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Full Length Research Paper

Estimates of genetic parameters for yield and yield attributes in elite lines and popular cultivars of India's pearl millet

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Estimation of genetic parameters would be useful in developing appropriate selection strategies. Heritability is a measure of possible genetic advancement under selection. The research work pertaining to the study of genetic variability, heritability, and genetic advance for yield and yield contributing characters in twenty one diverse elite lines and cultivars of pearl millet was conducted during 2007 at the Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore. Analysis of variance manifested highly significant differences among the genotypes for all the traits except number of productive tillers and days to maturity. Variability for genetic potential of twenty one genotypes for different traits was recorded and the highest variability were recorded for plant height (two folds), number of productive tillers (two fold) and for grain yield (four fold). The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV). Low, medium and high estimates of broad sense heritability were found in different plant characters under the study. High estimates of broad sense heritability were recorded for grain yield per plant followed by panicle girth. Greater magnitude of broad sense heritability coupled with higher genetic advance in grain yield per plant and panicle length revealed that the simple selection should lead to a fast genetic improvement of the genotypes used in this study.

Key words: PCV, GCV, heritability and genetic advance.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) originated in Africa from where it was imported into India in the early days (Hein, 1953) and is commonly grown in the arid and semi-arid regions of Africa and India as a staple food for millions of people. It is particularly adapted to nutrient-poor soil and low rainfall conditions, yet it is capable of rapid and vigorous growth under favorable conditions (Maiti and Bidinger, 1981). This crop is grown primarily for grain production on 26 million ha in the arid and semi-arid tropical regions of Asia and Africa (Rai et al., 2007) but in the USA and Europe, is grown chiefly as a fodder crop (Poehlman and Borthakur, 1969). Among the cereals in India, pearl millet is fourth in acreage behind rice, wheat and sorghum and fifth in production behind rice, wheat, sorghum and maize. Genetic variability for agronomic traits is the key component of breeding programmes for broadening the gene pool of crops. However, the genetic variability for many traits is limited in cultivated germplasm (Sabu et al., 2009). Genetic variation among landraces is of vital importance to breeding programmes that aim to produce improved landrace-based cultivars for marginal growing environments (Yadav et al., 2001). The overall performance of a genotype may vary due to changes in the environment, and if the heritability for the traits is higher, the selection process will be simpler and the response to selection will be greater (Larik et al., 1997; Larik et al., 2000; Soomro et al., 2008).

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It was found earlier that genetic improvement of crops for quantitative traits requires reliable estimates of genetic variability, heritability and genetic advancement in respect to the breeding material that is presently at hand in order to plan an efficient breeding program (Dudley and Moll, 1969; Chand et al., 2008). The information on variability and heritability of characters is essential for identifying characters amenable to genetic improvement through selection (Vidya et al., 2002).

In modern field of crop improvement programme, genetic studies have attained significant importance in evolving varieties suited to various environmental conditions. In such studies, heritability estimates of quantitative characters play an important role in expressing the reliability of variance value as a selection guideline to the plant breeder during the succeeding generations. The measures of transmission of characters from generation to generation are termed as heritability. Heritability along with genetic advancement should be jointly considered to arrive at a more reliable conclusion (Johnson et al., 1955). Therefore, it becomes necessary to partition the observed variability into its heritable and non heritable components and to have an understanding of parameters such as genetic coefficient of variation, heritability and genetic advancement. Earlier studies by Mahmood et al. (2004) and Chand et al. (2008) showed that grain yield per plant has the highest coefficient of variability. Heritability were high for grain yield, grain size and 50% flowering date and moderate for plant height in pearl millet (Gupta and Dhillon, 1974), whereas Nanda and Paul (1974) found that the heritability was highest for ear length followed by ear girth and lowest for grain yield. Plant height, ear length and girth had high heritability coupled with high genetic advancement (Pokhriyal et al., 1967). Keeping this in view, the present study was undertaken to achieve the following objectives: to estimate variability, heritability and genetic advancement for yield and yield contributing traits in a set of elite inbred lines and hybrids of popular cultivars in the pearl millet

