Int.J.Curr.Microbiol.App.Sci (2019) *8*(2): 4-9

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 02 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.802.002

Genetic Parameters for Grain Yield and Nutritional Quality Traits in Foxtail Millet [*Setaria italica* (L.) Beauv.]

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Keywords

Foxtail millet, Variability, Heritability and Genetic advance

Article Info

Accepted:
04 January 2018
Available Online:
10 February 2019

A B S T R A C T

The present investigation was carried out to assess the nature and magnitude of genetic variability for yield and quality related traits in 50 genotypes of foxtail millet germplasm collections. The experiment was laid out in an Augmented Randomised Complete Block Design (ARCBD) at RARS, Lam, Guntur during *Kharif*, 2017-18. The analysis of variance revealed the presence of significant differences for most of the traits *viz*., days to 50% flowering, plant height, days to maturity, fat, carbohydrate, iron, phosphorus, calcium and grain yield per plant indicating that the collections under study were genetically diverse for most of the traits. Coefficient of variation studies indicated that the estimates of GCV were lesser than the corresponding PCV estimates for all the traits indicating the influence of environment on expression of these traits. High PCV and GCV were recorded for no. of productive tillers per plant, fat, iron, phosphorus, calcium and grain yield per plant, while days to 50% flowering recorded moderate PCV and GCV. The low GCV and PCV were recorded in plant height, days to maturity and carbohydrate. The grain yield and its components *viz*., days to 50% flowering, plant height, panicle length, protein, fat, iron, phosphorus and calcium exhibited high genetic advance as per cent of mean coupled with high estimates of heritability indicating that, there is predominance of additive gene action in controlling the inheritance of these traits and direct phenotypic selection would be effective for improvement of these traits.

Introduction

Foxtail millet is largely self-pollinated, with cross pollination averaging about 4 per cent (Li *et al.*, 1935). Foxtail millet ranks second in the world's total production of millets and is an important staple food for millions of people in Southern Europe and Asia (Marathee, 1993). Foxtail millet is not thoroughly studied so far and germplasm is underutilized which resulted low productivity levels. The breeding effort for developing high yielding varieties followed through utilization of diverse germplasm, creation and exploitation of the genetic variation for different traits of economic importance is critical in crop improvement. In any crop improvement programme, the knowledge of variability available is necessary. Yield is a complex character and is the product of the contribution of various yield components. Presence of a wider spectrum of variability will enhance the chances of selecting a desired genotype. Besides genetic variability, knowledge on heritability and genetic advance measures the relative degree to which a character is transmitted to progeny, thereby helps the breeder to employ a suitable breeding strategy to achieve the objective. Keeping the above points in view, the present investigation was carried out with the objective to find the extent of genetic variability, heritability and genetic advance.

Materials and Methods

The present investigation was carried out during *kharif*, 2017-18 at RARS, Lam, Guntur, Andhra Pradesh, which is located at 16.10^0 N latitude, 28.29^0 E longitude and 31.5 m altitude with 50 genotypes of foxtail millet germplasm [*Setaria italica* (L.) Beauv.] including checks. The trial was laid out in an Augmented Randomised Complete Block Design (Federer, 1956) with three checks *viz*., korra local, Prasad and Suryanandi in each block. Each genotype was grown in a single row of 4 m length with a spacing of 22.5 cm between the rows and 10 cm between the plants. Data were collected on five randomly selected plants per treatment for plant height, panicle length, no. of productive tillers per plant and grain yield per plant. However data on days to 50% flowering, days to maturity, test weight, protein, fat, carbohydrate, iron, phosphorus and were recorded on plot basis. Phenotypic and genotypic coefficients of variation were calculated according to the formula given by Burton (1952) and these PCV, GCV values were classified as described by Sivasubramanian and Menon (1973). Heritability (h^2) in the broad sense and narrow sense heritability was computed as suggested by Hanson *et al.*, (1956) and heritability in the broad sense was categorised as per the classification given by Johnson *et al.*, (1955). The range of genetic advance as per cent of mean was classified and calculated based on the formula given by Johnson *et al.*, (1955). The estimates of mean, range, PCV, GCV, heritability (h^2_{bs}) and genetic advance as per cent of mean (GAM) for foxtail millet genotypes are presented in Table 1.

