

Characterization of black turmeric genotypes based on DUS descriptor (*Curcuma caesia* Roxb.)

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ABSTRACT

In accordance with the DUS multiscale scoring standards, a study was conducted at Farmer's Field in Vadapalani village of Erode district, Tamil Nadu to characterize twenty black turmeric genotypes for sixteen characters. Three of the examined characteristics viz., Leaf color (ventral side), Leaf margin, and Number of mother rhizome were found monomorphic. Seven characteristics were dimorphic and six were polymorphic. Tall plants with lengthy petioles, lamina lengths, and broad leaves were regarded as a plant morphological trait for choosing the best genotype (BTG 6, BTG 11, BTG 12, BTG 15, BTG 16, BTG 17, BTG 19) that are adaptable to local conditions. Black turmeric rhizome variations in inner core color have drawn attention. The inner core of the rhizome's greenish-blue color can be used to identify the genotype BTG3. Earliness can be a sign for genotypes BTG6, BTG11, BTG15 and BTG19 because they were shown to have short-duration types with less than 210 days. The differences seen with DUS characters provide a clear window for selection based on desired morphological characteristics may be used for selecting individuals based on particular traits.

Keywords: Black turmeric, distinctiveness uniformity and stability (DUS), Desirable morphological traits.

INTRODUCTION

A significant, lesser-known, unconventional medicinal plant in the Zingiberaceae family is *Curcuma caesia*, native to Java and Myanmar, is also widely dispersed throughout central and north-eastern India, as well as in Madhya Pradesh, Jharkhand, Chattisgarh, Orissa, and other places of South India [1]. The rhizomes of the plant *Curcuma caesia* have a wide range of medicinal properties, including the ability to treat cancer symptoms, diabetes, high cholesterol, stomach pain, menstrual irregularities, wounds, eczema, and psoriasis [3-4]. Tribal people use black turmeric plants for tantric sadhana and medicine. Rhizomes are employed by northern tribes as a talisman to ward off evil spirits, while in West Bengal they play a significant role in traditional medicine and are also used as a substitute for turmeric [9]. The National Medicinal Plant Board (NMPB) of India puts this plant on its list of critically threatened species at the moment. Export restrictions are imposed by the Ministry of the Environment without the consent of the appropriate legal authorities. As a result of high demand, widespread exploitation, and limited cultivation, it has been determined that *Curcuma caesia* is endangered [10-11]. The existence of wide variability among the turmeric genotypes concerning yield attributes and quality characters has been reported by many researchers [2]; [13-15]. Better conservation requires systematic and in-depth genetic characterization. In the era of advanced computer technology, morphological

characterization remains a valuable technique due to its reliability and ease of identification, particularly for stable characters unaffected by environmental interactions and requiring minimal resources. The guidelines outlined in the Protection of Plant Varieties and Farmers' Rights Act (2009) of India play a pivotal role in the quantitative and qualitative measurement of morphological characters. This study focuses on the characterization of a collection of 20 Black turmeric genotypes sourced from various regions across the nation. The investigation delves into diverse morphological and rhizome characters, aligning with the Distinctiveness, Uniformity, and Stability (DUS) guidelines. This approach not only aids in understanding the unique features of each genotype but also serves as a crucial step in conserving the species.

MATERIALS AND METHODS

Twenty Black turmeric genotypes were sourced from diverse regions across the country, as outlined in Table 1. The characterization process took place at the Department of Horticulture, Annamalai University, Tamil Nadu. The cultivation spanned two consecutive seasons, 2020-21 and 2021-22, following a randomized block design with three replications. Rhizomes were strategically planted at a spacing of 30 x 30 cm, adhering to recommended cultural practices for *Curcuma longa* [16]. Selection of five plants of uniform size and vigor was

undertaken for meticulous observation.

The evaluation encompassed 16 Distinctiveness, Uniformity, and Stability (DUS) traits, including Pseudostem habit, Plant height (cm), Number of leaves, Petiole length (cm), Lamina length (cm), Lamina width (cm), Leaf color (dorsal side), Leaf color (ventral side), Leaf margin, Leaf venation pattern, Leaf midrib color, Rhizome habit, Rhizome shape, Number of mother rhizomes, Rhizome inner core color, and Duration (No. of Days). Vegetative characters were assessed 150 days after planting, while rhizome characters were observed post-harvest, following the guidelines outlined by PPV & FRA, 2009 [12]. Color-related observations were documented under natural light conditions, utilizing the Royal Horticultural Society (RHS) Colour chart.

