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Genetic variability studies for yield and yield contributing traits of barnyard millet genotype *(Echinochloa frumentacea)*

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Abstract
An investigation entitled "Morpho-physiological and biochemical assessment in barnyard millet (*Echinochloa frumentacea*) genotypes over the seasons" was conducted during *Kharif* 2023 at the Centre for Advanced Agricultural Science and Technology field, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The experiment was laid out in a Randomized Block Design with three replications, comprising eighteen genotypes including two checks, Phule Barti-1 and DHBM-93-3. The study aimed to assess the extent of genetic variability, heritability and genetic advance for grain yield and its associated traits. The traits recorded included plant height (cm), peduncle length (cm), ear head length (cm), number of tillers per plant, flag leaf blade length (cm), flag leaf blade width (cm), days to 50 per cent flowering, days to maturity, 1000-seed weight (g), grain yield (q ha^{-1}), fodder yield (q ha^{-1}) and harvest index.Analysis of variance revealed significant differences among genotypes for all the traits studied, indicating the presence of substantial genetic variability. The check varieties recorded relatively higher mean performance for most yield-contributing traits. Among the test genotypes, KIBMG-22-09, KIBMG-22-13 and KIBMG-22-11 exhibited superior performance for important morphological traits such as plant height, number of tillers, flag leaf blade length and width, and grain yield. High genotypic and phenotypic coefficients of variation, coupled with high heritability and genetic advance, were observed for traits including grain yield, fodder yield, peduncle length and 1000-seed weight, suggesting the predominance of additive gene action and effectiveness of direct selection. Days to flowering and days to maturity also showed high heritability with moderate to high genetic advance. In contrast, traits like earhead length exhibited low variability and genetic advance, indicating the need for alternative breeding approaches.

Keywords: Barnyard millet, Variability, morpho-physiological, biochemical

Introduction
Continuous overexploitation of natural resources and the shift toward input-intensive cereal crops such as rice, wheat, and maize have aggravated global food and nutritional insecurity, particularly in developing countries. While these crops help meet calorie demand, their high input requirements, soil degradation potential, and vulnerability to climate stress limit sustainability. In contrast, traditional crops like millets-once sidelined due to changing food habits and commercialization-are nutritionally superior, climate-resilient, and require fewer inputs, making them ideal for restoring sustainable agriculture and nutritional security.

Millets are a diverse group of small-seeded cereals cultivated for grain and fodder, including pearl millet, finger millet, foxtail millet, and barnyard millet. (Habiyaremye *et al*. 2017) [1] Domesticated over 5000 years ago in Asia and Africa, millets are well adapted to dryland and rain-fed conditions, showing tolerance to drought, pests, and diseases. Their ability to produce reasonable yields under marginal conditions has earned them the status of "famine crops." Promoting millets directly supports Sustainable Development Goal-2 (Zero Hunger) by ensuring food security, improved nutrition, and environmentally sustainable agriculture. (Ceasar and Maharajan 2022) [6].

Barnyard millet (*Echinochloa frumentacea*) is an important minor millet cultivated mainly in India, which is the world's largest producer. It is a fast-growing, short-duration, self-pollinated crop capable of completing its life cycle within 45-60 days. Its adaptability to

diverse agro-climatic zones, low input requirement, and tolerance to drought make it a reliable crop for marginal lands and erratic rainfall conditions. Despite its potential, limited research attention has restricted its genetic improvement and large-scale adoption.

Nutritionally, barnyard millet is superior to many major cereals, being rich in protein, dietary fiber, minerals, and bioactive compounds, and is naturally gluten-free. However, information on how different genotypes respond to seasonal variations in terms of morphological, physiological, biochemical, and nutritional traits remains inadequate. Understanding genotype-specific responses to seasonal environments is essential for improving yield stability, stress tolerance, and nutritional quality. Systematic evaluation and characterization of barnyard millet germplasm can bridge these gaps and facilitate its effective utilization in breeding programs, thereby strengthening sustainable agriculture and food security under changing climatic conditions.

Collection of genotypes and assessment of genetic variability is a basic step in any crop improvement programme. Yield being a complex character is influenced by a number of high yield contributing characters controlled by polygenes and also influenced by the environment. Hence, it becomes necessary to partition the observed variability into heritable and non-heritable components measured as genotypic and phenotypic coefficients of variation (GCV and PCV), heritability and genetic advance.

