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VARIABILITY STUDIES FOR YIELD AND YIELD-CONTRIBUTING TRAITS IN M_3 GENERATION OF FOXTAIL MILLET (*Setaria italica* L. BEAUV.)

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ABSTRACT

The experiment was conducted at Sorghum Research Station, VNMKV, Parbhani, Maharashtra, India; during *kharif* 2024–25 using 60 M_3 progenies derived from ten mutagenic treatments of variety Siya 3156 along with one control. The mutagenic treatments included gamma irradiation at 100 Gy, 200 Gy and 300 Gy, EMS at 0.1%, 0.2% and 0.3%, and combinations of gamma rays with EMS. The experiment was laid out in a randomized block design (RBD) with two replications. PCV was higher than GCV for all traits. High GCV and PCV were observed for number of productive tillers per plant, internodal length and number of tillers per plant. High heritability coupled with high genetic advance was recorded for number of productive tillers per plant and internodal length, indicating good scope for selection. The study revealed useful genetic variability induced through mutagenesis for improving yield and its contributing traits in foxtail millet.

Key words : Foxtail millet, M_3 generation, Genetic variability, Heritability, Genetic advance.

Introduction

Foxtail millet (*Setaria italica* (L.) Beauv) commonly known as foxtail millet, is among the earliest domesticated millet crops and has been cultivated in India since ancient times (Jia *et al*., 2013). In India, it is popularly known as 'Kangni' and is recognized for its adaptability to diverse agro-climatic conditions. The crop performs well in both low-fertility and well-drained fertile soils and is predominantly grown in semi-arid and rainfed areas (Fukunaga and Kawase, 2024). Its ability to produce reasonably well under limited inputs and moisture-stressed conditions makes foxtail millet an important crop for farmers in marginal and resource-constrained environments, where it is often considered a 'life-saving crop' (Zhang *et al*., 2022).

The leading foxtail millet producing states in India include Andhra Pradesh, Karnataka, Maharashtra, Rajasthan, Tamil Nadu and Telangana. Among these, Rajasthan, Karnataka, Maharashtra, Madhya Pradesh, and Haryana together contribute more than 79.6% of the country's total millet production. India continues to be a major producer of millets, and the production of millets was estimated at 18.59 million tons during 2024–25. Rajasthan, Maharashtra and Karnataka were among the leading states in the production of millets. The average yield was 762 Kg/ha. However, recent official statistics generally report production at the aggregate millet or small-millet level rather than separately for foxtail millet. (APEDA, 2024-25).

Unlike rice and wheat, foxtail millet is a nutrient-dense whole grain that is naturally gluten-free and provides appreciable amounts of protein, vitamins, and essential minerals (Singh *et al*., 2020). Assessment of genetic variability provides valuable information on the genetic constitution and extent of variation present within a population, which serves as an important basis for

formulating effective breeding strategies and improving desirable traits in crops (Johnson *et al*., 1955).

Materials and Methods

The experimental material comprised 60 M_3 Progenies (6 progenies each from 10 mutagenic treatments of foxtail millet variety Siya 3156) along with 1 control. The field experiment was conducted at Sorghum Research Station, VNMKV, Parbhani during *kharif* 2024-25 with 30 cm × 10 cm spacing and with plot size of one row of 3m length On 17 Jully, 2024-25 the seeds were sown using Randomized Block Design (RBD) with two replications. From each treatment, five competitive plants were chosen randomly and observations are noted in each replication for twelve grain yield and their contributing traits: Days to 50% flowering, Plant height, No. of productive tillers per plant, No. of tillers per plant, Internodal distance, peduncle length, Flag leaf area, No. of ears per plant, Ear length, 1000 grain weight, Grain yield per ear head, Grain yield per plant.

Mean values of collected data was employed to analysis of variance (ANOVA) utilising Panse and Sukhatme (1985) statistical analysis techniques. While, phenotypic coefficient of variance (PCV) and genotypic coefficient of variance (GCV) were determined according to Burton's (1952) approach.

The formula provided by Johnson *et al*. (1955) was used to estimate heritability (h^2) in the broad sense, genetic advance and genetic advance as per cent mean for all characters.

Results and Discussion

Analysis of variance revealed the presence of significant differences among the treatments for all the trait under study, indicating that treatments under study were genetically diverse for most of the traits (Table 1).

For the success of a plant breeding programme, the availability of adequate genetic variability in the breeding material is essential. The extent of genetic variability present within a population determines the effectiveness of selection. In the present study, genetic variability was assessed using estimates of mean, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advance, and genetic gain.

Estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) for the studied traits are presented in Table 2 and Fig. 1. Considerable variation was observed across all the characters evaluated. However, the phenotypic variance was consistently higher than the corresponding genotypic variance for all yield and yield-contributing traits, indicating that environmental effects contributed to the observed phenotypic variation. The genotypic coefficient of variation (GCV) ranged from 2.921 per cent for plant height to 17.214 per cent for number of productive tillers per plant, while the phenotypic coefficient of variation (PCV) ranged from 3.149 to 18.111 per cent for the same traits. In general, PCV values were slightly higher than the corresponding GCV values, indicating the influence of environmental factors on the expression of these characters. Similar results were reported by Muduli *et al*. (2008), Kavya *et al*. (2017), Karvar *et al*. (2020), Dharnishkumar *et al*. (2023).

High heritability in the broad sense was observed for flag leaf area (98.33%), internodal length (95.63%), days to 50 per cent flowering (94.07%), number of productive tillers per plant (90.34%), grain yield per ear head

Table 1 : ANOVA for yield and yield contributing characters in Siya 3156 foxtail millet.