Results and Discussion

The variation for number of days taken to 50% flowering ranged from 41 days (Ise-458) to 75 days (Ise-769) with a mean of 49.34 days. For plant height the range of variation varied from 89.08 cm (Ise-1026) to 168.08 cm (Ise-160) with a mean of 133.73 cm. The trait panicle length has shown a variation ranging from 3.53 cm (Ise-785) to 18.53 cm (Ise-31) with a mean of 13.59 cm. The variation for the character number of productive tillers per plant ranged from 1.52 (Ise-785) to 8.30 (Ise-1605) with a mean of 4.42. Days to maturity is the another important character having a variation ranging from 72 days (Ise-1593) to 110 days (Ise-769) with a mean of 82.47days. Test weight on the other hand has shown a variation ranging from 1.13 g (Ise-1026) to 4.41 g (Ise-31, Ise-1881 and Ise-1892) with a mean of 2.72 g. The protein content of the studied genotypes ranged from 6.01 g (Ise-362) to 19.56 g (Ise-838) with a mean of 11.58 g. Similarly it was 1.81 g (Ise-995) to 5.62 g (Ise-1269) for fat with a mean of 3.52 g, 49.78 g (Ise-1419) to 73.00 g (Ise-1605) for carbohydrate with a mean of around 64.54 g, 1.22 mg (Ise-840) to 27.73 mg (Ise-1354) for iron with a mean of 12.54 mg, 0.11 mg (Ise-1026) to 0.43 mg (Ise-1780) for phosphorous with a mean of 0.28 mg, 5.57 mg (Ise-909) to 30.55 mg (Ise-907 and Ise-1059) for calcium with a mean of 16.16 mg and 3.77 g (Ise-785) to 39.83 g (Ise-1605) for grain yield per plant with a mean of around 15.18 g. Yield is a complex character and is the product of the contribution of various yield components. Presence of a wider spectrum of variability will enhance the chances of selecting a desired genotype, as the success of any breeding programme depends upon the quantum of genetic variability present in the population.

For the trait days to 50% flowering the PCV (10.64) and GCV (10.48) estimates were moderate indicating moderate variation among genotypes studied and such estimates of PCV and GCV were earlier reported by Nirmalakumari *et al.,* (2008), Tyagi *et al.,* (2011) and Brunda *et al.,* (2014). The estimates of PCV (9.91) and GCV (9.87) were low for plant height indicating less variation among the genotypes studied. Similar results were reported by Brunda *et al.,* (2014) and Jyothsna *et al.,* (2016). The estimates of PCV (22.28) and GCV (19.69) were high and moderate for the character panicle length and the difference between PCV and GCV value is less indicating that there is little role of environmental component in the observed variation. Similar results for high PCV and moderate GCV were earlier reported by Prasad *et al.,* (1985). For the trait number of productive tillers per plant, the estimates of PCV (36.36) and GCV (22.03) were high. The difference between PCV and GCV value is more which indicates that there is high influence of environment in the observed variation. Similar results of high PCV and GCV were reported by Nirmalakumari *et al.,* (2008), Nirmalakumari and Vetrivethan (2010), Prasanna *et al.,* (2013), Yogeesh *et al.,* (2015), Jyothsna *et al.,* (2016), Ashok *et al.,* (2016) and Kavya *et al.,* (2017). The estimates of PCV (7.30) and GCV (7.12) were low for days to maturity and the difference between PCV and GCV value is less which indicates that there is little role of environmental component in the observed variation. These results are in agreement with Nirmalakumari *et al.,* (2008), Nirmalakumari and Vetrivethan (2010), Jyothsna *et al.,* (2016) and Ashok *et al.,* (2016). For the character test weight the estimate of PCV (23.08) was high and GCV (14.44) was moderate. Similar results for high PCV were reported by Sirisha *et al.,* (2009), and Kavya *et al.,* (2017). While moderate GCV was reported by Nirmalakumari *et al.,* (2008). High PCV (21.76) and moderate GCV (19.35) were recorded for the trait seed protein. Similar results of high PCV were reported by Rani (2014) in finger millet, while Sirisha *et al.,* (2009), Smita *et al.,* (2016) and Kavya *et al.,* (2017) reported moderate GCV for this trait in foxtail millet.

High PCV (26.19) and GCV (24.11) were recorded for seed fat and it was in line with the results of Govindaraj *et al.,* (2011) in pearl millet. The estimates of PCV (7.03) and GCV (6.89) were low for carbohydrate indicating less variation among genotypes studied and these findings are in conformity with the results of Kavya *et al.,* (2017). The estimates of PCV (52.15) and GCV (51.83) were high for the character iron and these findings are in conformity with the results of Govindaraj *et al.,* (2011) in pearl millet and Smita *et al.,* (2016) in foxtail millet. For phosphorous content the estimates of PCV (26.98) and GCV (26.64) were high indicating large variation among genotypes studied. These findings are in contrary to the results of Govindaraj *et al.,* (2011) in pearl millet where he obtained low PCV and GCV. High PCV (35.97) and GCV (35.47) were recorded for the trait calcium indicating large variation among genotypes studied and these findings are in conformity with the results of Prasanna *et al.,* (2013). From the above studied PCV and GCV values we can infer that the genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the influence of environment on expression of these traits.

