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Performance evaluation of brown top millet (*Brachiaria ramosa* L.) genotypes under rainfed upland ecology of the Bastar plateau of Chhattisgarh

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ABSTRACT: Brown top millet (*Brachiaria ramosa* L.) is an underutilized, climate-resilient cereal with considerable potential for enhancing food, nutritional, and fodder security in rainfed production systems. However, information on the performance of improved genotypes under the rainfed upland ecology of the Bastar Plateau of central India remains limited. The present study evaluated eight advanced genotypes and one local check during Kharif 2025 at Shaheed Gundadhur College of Agriculture and Research Station, Jagdalpur, using a randomized block design with three replications under natural rainfall conditions. Significant ($P < 0.05$) genotypic differences were observed for phenological, morphological, and productivity-related traits, indicating substantial genetic variability for selection. Days to 50% flowering ranged from 57 to 59 days, while maturity varied from 88 to 90 days. Grain yield ranged from 910 to 1418 kg ha⁻¹, and fodder yield from 3704 to 4660 kg ha⁻¹. TNBr 018 recorded the highest grain yield (1418 kg ha⁻¹), representing a 48.3% yield advantage over the local check, whereas TNBr 017 produced the highest fodder yield (4660 kg ha⁻¹) while maintaining high grain productivity (1356 kg ha⁻¹). The favourable seasonal rainfall (1476.1 mm over 68 rainy days) enabled reliable assessment of genotype performance under representative rainfed conditions. Based on overall agronomic performance, TNBr 018 was identified as the most promising genotype for grain production, whereas TNBr 017 showed superior dual-purpose potential. These genotypes warrant further multi-location evaluation and may serve as valuable genetic resources for developing climate-resilient brown top millet cultivars for rainfed agroecosystems.

Keywords: Bastar Plateau Brown top millet, Climate-resilient crops, Genotype evaluation, Rainfed upland ecology

Millets have historically played a significant role in ensuring food and nutritional security in semi-arid and rainfed regions of Asia and Africa. Owing to their ability to thrive under marginal environments, low-fertility soils and erratic rainfall conditions, these crops are increasingly recognized as climate-smart cereals for sustainable agriculture (Baltensperger, 2002; Goron and Raizada, 2015; FAO, 2023). The declaration of 2023 as the International Year of Millets by the Food and Agriculture Organization (FAO) has renewed global interest in promoting both major and minor millet species for resilient food systems and sustainable agricultural diversification (FAO, 2023). Brown top millet (*Brachiaria ramosa* L.) is one of the oldest but least explored millet crops cultivated primarily in southern India. The crop is characterized by rapid growth, short duration (80–100 days), efficient water-use efficiency, drought tolerance and adaptability to poor soils (Goron and Raizada, 2015; Singh *et al.*, 2022; Bhavani *et al.*, 2024). Brown top millet grains are rich in dietary fibre, iron, calcium and essential micronutrients, making them suitable

for addressing malnutrition and hidden hunger among resource-poor populations (Dayakar Rao *et al.*, 2018 ; Nithyanantham *et al.*, 2019). Furthermore, the crop produces substantial fodder biomass and therefore contributes significantly to integrated crop–livestock farming systems in dryland agriculture (Verma *et al.*, 2020; Kumar *et al.*, 2021a).

The Bastar Plateau of Chhattisgarh represents one of the major rainfed agro-ecological regions of central India. Agriculture in this region is predominantly dependent on monsoon rainfall and is characterized by low-input farming, undulating topography, and acidic soils. Frequent dry spells during critical crop growth stages often limit the productivity of conventional cereals such as rice and maize under upland situations (Kumar *et al.*, 2021b; Choudhary *et al.*, 2023). Under such conditions, brown top millet offers a promising alternative because of its inherent drought tolerance, short crop duration, and ability to produce stable yields under moisture-stress environments (Singh *et al.*, 2022; Bhavani *et al.*, 2024). Despite its considerable

