

Research Article

## Performance of Brown top millet (*Brachiaria ramosa* L.) grown under problematic soils

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**Abstract**

Brown top millet distinguishes itself as unique due to its elevated levels of protein, carbohydrates, crude fibre, calcium, iron, and dietary fibre. Recently, it has gained recognition among various little millets for its significant potential to thrive in resource-poor and vulnerable ecological conditions. The present study was undertaken to evaluate the performance of this emerging Brown top millet in diverse and challenging soils prevalent in Tamil Nadu. The assessment primarily focused on its growth, yield, and yield attributes in these diverse soil environments. The pot experiment was conducted in the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, during the *Kharif* 2023 season. Five problematic soils were collected from various zones in Tamil Nadu and compared with the millet-growing soils of TNAU, Coimbatore (Control), and tested in a randomized complete block design with four replications. Brown top millet's growth, yield, and yield attributes were calculated using the standard formula. The study revealed that the treatment of acidic soils of Annaikatti, Coimbatore district recorded significantly higher plant height (105.5 cm), Leaf area index (LAI) (2.13), Soil Plant Analysis Development chlorophyll meter value (28.5), dry matter production (26.68 g plant<sup>-1</sup>), number of effective tillers plant<sup>-1</sup> (8.0), panicle length (17.6 cm), panicle weight (14 g), grain yield (12.7 g plant<sup>-1</sup>), and test weight (3.3 g) and found comparable with sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control). The lowest values were recorded with the sodic soils of ADAC& RI, Trichy. The present study concluded that the Brown top millet has shown its adaptability to acidic and moderate saline soils and could perform better with effective management strategies.

**Keywords:** Brown top millet, Growth, Problematic soils, Yield

**INTRODUCTION**

Brown top millet (*Brachiaria ramosa* L.), a member of the Poaceae family, is known by various names such as pedda-sama, korne, korale in Kannada, and Andu korralu in Telugu. Originally hailing from Southeast Asia, this resilient millet crop is traditionally cultivated

along the border regions of Karnataka and Andhra Pradesh, mainly for food and fodder. Historical evidence suggests that it played a significant role as a staple crop in the late pre-history of the Deccan region (Singh *et al.*, 2022). Brown top millet distinguishes itself from other millet types by its capacity to tolerate shade and thrive in partially shaded conditions from sea level to

2450 m above MSL. Due to its short growth period and ability to tolerate shade, it can be cultivated as a catch, cover, and nurse crop (Maitra, 2020). Grains are rich in protein (11.5 g/100 g of grains), dietary fiber (12.5 g/100 g of grains), and minerals (4.2 g/100 g of grains) (IIMR, 2019). Problematic soils refer to soils with characteristics or properties that can pose challenges or difficulties for agricultural activities. These challenges may arise due to the soil's physical, chemical, or biological characteristics, making it less suitable for the cultivation of crops. Globally, challenging soils exist in diverse locations, and gaining insights into their characteristics is essential for effective farming. Some millet crops, such as pearl millet (*Pennisetum glaucum*) and finger millet (*Eleusine coracana*), have shown resilience to saline soils and acidic soils, respectively (Singh *et al.*, 2024). A notable characteristic of Browntop millet is its capacity to flourish in various soil conditions, rendering it suitable for cultivation in marginal lands (Agarwal, 2023). However, there is currently no research evidence regarding the impact of challenging soils on the performance of Brown top millet. Since the information on such study is meagre, this research experiment was conducted to investigate the performance of this traditionally cultivated, underutilized Brown top millet crop on different problematic soils to analyze the impact of the soil conditions on the growth, yield, and yield attributes.

## MATERIALS AND METHODS

### Study area

Soils were collected from five distinct problematic locations within the upper 30 cm layer of fields across various regions of Tamil Nadu and compared with millet-growing soils of TNAU, Coimbatore (Control). This comparative analysis was part of a pot experiment conducted during the *Kharif* season of 2023 (June-September) at the Department of Agronomy, Tamil Nadu Agricultural University (TNAU), Coimbatore. Each pot size 8 inches large (20 cm length x 22.5 cm top diameter x 18 cm base diameter) was filled with 6 kg of air-dried soil and arranged in a randomized complete block design with 6 treatments and four replications. The specific locations from where the soils were collected are given as treatments viz., T<sub>1</sub>- Sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control); T<sub>2</sub>- Heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district; T<sub>3</sub>- Acidic soils of Annaikatti, Coimbatore district; T<sub>4</sub>- Coastal saline soils of Cuddalore district; T<sub>5</sub>- Waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district; T<sub>6</sub>- Sodic soils of ADAC & RI, Trichy district.