MATERIALS AND METHODS

Genetic materials

The experimental materials comprised of twenty one different pearl millet genotypes having broad genetic base inbred, newly developed hybrids (under advance yield trial) and commercial varieties which is released by varied year, pedigree, and yield as well as grain quality traits (based on the earlier studies conducted by millet breeding station). The popular commercial varieties included in this study are X7, CO 7, ICMV 221 and CO (Cu) 9. These varieties and hybrids are mostly recommended for rainfed conditions.

Experimental design and field procedures

The experimental work comprised of using various kinds of genotypes, to study the genetic variability and potential of genotypes, heritability and genetic advancement of grain yield with yield contributing traits. This study was carried out during 2007 under the prevailing environmental conditions at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore, which lies between 11° North latitude and 77° East longitude. Experimental genotypes were hand sown during mid of May 2007 with intra- and inter row spacing of 15 and 60 cm, respectively in a Randomized Complete Block Design (RCBD) with three replications. Each plot consists of eight rows of four meter in length. Thinning was performed after 15 days of germination when the plant height was 10 -15 cm, to ensure single plant per hill. All recommended cultural practices and inputs including fertilizer, hoeing, irrigation and pest control were applied same for all the entries from sowing to harvesting and the crop was grown under uniform conditions to minimize environmental variability to the maximum possible extent. Harvesting was made during the months of August 2007 on single plant basis and single head thresher was used for threshing.

Statistical analysis

Analysis of variance (ANOVA) was performed for the RCBD as described by Steel and Torrie (1980) through GenStat (12th edition) for all the plant traits recorded. The heritability estimate of a trait was computed as the ratio between estimate of genetic variance and phenotypic variance. Coefficient of variability (CV), Heritability (Broad Sense) and Genetic Advance estimate was worked out as procedures outlined by Singh and Chaudhry (1985).

RESULTS AND DISCUSSION

Analyses of variance were carried out to partition the variances into its components. The results of the analyses revealed that highly significant differences exist among the traits except number of productive tillers and days to maturity (Table 1). The genotype mean values for each character under the trail were given Table 3. The genetic potential range of twenty one genotypes for different traits was recorded, that is, days to 50% flowering (44 - 51), plant height (110.0 - 194.5 cm), panicle length (18.75 - 32.29 cm), panicle girth (6.2 - 9.88 cm), number of productive tillers (1.50-3.98) days to maturity (82 - 87) and grain yield (40.85 - 189.78). For potential genetic variability, two folds variations were observed each for plant height (110 - 194.50) and number of productive tillers (1.50 - 3.98) and four fold variations were observed for grain yield (40.85 - 189.78). With respect to contribution of each character towards the total variability, plant height contributed much to the variability followed by days to maturity (Figure 1). Grain yield per plant of inbred lines revealed the low genetic yield potential, whereas all the commercial cultivars and hybrids showed optimum yield potential. A hybrid TNBH - 0538 had higher grain yield per plant followed by variety X7 than any other popular varieties included in this study (Figure 2). As indicated in the materials and methods section, genetic materials used in the present study had different set of genotypes such as elite inbred line, commercial cultivars and hybrids. These genotypes are proven to have much variability in plant height, days to maturity and yield potential as well.

The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV)

Table 1. Analysis of variance for yield and yield components in pearl millet partial inbred and hybrid culture.