potential for enhancing food, nutritional and fodder security, systematic evaluation of brown top millet genotypes under the rainfed upland ecology of the Bastar Plateau remains limited. Identification of high-yielding and well-adapted genotypes suitable for local agro-climatic conditions is therefore essential for promoting the crop among tribal and smallholder farming communities. Evaluation of genetic variability for yield and associated agronomic traits provides the foundation for identifying superior genotypes and developing climate-resilient cultivars adapted to rainfed production systems (Ceccarelli *et al.*, 2009; Choudhary *et al.*, 2023). Similar observations under Bastar Plateau conditions have been reported in finger millet and upland rice, where substantial genetic variability and adaptation differences among genotypes were documented (Kumar *et al.*, 2015; Kumar *et al.*, 2021a). Keeping these considerations in view, the present investigation was undertaken to: (a) evaluate the performance of brown top millet genotypes under rainfed upland ecology of the Bastar Plateau, (b) assess variability for yield and related agronomic traits, (c) identify promising dual-purpose genotypes suitable for grain and fodder production.

MATERIALS AND METHODS

Experimental Site

The field experiment was conducted during Kharif 2025 at the Research Farm of Shaheed Gundadhur College of Agriculture and Research Station (SGCARS), Jagdalpur, Chhattisgarh, India. The station is located in the Bastar Plateau Agro-climatic Zone at approximately 19.08°N latitude and 82.03°E longitude with an altitude of about 552 m above mean sea level. The climate of the region is humid tropical with an average annual rainfall of approximately 1300–1500 mm, most of which is received during the southwest monsoon season (June–September). The experimental soil was sandy loam to lateritic in texture, moderately acidic in reaction and low to medium in available nitrogen, phosphorus and potassium.

Weather Conditions During Crop Growth

The crop was sown during the last week of June and

harvested during September–October. Weather conditions during the crop season were generally favourable. A total rainfall of 1476.1 mm was received during the cropping period over 68 rainy days. July received the highest rainfall (550.7 mm), followed by August (501.1 mm). Mean maximum temperature ranged from 28.5 to 31.4°C, whereas mean minimum temperature ranged from 22.0 to 22.6°C. Relative humidity remained above 90% during most of the crop season.

Experimental Materials, Experimental Design and Crop Management

The present investigation was conducted using eight brown top millet (*Brachiaria ramosa* L.) genotypes along with one local check to assess their performance under the rainfed upland ecology of the Bastar Plateau. The genotypes evaluated were TNBr 017, TNBr 018, DHBT 8-3, IIMR BTMC-2023, VBT 031, SHBTM-1, GPUTB-6, HBr 2 and the Local Check. The materials were received from PC Unit, AICRP Sorghum and Small Millets, IIMR, Hyderabad. These entries represented a diverse range of genetic backgrounds and were selected for evaluation of their adaptability, productivity and agronomic performance under local environmental conditions. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The plot size was maintained at 4.5x3.0m; as SOPs of small millets crop. Each genotype was grown under uniform management practices to ensure a fair comparison of performance. The crop was sown during the last week of June 2025 under rainfed upland conditions prevailing in the Bastar Plateau agro-climatic zone of Chhattisgarh. Recommended agronomic practices for millet cultivation were followed throughout the crop growth period. Necessary intercultural operations, including weeding and field maintenance, were carried out at appropriate stages of crop growth. Plant protection measures were adopted whenever required to safeguard the crop from pests and diseases. The entire experiment was dependent on natural rainfall without supplemental irrigation, thereby providing suitable conditions for evaluating genotype performance under typical rainfed farming situations.

Observations Recorded and Statistical Analysis

Data were recorded on important phenological, morphological and productivity-related traits to assess the performance of brown top millet genotypes under rainfed upland conditions. Observations included days to 50% flowering, days to maturity, plant height (cm), productive tillers per plant, fodder yield (kg ha⁻¹), grain yield (kg ha⁻¹) and 1000-seed weight (g). Days to 50% flowering and days to maturity were recorded on a plot basis, while plant height and productive tillers were measured from representative plants selected from each plot. Grain and fodder yields were recorded at harvest and subsequently converted to kilogram per hectare values. Thousand-seed weight was determined by weighing a random sample of 1000 well-filled seeds from each genotype. The recorded data were subjected to statistical analysis to determine the significance of genotypic differences. Analysis of variance (ANOVA) was performed following the procedure described by Gomez and Gomez (1984). The significance of treatment effects was tested using the F-test at appropriate probability levels. Whenever significant differences among genotypes were detected, mean comparisons were made using Critical Difference (CD) values at 5% and 1% levels of significance. The statistical analysis facilitated the identification of superior genotypes and assessment of the extent of variability present among the tested entries under the rainfed agro-ecological conditions of the Bastar Plateau.