RESULTS AND DISCUSSION

The genotypes showed considerable variations for the studied characters. Among the sixteen characters studied three were found to be monomorphic viz., Leaf color (ventral), Leaf margin and Number of mother rhizomes. Whereas Pseudostem habit, Plant height (cm), Number of leaves, Leaf color (dorsal), Leaf venation pattern, Rhizome habit, and Rhizome shape showed dimorphic nature. The characters Petiole length (cm), Lamina length (cm), Lamina width (cm), Leaf midrib color, Rhizome inner core color, and Duration were found to be polymorphic.

Morphological characters

The pseudostem of BTG3, BTG7, BTG13, and BTG14 showed compact habit, whereas the remaining sixteen genotypes showed open pseudostem habit. None of the genotypes exhibit short stature when considering the plant height. Medium plant height (85-100cm) was found in thirteen genotypes while seven genotypes exhibited tall stature (>100cm) which is mostly undesirable. While considering the Number of leaves intermediate type were found more prominent with fourteen genotypes than many type which was found only at six genotypes. The genotypes BTG3, BTG5, and BTG14 exhibited short petiole length (15cm), short lamina length (<30cm), and Narrow Lamina width (10cm) while ten and seven genotypes showed intermediate (15-25cm) and long(>25cm) petiole length respectively. For the character Lamina length nine genotypes exhibited medium length with 30-40cm and eight genotypes were found to be long (>40cm). Broad lamina width was found in five genotypes *Viz.*, BTG6, BTG11, BTG15, BTG16, and BTG19, while medium lamina width was found in twelve genotypes. Except for BTG3 and BTG5, all were found to have green color in the dorsal side of the leaf whereas BTG3 and BTG5 showed a light green color. The ventral side of the leaf showed a green color in all the genotypes. The leaf margin of all the genotypes exhibited even nature. The unique leaf venation pattern i.e. Distant was found in BTG8, BTG20. The remaining genotypes showed a close leaf venation pattern. The genotypes

BTG6, BTG8, BTG20 exhibited grey-purple leaf midrib color while violet-blue and purple were found in five and twelve genotypes respectively. A similar study on turmeric characterization based on DUS character was reported by [5-6] and [1].

Rhizome character

Except BTG8, BTG17, and BTG19 others showed compact rhizome habit, whereas the above genotypes showed loose rhizome habit. The straight rhizomes were found in BTG8, BTG11, BTG17, and BTG19 while others exhibited curved rhizome shapes. More than three mother rhizomes were found in all the genotypes. The only genotype BTG3 exhibited a greenish blue rhizome inner core color which can be used as a marker for the identification of this genotype. The genotypes BTG5, BTG9, BTG12, and BTG18 exhibited light blue color in their inner core of the rhizome while BTG2, BTG8, and BTG11 showed moderate blue color and the remaining genotypes have strong blue color. Variation in the rhizome core color of turmeric was reported by [7-8]; [1].

Duration

The genotypes BTG6, BTG11, BTG15, and BTG19 were found to be earlier (<210 days) which is more desirable, while BTG8 and BTG17 showed medium duration (211-240 days) and the remaining genotypes showed later maturity. Swift maturation is a sought-after trait, especially in regions facing significant irrigation challenges. This preference for early varieties has been acknowledged not only in the assessment of soma clones in ginger using Distinctiveness, Uniformity, and Stability (DUS) guidelines [6] but also in a study involving fifteen turmeric genotypes conducted by [1].

CONCLUSION

From the study, it was found that the genotypes BTG6, BTG11, BTG12, BTG15, BTG16 and BTG17 had the many leaves, long petiole length, long lamina length, and broad lamina width. These characters were considered as more desirable morphological characters upon which the selection can be made for further development or can be used in the developmental breeding program. Distant leaf venation can be used as a morphological marker for the identification of the genotypes BTG8 and BTG20. More variations were found in the rhizome inner core color character. The greenish-blue rhizome inner core color can be used as the marker identification for the genotype BTG3. The genotypes BTG6, BTG11, BTG15, and BTG19 were found to have early maturity which can be used for commercial production of black turmeric with improved rhizome yield. The variations found in this study emphasize selection based on morphological characters which can be potentially utilized in trait-specific selection.

Table 1. Characterization of twenty genotypes based on DUS descriptors.