Sources of variation	DF	Mean squares						
		Days to 50% Bloom	Plant height (cm)	No. of productive tillers	Panicle length (cm)	Panicle girth (cm)	Days to maturity	Grain yield/ plant (g)
Replication	2	0.8571	93.90	0.5082	2.4481	0.46305	6.095	40.161
Genotypes	20	10.6238**	1057.21**	0.8490 ns	19.2747**	2.67558**	2.600 ns	4119.024**
Error	20	0.9571	40.49	0.2862	0.6018	0.07973	1.495	5.909
CV (%)		2.1	4.2	17.9	3.2	3.3	1.5	2.3

** Significant at 1% probability level; ns – not significant.

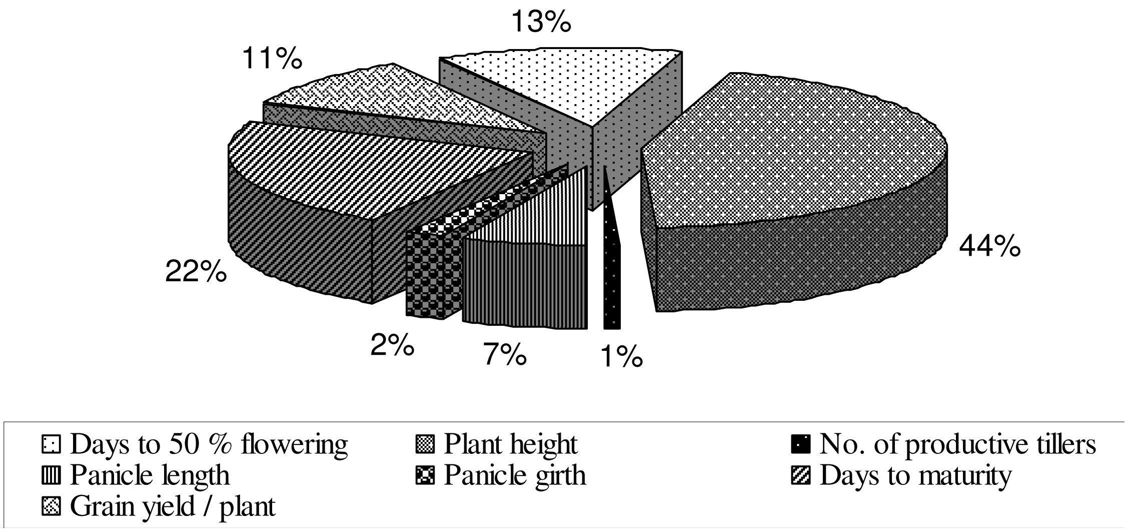

Figure 1. Contribution of plant characters towards total variability in genetic materials used in present study

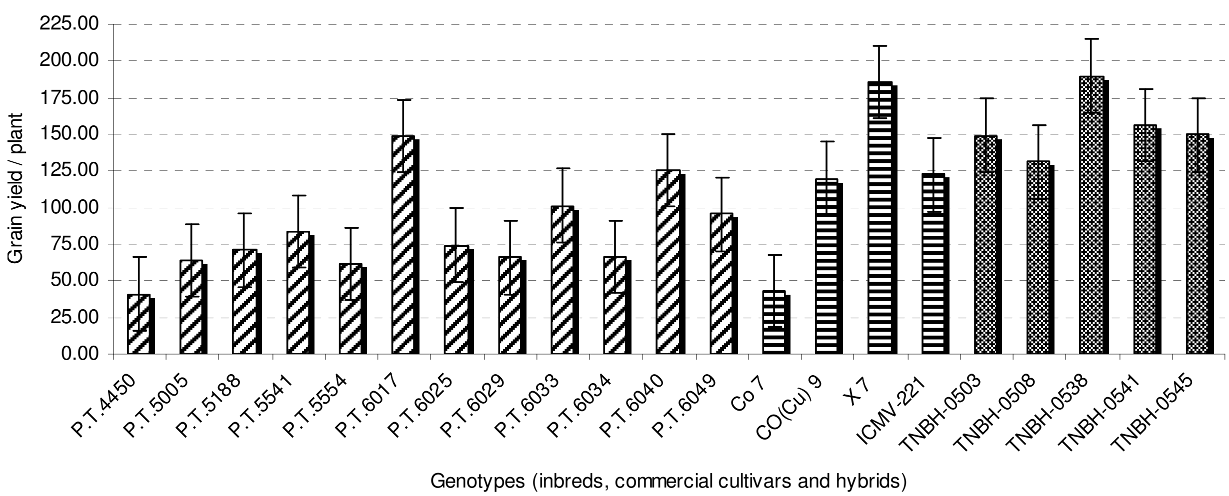

Figure 2. Variability for individual plant yield by elite inbreds (cross line bar), commercial cultivars (horizontal line bar) and hybrids (grey bar)