RESULTS AND DISCUSSION

Weather Conditions During Crop Growth

The crop was established successfully following sowing during the last week of June 2025 under rainfed upland conditions of the Bastar Plateau. Weather conditions during the cropping season were generally favourable and supported normal crop growth and development. A total rainfall of 1476.1 mm was received during the crop period, distributed over 68 rainy days, ensuring adequate soil moisture availability throughout the growing season (Table 1). The highest monthly rainfall was recorded during July (550.7 mm), followed by August (501.1 mm), which coincided with the active vegetative growth,

tillering and reproductive phases of the crop. September received 287.3 mm rainfall, providing sufficient moisture during grain-filling and maturity stages. The relatively uniform distribution of rainfall minimized the occurrence of prolonged moisture stress and contributed to stable crop growth under rainfed conditions. The mean maximum temperature during the season ranged from 28.5 to 31.4°C, while the mean minimum temperature varied between 22.0 and 22.6°C. Such temperature conditions are considered favourable for millet growth, promoting efficient photosynthetic activity, biomass accumulation, and grain development. Relative humidity remained high throughout the season, exceeding 90% during most months, which further facilitated vigorous vegetative growth and enhanced crop establishment. The moderate evaporative demand and adequate sunshine hours also supported efficient utilization of available moisture and sustained physiological activity throughout the crop growth period.

The favourable interaction of rainfall, temperature, and humidity created an ideal environment for evaluating the genetic potential of the tested brown top millet genotypes. Adequate rainfall during critical growth stages ensured uninterrupted crop development, while the prevailing thermal regime supported efficient assimilate production and partitioning. Similar observations regarding the adaptability, productivity, and resilience of millet crops under rainfed agroecosystems have been reported by Baltensperger (2002), Goron and Raizada (2015); Kheya *et al.* (2023) and Bhavani *et al.*, 2024, who emphasized the ability of small millets to perform well under marginal environments and variable rainfall conditions. Saleh *et al.* (2013) further highlighted the suitability of millets for low-input production systems owing to their efficient resource utilization and stress tolerance. Studies by Nithiyanantham *et al.* (2019) and Vetriventhan *et al.* (2020) also demonstrated that favourable moisture availability and moderate temperatures play a crucial role in realizing the yield potential of millet crops under rainfed cultivation. Therefore, the weather conditions prevailing during the present investigation provided a reliable basis for assessing

Table 1: Weather parameters during crop growth period at Jagdalpur during Kharif 2025

Month	Maximum temperature (°C)	Minimum temperature (°C)	Rainfall (mm)	Rainy days
June	31.4	22.6	137.0	11
July	28.5	22.1	550.7	20
August	29.8	22.3	501.1	16
September	30.7	22.0	287.3	21
Total/Mean	30.1	22.2	1476.1	68

Note. Total is shown for rainfall and rainy days; mean is shown for maximum and minimum temperature

Table 2: Mean performance of brown top millet genotypes for phenological, morphological and productivity traits under rainfed upland conditions of the Bastar Plateau

Genotype	DF	DM	PH (cm)	Tillers plant ⁻¹	TW (g)	Grain Yield (kg ha ⁻¹)	Fodder Yield (kg ha ⁻¹)
TNBr 017	56.67	89.67	107.20	4.33	3.44	1356.48	4660.49
TNBr 018	57.00	88.33	108.40	4.67	3.39	1417.59	4567.90
DHBT 8-3	57.67	89.33	106.40	4.33	3.39	1089.81	4506.17
IIMR BTMC-2023	59.00	88.33	104.07	5.00	3.35	1218.52	4506.17
VBT 031	58.67	88.67	110.00	5.33	3.39	910.49	3703.70
SHBTM-1	57.67	88.33	98.20	4.33	3.46	1112.96	4166.67
GPUBT-6	57.33	89.00	102.33	4.33	3.35	1216.67	4506.17
HBr 2	57.00	88.00	107.40	5.00	3.34	1198.15	4413.58
Local Check	57.00	89.00	103.60	4.67	3.39	956.48	3919.75
Mean	57.56	88.74	105.29	4.67	3.39	1164.13	4327.84
CV (%)	1.21	1.35	5.97	12.81	2.46	6.93	5.66
CD (P=0.05)	1.13	1.94	10.18	0.97	0.13	130.66	397.20
CD (P=0.01)	1.50	2.56	13.48	1.28	0.18	172.98	525.83

Note. NR = exact genotype-wise value not reported in the provided manuscript text. Mean and range are taken from the manuscript narrative

genotype performance and identifying superior brown top millet genotypes suitable for cultivation in the rainfed upland ecology of the Bastar Plateau.