The physical properties of initial soil samples were tested by Robinson's International Pipette method (Piper,

1966). The pH and EC of the soil were determined in 1:2.5 soil-water suspension using an Elico pH meter with a glass electrode and electrical conductivity meter respectively as described by Jackson (1973). The organic carbon of the soil sample was determined by using the wet digestion method (Walkley and Black, 1934). The available N, P, and K of the initial soil sample were determined by the alkaline KMnO<sub>4</sub> method as suggested by Subbiah and Asija (1956), Olsen's extractant method by Olsen *et al.* (1954), and neutral normal ammonium acetate method by using a flame photometer by Jackson (1973) respectively. The results are given in Table 1. Each pot was planted with 20 Brown top millet seeds on the soil surface, covered with a thin layer of soil and later thinned to 1 pot<sup>-1</sup>. The Brown top millet variety GPUBT-6, which had a duration of 80-90 days, was used in the experiment. No fertilizers were supplied to pots to assess the impact of stress induced by unfavourable soil conditions on brown top millet production. Irrigation was provided as needed.

The crop was harvested at the physiological maturity of the crop. Plant height (cm), LAI, SPAD, dry matter production (g plant<sup>-1</sup>), number of effective tillers plant<sup>-1</sup>, panicle length (cm), panicle weight (g), grain yield (g plant<sup>-1</sup>) and test weight (g) were accounted for at the maturity stage with standard procedure.

The collected data were subjected to statistical analysis using AgRes statistical software (Gomez and Gomez, 2010).

## RESULTS AND DISCUSSION

### Soil characteristics

The physical and chemical properties of the soil used in this trial are shown in Table 1. The texture of soil collected from Eastern Block 37B, TNAU, Coimbatore (Control) (T<sub>1</sub>), and the sodic soils of Anbil Dharmalingam Agricultural College & Research Institute (ADAC & RI), Trichy district (T<sub>6</sub>) were characterized as sandy clay loam. In contrast, the acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>), and the waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district displayed a clay loam texture. The soil pH varied from neutral to saline (7.3-8.5), except for the soils of Annaikatti, Coimbatore district (T<sub>3</sub>), with a pH of 5.65, which was acidic, and the soils of ADAC & RI, Trichy district (T<sub>6</sub>), with a pH of 8.92 which was alkaline. The electrical conductivity levels of the soils ranged from 0.22 to 2.4 dSm<sup>-1</sup> (Table 1). The organic carbon in content sodic soils of ADAC & RI, Trichy district (T<sub>6</sub>) was identified as low. Conversely, it was elevated in the sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control) (T<sub>1</sub>), and the acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>). The available nitrogen level in the sodic soils of ADAC & RI, Trichy (T<sub>6</sub>)

district was low. In contrast, they are of moderate levels in the sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control) (T<sub>1</sub>). Moreover, the available nitrogen content was high in the acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>). The available phosphorus levels in the soils obtained from the sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control) (T<sub>1</sub>), and acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>) showed elevated concentrations. All the soils used in this study exhibited elevated levels of available potassium, except the sodic soils gathered from ADAC& RI, Trichy district (T<sub>6</sub>), which showed a moderate level (Table 1).

### Plant height and dry matter production

The experimental results indicated that different challenging soils significantly influenced the plant height (cm) and dry matter production (g plant<sup>-1</sup>) of Brown top millet. The plant height (105.5 cm), and dry matter production (26.68 g plant<sup>-1</sup>) observed with the acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>) was significantly higher over sodic soils of ADAC& RI, Trichy district (T<sub>6</sub>), waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district (T<sub>5</sub>), coastal saline soils of Cuddalore district (T<sub>4</sub>), and heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district (T<sub>3</sub>). However, the differences in plant height and dry matter production among the treatments T<sub>3</sub>, and T<sub>1</sub>, viz., acidic soils of Annaikatti, Coimbatore district, and sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control) were found to non-

