60	13.35
2	PCV	13.3	17.22	15.38	12.9	36.32	23.98	13.79	38.55	17.60	21.02
3	ECV	16.32	16.7	12.8	11.7	8.3	3.21	12.1	21.6	10.12	16.24
4	H^2 (Broad Sense)	0.5	0.69	0.77	0.72	0.98	0.99	0.74	0.89	0.89	0.40
5	Genetic Advance	0.82	4.34	1.77	2.04	39.56	22.66	1.46	3.69	7.82	10.17
6	GAM	13.64	24.34	24.35	19.23	73.48	49.1	21.08	71.06	32.25	17.47

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