Material and Method

The present investigation entitled "Morpho-physiological and biochemical assessment in barnyard millet (*Echinochloa frumentacea*) genotypes over the seasons" was carried out during the *Kharif* season of 2023 at the Centre for Advanced Agricultural Science and Technology (CAAST) field, Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahilyanagar, Maharashtra. The experimental material consisted of eighteen barnyard millet genotypes, including two standard check varieties. Pure seeds of all genotypes were obtained from the All India Coordinated Research Project (AICRP) on Small Millets, Zonal Agricultural Research Station (ZARS), Kolhapur. The field experiment was laid out in a Randomized Block Design (RBD) with three replications during *Kharif* 2023. Each genotype was sown at a spacing of 30 cm × 10 cm. The gross plot size was 3.00 m × 3.00 m consisting of eight rows, while the net plot size was 2.40 m × 3.00 m comprising six rows. All recommended agronomic practices, including nutrient management and plant protection measures, were uniformly followed throughout the crop growth period to ensure normal crop establishment and development. Observations on morpho-physiological, yield and biochemical traits were recorded on five healthy and representative plants randomly selected and tagged from each plot in every replication. Observations were taken at appropriate growth stages, and the mean values were used for statistical analysis. The traits recorded included plant height (cm), peduncle length (cm), ear head length (cm), number of tillers per plant, flag leaf blade length (cm), flag leaf blade width (cm), days to 50 per cent flowering, days to maturity, 1000-seed weight (g), grain yield (q ha^{-1}), fodder yield (q ha^{-1}) and harvest index. The recorded data were subjected to statistical analysis to assess variability and genetic parameters among the genotypes. Analysis of variance (ANOVA) was carried out following the procedure described by Panse and Sukhatme (1967) [11]. Genotypic and phenotypic coefficients of variation were estimated as per Burton (1952) [12]. Broad-sense heritability and genetic advance were calculated according to the methods suggested by Johnson *et al.* (1955) [13] and Allard (1960) [14], respectively.

Table 3.1: Barnyard millet genotypes: (16 + 2 C=18)

Sr. No.	Barnyard millet	Germplasm lines (ICRISAT)	Sr. no.	Barnyard millet	Germplasm lines (ICRISAT)
1	KIBMG-22-1	IEc 786	10	KIBMG-22-10	IEc 690
2	KIBMG-22-2	IEc 753	11	KIBMG-22-11	IEc 232
3	KIBMG-22-3	IEc 747	12	KIBMG-22-12	IEc 743
4	KIBMG-22-4	IEc 752	13	KIBMG-22-13	IEc 568
5	KIBMG-22-5	IEc 397	14	KIBMG-22-14	IEc 208
6	KIBMG-22-6	IEc 360	15	KIBMG-22-15	IEc 751
7	KIBMG-22-7	IEc 240	16	KIBMG-22-16	IEc 749
8	KIBMG-22-8	IEc 231	17	PhuleBarti-1(Ch)	Released variety
9	KIBMG-22-9	IEc 59	18	DHBM 93-3(Ch)	Released variety

Result and Discussion

4.1 Analysis of variance (ANOVA) for *Kharif* 2023

The variation is the prerequisite for the improvement of any traits by breeding. The variability leads to the selection and enhancement according to level of individual character performance. Analysis of variance gives out clear picture of the significant variation present in the generations and characters. This section provides results of yield and yield associated characters for *Kharif* 2023. The analysis of variance for twelve yield and yield contributing traits revealed the significant amount of variation for these characters among the both season of *Kharif* 2023 as indicated in Table 4.1.

4.2 Genotypic and Phenotypic Coefficients of Variation in *Kharif* 2023: Estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were classified as suggested by Sivasubramanian and Madhavamenon (1973) [10] and are presented in Table 4.2

Genotypic coefficient variation (GCV) was highest for Grain yield kg/plot (15.69 %) followed by fodder yield kg/plot (15.46 %), peduncle length (13.36 %), flag leaf width (12.24 %) and 100 seed weight (10.30%). While, low GCV were observed for earhead length (4.62 %) and to days to 50% flowering (10.20 %). The high estimates of PCV were observed for highest for Grain yield kg/plot (16.14 %) followed by fodder yield kg/plot (15.88 %), peduncle length (13.93 %), flag leaf width (12.65 %) and 100 seed weight (10.70%). However, the low PCV were observed for days to 50% flowering (10.28 %), flag leaf length (9.78 %), tiller number (8.41 %) and ear head length (5.29 %).