Phenological Performance

Significant variability was observed among the evaluated brown top millet genotypes for days to 50% flowering and days to maturity, indicating the presence of exploitable genetic differences for crop duration and adaptation under rainfed upland conditions of the Bastar Plateau (Table 2). Days to 50% flowering ranged from 57 to 59 days with an overall mean of 58 days. Genotypes TNBr 017, TNBr 018, GPUBT-6, HBr 2 and the Local Check were the earliest flowering entries, attaining 50% flowering in 57 days, whereas IIMR BTMC-2023 and VBT 031 flowered comparatively later (59 days). The relatively narrow variation in flowering duration suggests that all genotypes were well adapted to the prevailing agro-climatic conditions while still providing opportunities for selection

Table 3: Yield superiority of promising brown top millet genotypes over the local check

Genotype	Grain yield (kg ha ⁻¹)	Yield advantage over local check (%)
TNBr 018	1418	48.3
TNBr 017	1356	41.8
IIMR BTMC-2023	1219	27.5
GPUBT-6	1217	27.3
HBr 2	1198	25.3

Note. Yield advantage was calculated relative to the local check (956 kg ha⁻¹)

based on earliness. Similar variability for flowering behaviour among millet genotypes has been reported in diverse germplasm collections, reflecting the importance of phenological adaptation in crop improvement programmes (Dwivedi *et al.*, 2011; Vetriventhan *et al.* (2020). Days to maturity varied from 88 to 90 days with a location mean of 89 days. TNBr 018, SHBTM-1, IIMR BTMC-2023 and HBr 2 matured earliest (88 days), whereas TNBr 017 required 90 days to reach physiological maturity.

Table 4: Classification of brown top millet genotypes based on breeding utility and production objectives

Category	Genotypes	Key characteristics	Potential use
High-yielding	TNBr 018, TNBr 017	Superior grain productivity	Variety development
Dual-purpose	TNBr 017, TNBr 018, IIMR BTMC-2023, GPUBT-6	High grain and fodder yield	Crop-livestock systems
Early-maturing	TNBr 018, SHBTM-1, HBr 2, IIMR BTMC-2023	Maturity within 88 days	Drought-prone areas
High biomass	TNBr 017, TNBr 018	Superior fodder production	Fodder improvement
Large-seeded	SHBTM-1, TNBr 017	Higher 1000-seed weight	Grain quality improvement

Note. Classification is based on overall performance under rainfed upland conditions during Kharif 2025

Early maturity is an important adaptive trait in rainfed upland ecosystems where crops frequently encounter declining soil moisture during the terminal stages of crop growth. Genotypes with shorter crop duration are better able to escape terminal drought, stabilize productivity, and fit efficiently into diverse cropping systems. Moreover, early maturity facilitates timely sowing of succeeding crops and enhances overall cropping system efficiency. The significance of earliness and drought escape mechanisms in millet adaptation has been emphasized by Yadav *et al.* (2012), Rai *et al.* (2013) and Bibas *et al.* (2026).

The superior performance of TNBr 018 is particularly noteworthy because it combined early maturity with the highest grain yield, indicating efficient utilization of available resources and favourable adaptation to the Bastar Plateau environment. The association between optimum crop duration and enhanced productivity has been widely documented in small millets and other dryland cereals, where phenological traits strongly influence resource-use efficiency and yield stability under rainfed conditions (Bidinger *et al.*, 2007; Serba and Yadav, 2016; Muthamilarasan and Prasad, 2021). The observed variability in flowering and maturity duration therefore offers valuable opportunities for identifying climate-resilient brown top millet genotypes suitable for cultivation in the rainfed upland agroecosystems of central India.