Table.1 Estimates of variability, heritability and genetic advance as per cent of mean for grain yield and quality components in foxtail millet [*Setaria italica* (L.) Beauv.]

S. No.	Character	Mean	Range		Coefficient of variation		Heritability (broad sense) (%)	Genetic advance as % of mean
			Minimum	Maximum	PCV (%)	GCV (%)		
1	Days to 50% flowering	49.34	41.00	75.00	10.64	10.48	96.90	21.25
2	Plant height (cm)	133.73	89.08	168.08	9.91	9.87	99.10	20.24
3	Panicle length (cm)	13.59	3.53	18.53	22.28	19.69	78.10	35.86
4	No. of productive tillers/plant	4.42	0.52	8.30	36.36	22.03	36.70	27.51
5	Days to maturity	82.47	72.00	110.00	7.30	7.12	95.40	14.33
6	Test wt (g)	2.72	1.13	4.41	23.08	14.44	39.20	18.62
7	Protein (g/100g)	11.58	6.01	19.56	21.76	19.35	79.10	35.44
8	Fat (g/100g)	3.52	1.81	5.62	26.19	24.11	84.80	45.74
9	Carbohydrate (g/100g)	64.54	49.78	73.00	7.03	6.89	96.20	13.93
10	Iron (mg/100g)	12.54	1.22	27.73	52.15	51.83	83.34	89.00
11	Phosphorus (g/100g)	0.28	0.11	0.43	26.98	26.64	97.50	54.19
12	Calcium (mg/100g)	16.16	5.57	30.55	35.97	35.47	97.20	72.05
13	Grain yield/plant (g)	15.18	3.77	39.83	44.95	44.00	95.80	88.73

PCV = Phenotypic coefficient of variation
GCV = Genotypic coefficient of variation

Consistency in the performance of selection in succeeding generations depends on the magnitude of heritable variation present in relation to observed variation. The estimates of heritability revealed that except for the traits number of productive tillers per plant (36.70) and test weight (39.20) all the remaining traits were found to have high magnitude of heritability. Heritability estimates alone cannot give a better idea in selecting suitable breeding method. So in order to fulfil the requirement we have also estimated genetic advance in addition to the heritability. Heritability estimates along with genetic advance are more helpful in predicting the gain under selection than heritability estimates alone and these will also give a better picture for having an idea of gene action involved. However, it is not necessary that a character showing high heritability will always exhibit high genetic advance. Of the thirteen characters concerned, high heritability coupled with high genetic advance was noted for days to 50% flowering, plant height, panicle length, protein, fat, iron, phosphorous, calcium and grain yield per plant indicating the predominance of additive gene action, there by direct selection will be effective to obtain the desired results. The results were in accordance with Sirisha *et al.*, (2009), Nirmalakumari and Vetrivethan (2010), Tyagi *et al.*, (2011), Govindaraj *et al.*, (2011) in pearl millet, Brunda *et al.*, (2014), Yogeesh *et al.*, (2015), Ashok *et al.*, (2016), Smita *et al.*, (2016) and Kavya *et al.*, (2017). High heritability coupled with moderate genetic advance were recorded for days to maturity and carbohydrate indicating the preponderance of both additive and non additive gene action indicating that simple selection will not be rewarding in improving this trait. Similar results were earlier reported by Nirmalakumari *et al.*, (2008), Nirmalakumari and Vetrivethan (2010) and Jyothsna *et al.*, (2016). Moderate heritability coupled with moderate genetic advance was recorded for the trait test weight indicating that there is involvement of both additive and non-additive gene actions which may not be exploited through simple selection procedures. However different results of high heritability and moderate genetic advance as per mean were indicated by Prasad *et al.*, (1985). Moderate heritability coupled with high genetic advance was recorded for number of productive tillers per plant indicating the preponderance of both additive and non-additive gene action and hence simple selection may not be rewarding. These findings are in accordance with those of Jyothsna *et al.*, (2016).

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How to cite this article:

Md Ayesha, D. Ratna Babu, J. Dayal Prasad Babu and Srinivasa Rao, V. 2019. Genetic Parameters for Grain Yield and Nutritional Quality Traits in Foxtail Millet [*Setaria italica* (L.) Beauv.]. *Int.J.Curr.Microbiol.App.Sci.* 8(02): 4-9.
doi: https://doi.org/10.20546/ijcmas.2019.802.002