significant (Table 2). The increase in both the plant height and dry matter accumulation of Brown top millet in the acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>) could be ascribed to the elevated initial nutrient levels in the acidic soils, which might have a positive influence on cell division and enlargement, ultimately reflected in overall increased in plant growth. Bashir *et al.* (2022) documented similar outcomes, which showed a substantially increased number of leaves (41.5), in conjunction with a nutrient-rich soil profile without the application of fertilizers in acidic soils. The lowest plant height (67.8 cm) and dry matter production (19.68 g plant<sup>-1</sup>) were noticed with the sodic soils of ADAC & RI, Trichy district (T<sub>6</sub>) due to the presence of poor structure, high exchangeable sodium levels, and nutrient imbalances.

### Leaf Area Index (LAI) and Soil Plant Analysis Development (SPAD) chlorophyll value

Significantly the higher SPAD value (28.5) and LAI (2.13) were recorded in acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>) over sodic soils of ADAC & RI, Trichy district (T<sub>6</sub>), waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district (T<sub>5</sub>), coastal saline soils of Cuddalore district (T<sub>4</sub>), and heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district (T<sub>3</sub>). However, it was found to be on par with the sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control) (T<sub>1</sub>) (Table 2). The increase in the SPAD and leaf area index of Brown top millet in the acidic soils of Annaikatti,

**Table.1** Physico-chemical properties of soils used in the experiment

Treatments	Textural class	Physical properties				Chemical properties				
		Sand %	Silt %	Clay %	pH	EC (dSm <sup>-1</sup> )	OC %	N kg ha <sup>-1</sup>	P kg ha <sup>-1</sup>	K kg ha <sup>-1</sup>
T <sub>1</sub> : Sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control)	Sandy clay loam	53.6	16.9	29.1	8.2	0.23	0.93	254	31.5	566
T <sub>2</sub> : Heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district	Clay	10.2	19.2	70.5	8.3	0.42	0.92	290	32.5	368
T <sub>3</sub> : Acidic soils of Annaikatti, Coimbatore district	Clay loam	33.5	27.8	38.6	5.65	0.40	3.84	568	28.6	585
T <sub>4</sub> : Coastal saline soils of Cuddalore district	Sandy loam	65.0	16.8	18.2	8.5	2.4	0.46	220	16.5	324
T <sub>5</sub> : Waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district	Clay loam	38.2	15.3	46.5	7.8	0.58	0.48	210.5	12.8	418
T <sub>6</sub> : Sodic soils of ADAC& RI, Trichy district	Sandy clay loam	66.3	13.4	20.2	8.92	0.22	0.42	224	19.6	154

**Table 2.** Growth attributes and physiological indices of Brown top millet as influenced by different treatments

Treatments	Plant height (cm)	LAI	SPAD	Dry matter production (g plant <sup>-1</sup> )
T <sub>1</sub> : Sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control)	92.5	1.90	27.00	24.25
T <sub>2</sub> : Heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district	88.3	1.75	25.75	23.38
T <sub>3</sub> : Acidic soils of Annaikatti, Coimbatore district	105.5	2.13	28.50	26.68
T <sub>4</sub> : Coastal saline soils of Cuddalore district	77.0	1.70	20.50	22.55
T <sub>5</sub> : Waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district	73.8	1.58	18.50	21.55
T <sub>6</sub> : Sodic soils of ADAC& RI, Trichy district	67.8	1.50	17.50	19.68
Sem±	4.71	0.11	0.96	0.92
CD (P=0.05)	14.21	0.32	2.89	2.78

Coimbatore district (T<sub>3</sub>) was mainly due to the higher availability of nitrogen and organic carbon in acidic soils, which might have enhanced metabolic processes, meristematic activities, formation of chlorophyll and retention of higher number of leaves plant<sup>-1</sup>, ultimately this led to an overall improvement in photosynthetic surface of the plants. Kakabouki *et al.* (2019) noted a substantial rise in leaf area correlated with elevated nitrogen levels. The lowest SPAD values (17.5) and LAI (1.50) were noticed in the sodic soils of ADAC& RI, Trichy district (T<sub>6</sub>) due to sodicity and poor nutrient status.