Plant Architecture and Tillering Behaviour

Plant height and productive tillering are important agronomic traits influencing biomass production, photosynthetic efficiency and ultimately crop productivity in small millets. Significant differences were observed among the evaluated brown top millet genotypes for both traits, indicating the presence of substantial genetic variability under the rainfed upland conditions of the Bastar Plateau (Table 2). Plant height ranged from 98 to 110 cm with a population mean of 105 cm. Among the tested genotypes, VBT 031 produced the tallest plants (110 cm), followed by TNBr 018 (108 cm), TNBr 017 and HBr 2 (107 cm). In contrast, SHBTM-1 recorded the shortest plant stature (98 cm). Taller plants generally contribute to increased biomass accumulation and fodder yield, particularly under rainfed production systems where vegetative growth plays an important role in overall crop performance. Productive tillers per plant ranged from 4.3 to 5.3 with an overall mean of 4.7. The highest number of productive tillers was recorded by VBT 031 (5.3), followed by IIMR BTMC-2023 and HBr 2 (5.0). However, despite exhibiting superior tillering ability, VBT 031 did not produce the highest grain yield, indicating that productive tiller number alone is not sufficient to determine final productivity. This suggests the involvement of other physiological and yield-contributing factors such as panicle development, source-sink relationship and assimilate partitioning efficiency (Verma *et al.*, 2020; Kumar *et al.*, 2023).

The superior grain performance of TNBr 018, despite having moderate tillering ability, highlights the importance of efficient conversion of biomass into economic yield. Similar observations have been reported in finger millet and

other small millet crops, where plant height and tillering contributed significantly to biomass production but showed variable relationships with grain yield depending on genotype and environmental conditions (Dayakar Rao *et al.*, 2018; Kumar *et al.*, 2021a; Choudhary *et al.*, 2023; Bhavani *et al.*, 2024). Similar relationships among plant architecture, biomass production and yield were reported in finger millet under Bastar Plateau conditions, where productive tillers and vegetative vigour contributed significantly to overall productivity (Kumar *et al.*, 2020).

Grain Productivity and Genotypic Performance

Grain yield represents the cumulative outcome of genetic potential, environmental influences, and their interaction, and is therefore considered the most important criterion for assessing genotype performance and adaptation. In the present investigation, grain yield exhibited highly significant variation among the evaluated brown top millet genotypes, indicating the existence of substantial exploitable genetic variability under the rainfed upland conditions of the Bastar Plateau (Table 2). Such variability is of considerable importance for crop improvement programmes because it provides opportunities for selection of superior genotypes possessing enhanced productivity and adaptation to moisture-limited environments (Dwivedi *et al.*, 2011; Muthamilarasan and Prasad, 2021). The grain yield ranged from 910 to 1418 kg ha⁻¹ with an overall mean of 1164 kg ha⁻¹. Among the tested entries, TNBr 018 emerged as the highest-yielding genotype with a grain yield of 1418 kg ha⁻¹, followed by TNBr 017 (1356 kg ha⁻¹), IIMR BTMC-2023 (1219 kg ha⁻¹), GPUBT-6 (1217 kg ha⁻¹) and HBr 2 (1198 kg ha⁻¹). In contrast, VBT 031 recorded the lowest grain yield (910 kg ha⁻¹), followed by the local check (956 kg ha⁻¹). The superior performance of TNBr 018 translated into a yield advantage of 48.3% over the local check, while TNBr 017 exhibited a corresponding advantage of 41.8% (Table 3). Similarly, IIMR BTMC-2023, GPUBT-6, and HBr 2 outperformed the local check by 27.5%, 27.3%, and 25.3%, respectively. Such substantial differences among genotypes indicate differential efficiency in resource acquisition and utilization under rainfed

conditions, which has been recognized as a key determinant of productivity in small millet crops (Bidinger *et al.*, 2007; Serba and Yadav, 2016).

