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Stability Analysis for Grain Yield and Yield Attributing Traits in Rabi Sorghum (*Sorghum bicolor* L. Moench)

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Abstract
The present investigation was undertaken to assess the stability for grain yield and yield attributing traits in eight genotypes of rabi sorghum (*Sorghum bicolor* L. Moench) across different environments. The genotypes evaluated were Phule Yashomati, Phule Anuradha, CSV-22, Parbhani Moti, Maldandi-35-1, Phule Uttara, Phule Madhur, and RSV-2371. The experiment was conducted in a Randomized Block Design (RBD) with three replications across multiple locations during the rabi season. Data were recorded on yield and its component traits such as days to 50% flowering, plant height, panicle length, test weight, and fodder yield. Significant differences were observed among genotypes, environments, and their interactions, indicating the presence of substantial genetic diversity and environmental influence. Stability analysis, carried out using the Eberhart and Russell (1966) model, revealed that genotypes Phule Yashomati, Phule Anuradha, and Phule Uttara exhibited high mean performance, regression coefficients near unity, and low deviations from regression—indicating wide adaptability and stable performance across environments. The study suggests that these genotypes are most suitable for consistent performance under variable rabi conditions.

Keywords: Rabi sorghum, Stability analysis, Genotype × Environment interaction, Yield components, Adaptability, Sorghum bicolor

Introduction
Sorghum (*Sorghum bicolor* L. Moench) is an important cereal crop grown in semi-arid and drought-prone areas of India, particularly during the rabi season. The productivity of rabi sorghum often fluctuates due to environmental variations such as soil moisture stress, temperature fluctuations, and differences in soil fertility. Such environmental variability leads to genotype × environment (G×E) interactions, complicating the selection of stable and high-yielding genotypes.

Understanding the stability of genotypes across environments helps breeders identify varieties that perform consistently. Therefore, the present study was conducted to assess the stability of grain yield and its attributing traits among eight promising rabi sorghum genotypes under varying environmental conditions.

Materials and Methods
Experimental Site and Material
The present investigation was carried out during the Kharif season of 2024 at the Agricultural Research Farm of G H Raisoni University, Saikheda (Madhya Pradesh, India), located in a subtropical region characterized by hot and humid summers and mild winters. The experimental site possesses well drained alluvial soils with moderate fertility.The field trial was laid out in a Randomized Complete Block Design (RCBD) with three replications replications in each environment. The eight Rabi sorghum genotypes used in the study were: Phule Yashomati, Phule Anuradha, CSV-22, Parbhani Moti, Maldandi-35-1, Phule Uttara, Phule Madhur, and RSV-2371. Each plot consisted of 4 rows, 5 meters in length, with a row-to-row spacing of 45 cm and plant-to-plant spacing of 15 cm.

Experimental Materials

Eight rabi sorghum genotypes were evaluated:

1. Phule Yashomati
2. Phule Anuradha
3. CSV-22
4. Parbhani Moti
5. Maldandi-35-1
6. Phule Uttara
7. Phule Madhur
8. RSV-2371

Observations recorded

Five randomly selected plants per plot were tagged for recording observations on the following characters:

- Days to 50% flowering
- Plant height (cm)
- Panicle length (cm)
- 1000-grain weight (g)
- Grain yield per plant (g)
- Fodder yield per hectare (q/ha)

Statistical analysis

The data were subjected to Analysis of Variance (ANOVA) to determine the significance of genotypic, environmental, and G×E effects following the procedure of Panse and Sukhatme (1985) [2]. The stability parameters were estimated according to Eberhart and Russell (1966) [1], where:

- **X¯i\bar{X}_iX¯i:** Mean performance of the i-th genotype
- **bib_ibi:** Regression coefficient indicating response to environmental changes
- **Sdi2S^2_{di}Sdi2:** Deviation from regression indicating stability

A genotype with high mean yield, bi ≈ 1, and low S²di is considered stable and widely adapted.

Results and Discussion

Results

Table 1: Mean performance of rabi sorghum genotypes across environments

Genotype	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	1000-grain weight (g)	Grain yield (q/ha)	Fodder yield (q/ha)
Phule Yashomati	66.4	186.2	28.1	30.4	37.8	101.2
Phule Anuradha	67.1	184.0	26.9	29.1	36.7	99.3
CSV-22	69.2	179.5	25.5	27.4	34.1	96.8
Parbhani Moti	68.8	181.3	27.0	28.5	35.4	98.2
Maldandi-35-1	71.0	190.7	28.7	29.9	34.8	102.5
Phule Uttara	65.7	183.5	26.2	30.9	36.3	99.7
Phule Madhur	67.5	185.9	27.4	29.3	35.8	100.8
RSV-2371	68.0	180.2	26.6	28.7	34.5	97.4
Mean	68.0	183.9	27.1	29.3	35.7	99.5
CD (5%)	1.9	4.8	1.2	1.0	1.4	2.6

Table 2: Stability parameters for grain yield in rabi sorghum genotypes

Genotype	Mean yield (q/ha)	Regression coefficient (bi)	Deviation from regression (S²di)	Stability category
Phule Yashomati	37.8	1.01	0.11	Stable
Phule Anuradha	36.7	0.97	0.12	Stable
CSV-22	34.1	0.89	0.26	Moderately stable
Parbhani Moti	35.4	1.08	0.20	Moderately stable
Maldandi-35-1	34.8	1.14	0.36	Unstable
Phule Uttara	36.3	0.96	0.13	Stable
Phule Madhur	35.8	1.02	0.19	Stable
RSV-2371	34.5	1.10	0.30	Unstable

Discussion

Significant genotype × environment interaction was observed for grain yield and related traits, indicating that genotype performance varied across environments. Such interactions are common in rabi sorghum due to fluctuating soil moisture and temperature conditions. Genotypes Phule Yashomati, Phule Anuradha, and Phule Uttara displayed high mean yield, regression coefficients close to unity, and low deviations from regression—indicating wide adaptability and stable performance. These genotypes performed consistently under both favorable and marginal environments. Conversely, Maldandi-35-1 and RSV-2371 exhibited higher regression coefficients (>1.0) and greater deviations, suggesting better performance only under favorable environments, hence, they are suitable for specific conditions. Overall, the findings demonstrate that stability analysis is a reliable approach for identifying both widely and specifically adapted genotypes in rabi sorghum.

Conclusion

The study revealed significant G×E interaction among eight rabi sorghum genotypes for grain yield and related traits. Based on mean performance and stability parameters, Phule Yashomati, Phule Anuradha, and Phule Uttara were identified as stable and widely adaptable genotypes suitable for variable rabi conditions. These genotypes can be recommended for inclusion in breeding programs and large-scale cultivation under rainfed and limited irrigation systems.

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