Source of Variation	DF	Days to 50 % flowering	Plant height (cm)	No. of tillers per plant	No. of productive tillers per plant	Internodal length (cm)	Peduncle length (cm)
Replications	1	0.141	2.005	0.182	0.065	0.021	0.703
Treatments	60	6.966**	30.870**	0.660**	0.949**	6.046**	7.338**
Error	60	0.212	2.312	0.170	0.048	0.135	1.193

To contd…..

Source of Variation	DF	Flag leaf area (cm^2)	No. of ear per plant	Ear length (cm)	1000 Grain yield(g)	Grain Yeild per ear head (g)	Grain yield per plant
Replications	1	0.003	0.030	0.214	0.009	0.000013	0.036
Treatments	60	22.777**	0.315**	0.828**	0.031**	0.123**	1.721**
Error	60	0.191	0.038	0.180	0.003	0.007	0.2988

* and ** Significant at 5 % and 1% level of significance, respectively.

Table 2 : Genetic variability parameters for yield and yield contributing characters in M_3 generation of Siya 3156 foxtail millet.

S. no.	Characters	Range		Mean	GV %	PV %	GCV (%)	PCV (%)	h^2 b.s. (%)	GA	GA as % of mean
		Minimum	Maximum								
1.	Days to 50 % flowering	49.61	55.72	52.40	3.376	3.589	3.506	3.615	94.07%	3.671	7.005
2.	Plant height (cm)	121.72	136.15	129.33	14.278	16.591	2.921	3.149	86.06%	7.221	5.583
3.	No. of Productive tillers per plant	2.78	5.38	3.89	0.450	0.498	17.214	18.111	90.34%	1.314	33.706
4.	No. of tillers per plant	3.12	5.52	4.2941	0.245	0.415	11.529	15.011	58.99%	0.783	18.241
5.	Internodal length (cm)	9.86	15.96	12.659	2.956	3.091	13.581	13.888	95.63%	3.463	27.360
6.	Peduncle length (cm)	19.92	28.42	24.088	3.072	4.266	7.276	8.574	72.02%	3.064	12.720
7.	Flag leaf area (cm)	35.92	48.26	41.434	11.293	11.484	8.110	8.178	98.33%	6.864	16.56
8.	No. of ear per plant	3.08	4.82	3.950	0.138	0.177	9.417	10.659	78.06%	0.677	17.140
9.	Ear length (cm)	16.22	19.02	17.582	0.323	0.504	3.235	4.039	64.14%	0.938	5.337
10.	1000 Grain weight (g)	2.6	3.18	2.853	0.013	0.017	4.117	4.6629	77.97%	0.213	7.489
11.	Grain yield per ear head (g)	2.48	3.54	2.967	0.058	0.065	8.114	8.6299	88.41%	0.466	15.718
12.	Grain Yield per plant	14.84	18.84	16.635	0.711	1.010	5.070	6.0419	70.42%	1.458	8.765

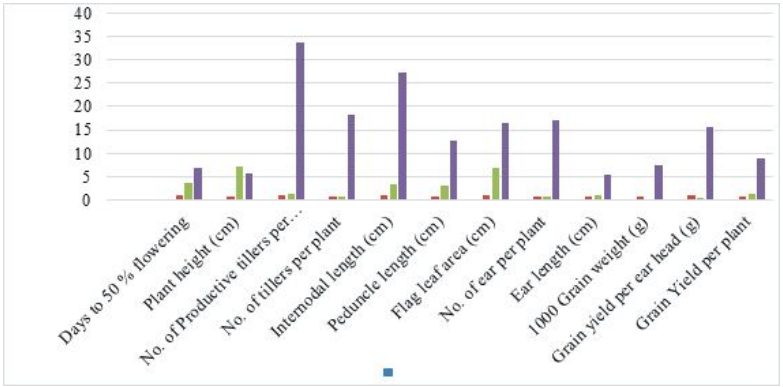


Fig. 1 : Heritability (h^2) Genetic Advance (GA) and Genetic Advance as percent of mean (GA%) in Foxtail Millet variety Siya 3156.

(88.41%) and plant height (86.06%). Moderate heritability was observed for number of tillers per plant (58.99%), ear length (64.14%), grain yield per plant (70.42%) and peduncle length (72.02%). The genetic advance as per cent of mean was highest for number of productive tillers per plant (33.706%), followed by internodal length (27.360%), number of tillers per plant (18.241%) and number of ears per plant (17.140%).

High heritability coupled with relatively high genetic advance was observed for number of productive tillers per plant, internodal length and number of ears per plant, suggesting that these traits were largely governed by genetic effects and could respond effectively to selection. Overall, the observed variability, heritability and genetic advance indicated considerable scope for selection and genetic improvement of yield and its contributing traits in the M_3 generation of Siya 3156 foxtail millet.

Conclusion

The estimates of GCV and PCV indicated the presence of considerable variability, particularly for number of productive tillers per plant and number of tillers per plant. High heritability coupled with high genetic advance as per cent of mean was observed for number of productive tillers per plant, indicating a predominance of genetic effects and the possibility of effective selection for improvement of this trait. High heritability was also recorded for flag leaf area, internodal length, days to 50 per cent flowering, grain yield per ear head and plant height. The observed variability and heritability estimates suggest good scope for selection among the M_3 progenies for improving yield and yield-contributing traits. Thus, the identified promising progenies can be utilized in subsequent generations for further evaluation and selection in foxtail millet breeding programmes.

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