The outstanding grain productivity of TNBr 018 may be attributed to its favourable combination of agronomic traits, including early maturity, optimum flowering duration, desirable plant architecture, and efficient assimilate partitioning towards grain production. Although certain genotypes exhibited greater tillering ability or taller plant stature, their grain yields were comparatively lower, suggesting that biomass production alone is insufficient for achieving superior productivity. Rather, efficient translocation of photosynthates from source tissues to developing grains and a favourable harvest index appear to have played a decisive role in determining yield performance (Rai *et al.*, 2013; Sheoran *et al.*, 2024). The superior performance of TNBr 018 and TNBr 017 further demonstrates the importance of combining earliness with productivity under rainfed ecosystems. Early and medium-duration genotypes are often able to avoid terminal moisture stress, thereby maintaining grain filling and yield stability under variable rainfall conditions. Previous studies have emphasized that adaptation to drought-prone environments depends not only on biomass accumulation but also on phenological adjustment, efficient water-use patterns and effective partitioning of assimilates towards reproductive structures (Blum, 2011; Serba and Yadav, 2016; Muthamilarasan and Prasad, 2021). The ability of TNBr 018 to combine early maturity with high grain productivity therefore represents a desirable ideotype for rainfed cultivation.

Biomass Accumulation and Fodder Productivity

Fodder yield is an important component of productivity in rainfed farming systems, particularly in the tribal regions of Bastar, where crop–livestock integration plays a vital role in sustaining rural livelihoods. In addition to providing grain for household consumption, millet crops serve as an important source of green and dry fodder during periods of feed scarcity. Therefore, identification of genotypes combining high biomass production with acceptable grain yield is essential for developing

dual-purpose cultivars adapted to upland agroecosystems (Blümmel *et al.*, 2009; Satyavathi *et al.*, 2021). Significant differences were observed among the evaluated genotypes for fodder yield, indicating substantial genetic variability for biomass production under rainfed conditions (Table 2). Fodder yield ranged from 3704 to 4660 kg ha⁻¹ with an overall mean of 4328 kg ha⁻¹. Among the tested entries, TNBr 017 recorded the highest fodder yield (4660 kg ha⁻¹), followed by TNBr 018 (4568 kg ha⁻¹), whereas VBT 031 produced the lowest fodder yield (3704 kg ha⁻¹). Despite exhibiting the highest plant height and productive tiller number, VBT 031 failed to produce higher biomass, suggesting that fodder productivity depends not only on plant stature but also on dry matter accumulation and growth efficiency. Similar observations have been reported in millet improvement programmes where biomass production was influenced by the combined effects of plant architecture and physiological efficiency (Sheoran *et al.*, 2024; Akplo *et al.*, 2023).

The superior fodder productivity of TNBr 017 may be attributed to its favourable plant architecture and efficient biomass accumulation. Notably, TNBr 017 also recorded the second-highest grain yield, demonstrating its potential as a dual-purpose genotype capable of meeting both food and fodder requirements. Such genotypes are particularly valuable in smallholder farming systems where total biological productivity is often more important than grain yield alone (Yadav *et al.*, 2021; Muthamilarasan and Prasad, 2021). The present findings highlight the importance of simultaneous selection for grain and fodder yield in brown top millet improvement. TNBr 017 and TNBr 018 emerged as promising dual-purpose genotypes and may serve as valuable breeding materials for developing climate-resilient cultivars suitable for the Bastar Plateau and similar rainfed agroecological regions.

Seed Weight and Grain Characteristics

Significant variation was observed among the evaluated brown top millet genotypes for 1000-seed weight, indicating the existence of genetic diversity for grain size and grain filling efficiency under

rainfed upland conditions of the Bastar Plateau (Table 2). Thousand-seed weight ranged from 3.34 to 3.46 g with a location mean of 3.39 g. Among the tested genotypes, SHBTM-1 recorded the highest 1000-seed weight (3.46 g), followed closely by TNBr 017 (3.44 g), whereas HBr 2 exhibited the lowest value (3.34 g). Although the range of variation was relatively narrow, the observed differences suggest the presence of useful variability that can be exploited in breeding programmes aimed at improving grain quality and seed characteristics. Seed weight is an important yield component because it reflects the efficiency of grain filling and assimilate accumulation during the reproductive phase of crop growth. Genotypes possessing higher seed weight generally exhibit improved seedling vigour, enhanced crop establishment and better grain quality, which are often preferred by farmers and consumers. In addition, heavier grains contribute positively to processing quality and market acceptability, thereby increasing the economic value of the crop (Bhavani *et al.*, 2024).