#### Yield and yield attributes

The maximum number of effective tillers plant<sup>-1</sup> (8.0), panicle length (17.6 cm), panicle weight (14 g), grain yield (12.7 g plant<sup>-1</sup>), and test weight (3.3 g) were registered in acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>) (Fig 1 & Table 3) and it was significantly superior over sodic soils of ADAC & RI, Trichy district, waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district, coastal saline soils of Cuddalore district, and the heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district (T<sub>6</sub>, T<sub>5</sub>, T<sub>4</sub> and T<sub>3</sub>). This might be due to higher

total dry matter accumulation due to available organic carbon and nitrogen and their translocation to the reproductive parts, which improved yield and yield attributes. Mobeena *et al.* (2023), found similar trends in Quinoa cultivation in acidic soils of Ooty without fertilizer application, where both yield and its associated attributes exhibited enhancements in response to increased soil nutrient levels. Conversely, Ashoka and Rajkumar (2020) noted a marked decrease in the number of tillers plant<sup>-1</sup> (4.85), and yield (3.95 q ha<sup>-1</sup>) in the control treatment (no fertilizer) with a poor nutrient status of acidic soil of Karnataka when cultivated with IIMR -Y-II variety of Brown top millet. This underscored the significant variability in the crop's response to nutrients, depending upon the inherent soil fertility, environmental conditions, and genotype varying across different locations. Although, it remained on par with the sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control) (T<sub>1</sub>). The minimum number of effective tillers plant<sup>-1</sup> (4.75), panicle length (13.8 cm), panicle weight (11 g), grain yield (7.9 g plant<sup>-1</sup>), and test weight (3.0 g) were registered in sodic soils of ADAC& RI, Trichy district (T<sub>6</sub>). The decline in yield and yield attributes might be attributed to increased sodicity and reduced nutrient availability for translocation into reproductive parts.

**Table 3.** Yield and yield attributes of Brown top millet as influenced by different problematic soil treatments

Treatments	Number of effective tillers plant <sup>-1</sup>	Panicle length (cm)	Panicle weight (cm)	Grain yield (g plant <sup>-1</sup> )	Test weight (g)
T <sub>1</sub> : Sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control)	7.25	17.2	13.1	11.4	3.3
T <sub>2</sub> : Heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district	6.75	15.0	12.1	9.9	3.1
T <sub>3</sub> : Acidic soils of Annaikatti, Coimbatore district	8.00	17.6	14.0	12.7	3.3
T <sub>4</sub> : Coastal saline soils of Cuddalore district	5.50	14.5	12.0	8.1	3.0
T <sub>5</sub> : Waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district	5.00	14.2	11.9	8.0	3.0
T <sub>6</sub> : Sodic soils of ADAC& RI, Trichy district	4.75	13.8	11.0	7.9	3.0
Sem±	0.38	0.66	0.54	0.48	0.05
CD (P=0.05)	1.13	2.00	1.64	1.45	0.14

## Conclusion

The current investigation revealed a significant variation in Brown top millet's growth, yield, and associated attributes across various problematic soil treatments. Among the treatments tested viz., sandy clay loam soils of Eastern Block 37B TNAU, Coimbatore (Control), heavy clay soils of Cotton Research Station (CRS), Veppanthattai, Perambalur district, acidic soils of Annaikatti, Coimbatore district, Coastal saline soils of Cuddalore district, waterlogged soils of Agricultural Research Station (ARS), Bhavani Sagar, Erode district, sodic soils of ADAC& RI, Trichy district, the acidic soils of Annaikatti, Coimbatore district (T<sub>3</sub>) exhibited significantly higher growth, yield attributes, and overall yield of Brown top millet, which was found comparable with the sandy clay loam soils of Eastern Block 37B TNAU (Control) (T<sub>1</sub>). Conversely, soils collected from ADAC & RI, Trichy district registered the lowest growth, yield, and associated attributes in Brown top millet due to its poor nutrient status, elevated sodium levels, and nutrient imbalances. Numerous studies have focused on various millet aspects, but none have dealt with this specific research idea. The study concluded that Brown top millet exhibited adaptability to acidic and moderate saline soil conditions. The study emphasized that the physical and chemical properties of the soil, along with its fertility status, played a crucial role in influencing the production of Brown top millet. Furthermore, implementing appropriate remedial measures for managing the challenging soils could potentially enhance the performance of Brown top millet.

## Conflict of Interest

The authors declare that they have no conflict of interest.

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