S. No.	Characters	Type of Assessment	State	Score	No. of genotypes	Reference genotypes
1	Pseudo stem habit	VG	Open	9	16	BTG1, BTG2, BTG4, BTG5, BTG6, BTG8, BTG9, BTG10, BTG11, BTG12, BTG15, BTG16, BTG17, BTG18, BTG19, BTG20
			Compact	1	4	BTG 3, BTG 7, BTG13, BTG14

2	Plant height (cm)	MS	Short (<85 cm)	3	0	
			Medium 85-100 cm	5	13	BTG1, BTG2, BTG3, BTG4, BTG5, BTG7, BTG8, BTG9, BTG10, BTG13, BTG14, BTG18, BTG20
			Tall >100 cm	7	7	BTG6, BTG11, BTG12, BTG15, BTG16, BTG17, BTG19
3	Number of leaves	MG	Few (<5)	3	0	
			Intermediate (6 – 10)	5	14	BTG1, BTG2, BTG3, BTG4, BTG5, BTG7, BTG8, BTG9, BTG10, BTG13, BTG14, BTG18, BTG19, BTG20
			Many (>10)	7	6	BTG6, BTG11, BTG12, BTG15, BTG16, BTG17
4	Petiole length (cm)	MS	Short (<15)	3	3	BTG3, BTG5, BTG14
			Intermediate (15 – 25)	5	10	BTG1, BTG2, BTG4, BTG7, BTG8, BTG9, BTG10, BTG13, BTG18, BTG20
			Long (>25)	7	7	BTG6, BTG11, BTG12, BTG15, BTG16, BTG17, BTG19
5	Lamina length (cm)	MS	Short (<30)	3	3	BTG3, BTG5, BTG14
			Medium (30-40)	5	9	BTG1, BTG2, BTG4, BTG7, BTG8, BTG9, BTG10, BTG18, BTG20
			Long (>40)	7	8	BTG6, BTG11, BTG12, BTG13, BTG15, BTG16, BTG17, BTG19
6	Lamina width (cm)	MS	Narrow (<10)	3	3	BTG3, BTG5, BTG14
			Medium (10-15)	5	12	BTG1, BTG2, BTG4, BTG7, BTG8, BTG9, BTG10, BTG12, BTG13, BTG17, BTG18, BTG20
			Broad (>15)	7	5	BTG6, BTG11, BTG15, BTG16, BTG19
7	Leaf colour (dorsal side)	VG	Light green	3	2	BTG3, BTG5
			Green	5	18	BTG1, BTG2, BTG4, BTG6, BTG7, BTG8, BTG9, BTG10, BTG11, BTG12, BTG13, BTG14, BTG15, BTG16, BTG17, BTG18, BTG19, BTG20
			Dark green	7	0	
8	Leaf colour (Ventral side)	VG	Green	5	20	BTG1, BTG2, BTG3, BTG4, BTG5, BTG6, BTG7, BTG8, BTG9, BTG10, BTG11, BTG12, BTG13, BTG14, BTG15, BTG16, BTG17, BTG18, BTG19, BTG20
			Dark green	7	0	
9	Leaf margin	VG	Even	3	20	BTG1, BTG2, BTG3, BTG4, BTG5, BTG6, BTG7, BTG8, BTG9, BTG10, BTG11, BTG12, BTG13, BTG14, BTG15, BTG16, BTG17, BTG18, BTG19, BTG20
			Wavy	5	0	
10	Leaf venation pattern	MS	Close	3	18	BTG1, BTG2, BTG3, BTG4, BTG5, BTG6, BTG7, BTG9, BTG10, BTG11, BTG12, BTG13, BTG14, BTG15, BTG16, BTG17, BTG18, BTG19
			Distant	5	2	BTG8, BTG20