Despite recording the highest seed weight, SHBTM-1 did not produce the highest grain yield, indicating that grain productivity is governed by the cumulative interaction of several yield-contributing traits rather than seed weight alone. In contrast, TNBr 018 and TNBr 017 achieved superior grain yields through a favourable combination of phenological adaptation, biomass production and efficient assimilate partitioning. Similar observations have been reported in millet crops where grain yield is influenced by the coordinated expression of multiple morphological, physiological and yield-attributing traits (Singh *et al.*, 2022; Choudhary *et al.*, 2023). Therefore, 1000-seed weight should be considered an important supportive trait rather than a sole selection criterion while developing high-yielding and well-adapted brown top millet cultivars for rainfed agroecosystems.

Identification of Superior Genotypes and Breeding Implications

The evaluation of brown top millet genotypes under the rainfed upland ecology of the Bastar Plateau revealed considerable variation for grain yield,

fodder yield, maturity duration and associated agronomic traits, indicating substantial scope for selection and genetic improvement. Such variability is a prerequisite for breeding programmes aimed at developing cultivars adapted to drought-prone and resource-constrained production environments. Based on overall performance, the evaluated genotypes could be grouped according to their potential utilization in breeding and production systems. The high-yielding group comprised TNBr 018 and TNBr 017, which consistently recorded superior grain productivity and demonstrated efficient adaptation to the prevailing agroecological conditions (Table 04). The dual-purpose group included TNBr 017, TNBr 018, IIMR BTMC-2023 and GPUBT-6, which combined relatively high grain yield with substantial fodder production. Such genotypes are particularly valuable in the tribal farming systems of Bastar, where crop–livestock integration is a major component of livelihood security. Simultaneous improvement in grain and biomass productivity can enhance food availability, fodder supply and overall farm resilience (Blümmel *et al.*, 2009; Satyavathi *et al.*, 2021; Sheoran *et al.*, 2024).

The early-maturing group consisted of TNBr 018, SHBTM-1, HBr 2 and IIMR BTMC-2023, which completed their life cycle within 88 days and are therefore suitable for areas prone to terminal moisture stress. Early-maturing genotypes are particularly desirable in rainfed ecosystems because they facilitate drought escape, improve yield stability and provide greater flexibility in cropping systems (Muthamilarasan and Prasad, 2021). Among all entries, TNBr 018 emerged as the most promising genotype owing to its highest grain yield (1418 kg ha⁻¹), early maturity and superior adaptation, while TNBr 017 was identified as the best dual-purpose genotype because of its highest fodder yield (4660 kg ha⁻¹) coupled with high grain productivity. The combination of earliness, productivity and biomass production observed in these genotypes represents desirable attributes for developing climate-resilient millet ideotypes suited to rainfed agriculture. Similar multi-trait selection approaches have been advocated in millet improvement programmes for identifying

superior breeding stocks and enhancing adaptation to variable environments (Baltensperger, 2002; Dwivedi *et al.*, 2011; Vetriventhan and Upadhyaya, 2018; Sheoran *et al.*, 2024). Therefore, TNBr 018 and TNBr 017 warrant further multi-location and multi-season evaluation and may serve as valuable genetic resources for future brown top millet breeding programmes.

CONCLUSION

The present investigation demonstrated the considerable potential of brown top millet for cultivation under the rainfed upland ecology of the Bastar Plateau of Chhattisgarh. Significant variability was observed among the evaluated genotypes for phenological, morphological and productivity-related traits, indicating the availability of useful genetic diversity for selection and crop improvement. Such variability provides opportunities for identifying superior genotypes adapted to the resource-constrained and moisture-limited production environments prevalent in the region. Among the tested entries, TNBr 018 emerged as the most promising genotype, recording the highest grain yield (1418 kg ha⁻¹), early maturity (88 days) and desirable agronomic characteristics. The genotype exhibited a yield advantage of 48.3% over the local check, highlighting its superior adaptation and productivity under rainfed conditions. TNBr 017 recorded the highest fodder yield (4660 kg ha⁻¹) along with the second-highest grain yield (1356 kg ha⁻¹), demonstrating its potential as an excellent dual-purpose genotype capable of fulfilling both food and fodder requirements. Genotypes such as IIMR BTMC-2023 and GPUBT-6 also exhibited favourable performance and may serve as useful breeding materials for future improvement programmes.

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