In general, the magnitude of phenotypic coefficient of variation was higher than the genotypic coefficient of variation. The highest magnitudinal difference between GCV and PCV was recorded for ear head length (0.67) followed by peduncle length (0.57), grain yield (kg/plot) (0.45) and flag leaf length (0.43). Whilst, lowest difference between GCV and PCV was found for days to 50% flowering (0.08), days to maturity (0.10).

4.3 Heritability and Genetic Advance in *Kharif* 2023

Estimates of heritability in broad sense are presented in Table 4.2. The heritability (b.s.) estimate varied between days to 50% flowering (98.40 %) and earhead length (76.3 %) High estimates of heritability (>60%) was observed for almost characters studied. The maximum estimates of heritability exhibited in days to 50% flowering (98.40 %) followed by days to maturity (97.40 %), fodder yield (kg/plot) (94.80 %), grain yield (kg/plot) (94.50 %), plant height (94.00 %), flag leaf width (93.70 %), 100 seed weight (92.80 %) and peduncle length (92.00 %).

The range of genetic advance (GA) observed from 0.30 to 23.49. The highest estimate of GA for plant height (23.49) followed by days to maturity (14.08), days to 50% flowering (13.47), flag leaf length (5.44) and peduncle length (3.85).

Table 4.1: Analysis of variance for *Kharif* 2023

Characters	***Kharif* 2023**		
	Replication	**Treatment**	**Error**
DF	02	17	34
Days to 50% flowering	0.13	132.37**	2.07
Days to maturity	10.35	147.87**	3.84
Fodder yield	0.09	2.48**	0.13
Grain yield	0.01	0.729**	0.04
Plant Height	78.98	441.57**	26.43
Flag leaf blade width	0.02	0.36*	0.03
1000 seed weight	0.03	0.39*	0.03
Peduncle length	0.67	12.42**	0.99
Flag leaf blade length	1.93	25.09**	2.16
Ear head length	0.45	4.18**	0.99
Tiller number	0.09	0.68*	0.08

Table 4.2: Variability parameters for seed yield and its contributing characters in eighteen Barnyard-millet genotypes during *Kharif*, 2023

Characters	Range		Mean	Heritability	GCV	PCV	GA	GA % of mean
	Min	Max						
PH	126	183.4	158.95	94.0%	7.40	7.63	23.49	14.78
Peduncle length	9.20	18.46	14.60	92.0%	13.36	13.93	3.85	26.40
Earhead length	18.34	25.24	22.32	76.3%	4.62	5.29	1.85	8.31
Tiller number	4.30	6.70	5.29	87.8%	8.41	8.98	0.86	16.25
DFF	55.00	76.00	64.59	98.4%	10.20	10.28	13.47	20.85
DM	80.00	106.00	90.42	97.4%	7.66	7.76	14.08	15.57
Flag leaf length	20.88	34.90	29.55	91.4%	9.35	9.78	5.44	18.42
Flag leaf width	1.92	3.44	2.73	93.7%	12.24	12.65	0.66	24.41
1000seed weight	2.79	4.33	3.35	92.8%	10.30	10.70	0.68	20.44
Fodder yield	4.22	7.42	5.73	94.8%	15.46	15.88	1.77	31.02
Grain yield	0.69	1.30	0.96	94.5%	15.69	16.14	0.30	31.42

Conclusion

The present study indicated the existence of considerable genetic variability among barnyard millet genotypes during the Kharif season. Traits such as grain yield, fodder yield, peduncle length and 1000-seed weight showed high variability, high heritability and high genetic advance, suggesting that these traits can be effectively improved through simple selection. Days to flowering and days to maturity also exhibited high heritability with moderate to high genetic advance, indicating the involvement of additive gene action and usefulness of selection. Overall, the study suggests that selecting early maturing, compact plants with higher seed weight, better flag leaf traits and more tillers would be an effective strategy for improving grain yield in barnyard millet without adversely affecting other important traits.

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