11	Leaf midrib colour	VG	Violet blue group	1	5	BTG3, BTG7, BTG10, BTG13, BTG15
			Purple group	3	12	BTG1, BTG2, BTG4, BTG5, BTG9, BTG11, BTG12, BTG14, BTG16, BTG17, BTG18, BTG19
			Grey purple group	5	3	BTG6, BTG8, BTG20
12	Rhizome habit	VG	Compact	3	17	BTG1, BTG2, BTG3, BTG4, BTG5, BTG6, BTG7, BTG9, BTG10, BTG11, BTG12, BTG13, BTG14, BTG15, BTG16, BTG18, BTG20
			Intermediate	5	0	
			Loose	7	3	BTG8, BTG17, BTG19
13	Rhizome shape	MS	Straight	3	4	BTG8, BTG11, BTG17, BTG19
			Curved	5	16	BTG1, BTG2, BTG3, BTG4, BTG5, BTG6, BTG7, BTG9, BTG10, BTG12, BTG13, BTG14, BTG15, BTG16, BTG18, BTG20
14	Number of Mother rhizomes	MG	One	1	00	
			Two – Three	3	00	
			> Three	5	20	BTG1, BTG2, BTG3, BTG4, BTG5, BTG6, BTG7, BTG8, BTG9, BTG10, BTG11, BTG12, BTG13, BTG14, BTG15, BTG16, BTG17, BTG18, BTG19, BTG20
15	Rhizome Inner core colour	VS	Light blue	1	04	BTG5, BTG9, BTG12, BTG18
			Greenish blue	3	01	BTG3
			Moderate blue	5	03	BTG2, BTG8, BTG11
			Strong blue	7	12	BTG1, BTG4, BTG6, BTG7, BTG10, BTG13, BTG14, BTG15, BTG16, BTG17, BTG19, BTG20
			Pale green	9	0	
16	Duration (No. of Days)	VG	Short (<210 days)	3	4	BTG6, BTG11, BTG15, BTG19
			Medium (211-240 days)	5	2	BTG 8, BTG 17
			Long (>240 days)	7	14	BTG1, BTG2, BTG3, BTG4, BTG5, BTG7, BTG9, BTG10, BTG12, BTG13, BTG14, BTG16, BTG18, BTG20

MG: Measurement by a single observation of a group of plants or parts of plants

MS: Measurement of a number of individual plants or parts of plants

VG: Visual assessment by a single observation of a group of plants or parts of plants

VS: Visual assessment by observations of individual plants or parts of plants

Table 2. DUS scoring of the sixteen characters for the twenty genotypes.

Characters	Pseudo stem habit	Plant height (cm)	Number of leaves	Petiole length (cm)	Lamina length (cm)	Lamina width (cm)	Leaf colour (dorsal side)	Leaf colour (Ventral side)
Genotypes								
BTG1	9	5	5	5	5	5	5	5
BTG2	9	5	5	5	5	5	5	5
BTG3	1	5	5	3	3	3	3	5
BTG4	9	5	5	5	5	5	5	5
BTG5	9	5	5	3	3	3	3	5
BTG6	9	7	7	7	7	7	5	5
BTG7	1	5	5	5	5	5	5	5
BTG8	9	5	5	5	5	5	5	5
BTG9	9	5	5	5	5	5	5	5

BTG10	9	5	5	5	5	5	5	5
BTG11	9	7	7	7	7	7	5	5
BTG12	9	7	7	7	7	5	5	5
BTG13	1	5	5	5	7	5	5	5
BTG14	1	5	5	3	3	3	5	5
BTG15	9	7	7	7	7	7	5	5
BTG16	9	7	7	7	7	7	5	5
BTG17	9	7	7	7	7	5	5	5
BTG18	9	5	5	5	5	5	5	5
BTG19	9	7	5	7	7	7	5	5
BTG20	9	5	5	5	5	5	5	5

Table 3. DUS scoring of the sixteen characters for the twenty genotypes.

Characters	Leaf margin	Leaf venation pattern	Leaf midrib colour	Rhizome habit	Rhizome shape	Number of Mother rhizomes	Rhizome Inner core colour	Duration (No. of Days)
BTG1	3	3	3	3	5	5	7	7
BTG2	3	3	3	3	5	5	5	7
BTG3	3	3	1	3	5	5	3	7
BTG4	3	3	3	3	5	5	7	7
BTG5	3	3	3	3	5	5	1	7
BTG6	3	3	5	3	5	5	7	3
BTG7	3	3	1	3	5	5	7	7
BTG8	3	5	5	7	3	5	5	5
BTG9	3	3	3	3	5	5	1	7
BTG10	3	3	1	3	5	5	7	7
BTG11	3	3	3	3	3	5	5	3
BTG12	3	3	3	3	5	5	1	7
BTG13	3	3	1	3	5	5	7	7
BTG14	3	3	3	3	5	5	7	7
BTG15	3	3	1	3	5	5	7	3
BTG16	3	3	3	3	5	5	7	7
BTG17	3	3	3	7	3	5	7	5
BTG18	3	3	3	3	5	5	1	7
BTG19	3	3	3	7	3	5	7	3
BTG20	3	5	5	3	5	5	7	7

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