for all the characters under this study. Low, medium and high estimates of broad sense heritability were found in different plant characters (Table 2). A perusal of coefficient of variability indicates that PCV was quite

Table 2. Genetic parameters for yield and yield components in pearl millet partial inbred and hybrid culture.

Traits	Range	Mean	Vg	Vp	GCV%	PCV %	Heritability %	GA% of mean
Days to 50 % Bloom	44 - 51	47.19 ± 2.30	4.83	5.79	4.66	5.10	83.47	8.69
Plant height (cm)	110 - 194.50	151.65 ± 22.99	508.36	548.85	14.87	15.45	92.62	21.84
No. of Productive tillers	1.50 - 3.98	2.99 ± 0.65	0.28	0.57	17.74	25.20	49.58	34.55
Panicle length (cm)	18.75 - 32.29	24.03 ± 3.10	9.34	9.94	12.72	13.12	93.94	45.01
Panicle girth (cm)	6.2 - 9.88	8.44 ± 1.15	1.30	1.38	13.50	13.91	94.21	23.19
Days to maturity	82 - 87	84.48 ± 1.19	0.55	2.05	0.88	1.69	26.98	2.96
Grain yield / plant (g)	40.85 - 89.78	106.84 ± 45.38	2056.56	2062.47	42.45	42.51	99.71	69.44

higher for grain yield per plant and number of productive tillers. Days to maturity showed considerably low heritability, which indicate a little prospect for improvement of this trait through selection. This observation is in agreement with the result of Bajaj and Phul (1982) and Chand et al. (2008). A high GCV was observed for grain yield per plant and number of productive tillers per plant. A low PCV as well as GCV goes to days to maturity. Considerable consistency of values were observed between PCV and GCV percentage for all the yield contributing characters studied, more closer values found for grain yield per plant followed by panicle length (differences of 0.06 and 0.4, respectively) and quiet a high level of differences was observed for number of productive tillers per plant (7.46), suggesting that environmental (field) manipulation may be less effective for bringing about favourable changes in expression of all the yield contributing characters of the genotypes used except for the number of productive tillers per plant. In general, high estimates of heritability (broad sense) were found for all the characters except days to maturity and number of productive tillers. In this study, the highest heritability was recorded for grain yield per plant followed by panicle girth, panicle length and plant height. Similar findings have been reported for grain yield by Gupta and Athwal (1966); Bhamre and Harinarayana (1992), for panicle length (Burton, 1951; Dass, 1989), for panicle girth (Vyas and Pokhriyal, 1985). Higher amount of genetic variability exists among the genotypes indicating an increased opportunity for the selection of desirable genotypes, provided variation is highly heritable. Genetic advancement expressed as percentage of mean, which showed wider range of variations for the different traits studied. The high estimates of genetic advance as percentage (GA %) was recorded for grain yield and panicle length. Greater magnitude of broad sense heritability coupled with higher genetic advance for grain yield per plant and panicle length, is the evidence that these plant traits were under the control of additive genetic effects for inheritance of these traits. For additive genetic effects, selection should lead to a fast genetic improvement of the trait concerned. However, the high estimates of heritability with low genetic advancement were found for plant height and panicle girth. The traits possessing low genetic advance with high heritability indicates the presence of non additive gene action, thus simple selection procedure in early segregating generation will not be effective for screening of the desirable character for potential breeding programme.

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