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Performance evaluation of selected turmeric (*Curcuma longa* L.) landraces prevailed in Karnataka (India) for growth, yield and quality attributes

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Abstract
A field experiment was conducted at College of Horticulture, Bengaluru, Karnataka, India during 2020-21 to evaluate the performance of twenty four land-races and two check varieties of turmeric. The results revealed that though released variety Prabha recorded highest plant height (141.10 cm) and Prathibha recorded highest curcumin (6.23%) and oleoresin (13.33%) contents whereas landrace TC-8 possessed highest number of leaves per clump (35.60), tillers per clump (8.40), leaf area (307.56 dm^2) and leaf area index (22.78) at 150 days after planting and produced maximum computed fresh rhizome yield (52.88 t ha^{-1}) and cured yield (13.17 t ha^{-1}). Hence, the landrace TC-8 is found to be best for Eastern dry zone of Karnataka.

Keywords: *Curcuma longa*, leaf area, cured yield, curing percentage, curcumin, oleoresin

Introduction
India, the 'land of spices' said to be a host to 63 kinds of spices (Pruthi, 1998) [22]. Turmeric also known as 'golden spice' or 'life spice' is a tropical perennial herb belongs to family Zingiberaceae and native to South-East Asia. Since time immemorial, it has been one of the most widely cultivated spices (Sigrist *et al*., 2011) [29]. Turmeric is referred to as 'earthy herb of the sun' and is esteemed for its underground rhizomes, which are profound yellow in colour (0.2 - 8.0% curcumin), pungent aromatic flavor (2.2 - 4.2% termerol) with 1.5 to 5.0 per cent volatile oil, 5.0 to 9.0 per cent essential oil and 3.0 to 13.0 per cent oleoresin contents (Karim *et al*., 2010) [9]. Curcumin is a yellow-coloured phenolic pigment that is utilized as a natural colourant in food, cosmetics and dyes, as well as an active ingredient in some medicines (Olojede *et al*. 2009 [19]; Nasri *et al.* 2014) [18]. Curcuminoids are the most promising compounds in Alzheimer's disease therapy (Li *et al*. 2011) [28]. Its antioxidant effect is beneficial against inflammation, ulcers, cancer and diabetes.
In India, turmeric is grown in an area of about 2, 95, 000 hectare with a production of 11,02,000 tonnes having a productivity of 3.73 tonnes per hectare. Major turmeric producing states in India are Telangana (55,443 ha), Odisha (27,864 ha), Tamil Nadu (18,296 ha), West Bengal (17,711 ha), Karnataka (17,598 ha), Assam (16,550 ha), Maharashtra (14,511 ha) and Andhra Pradesh (13,223 ha) (Anonymus, 2020) [2]. India accounts for about 80 per cent of world turmeric production and 60 per cent of world export. Major turmeric exporting countries are India, Thailand, Taiwan and several other South-East Asian, Central and Latin American countries. The performance of any crop or variety largely depends upon its genetic makeup. Furthermore, the performance of the crop is influenced by the climatic conditions of the region where it is grown. As a result, genotypes which perform well in one region may not perform good in other regions of varying climatic conditions. Hence, it is very much necessary to collect and evaluate all the available genotypes in order to identify suitable and high yielding genotypes for a specific agro-climatic condition (Singh and Prasad, 2006) [30]. Considering the importance of turmeric, the present study was conducted with the objective to evaluate the performance of different turmeric land-races collected from different locations of Karnataka with respect to growth, yield and quality attributes.

Materials and Methods
The present investigation was carried out at the Department of Plantation, Spice, Medicinal and Aromatic Crops, College of Horticulture, Bengaluru during the year 2020-21. The 24 landraces collected from different locations of Karnataka and two check varieties *viz.*,

Prathibha and Prabha were taken for the overall assessment (Table 1). The experiment was carried out by using Randomized Complete Block Design (RCBD) with two replications. During the first week of June, rhizome bits weighing 25 to 30 g with well-developed 3 to 4 buds were planted at a spacing of 30 cm x 45 cm in 2 m x 1.8 m sized plots. A uniform quantity of farm yard manure (25 t ha^{-1}) was applied to all plots and mixed with soil prior to planting and a fertilizer dose of 150: 125: 250 kg N, P_2O_5, K_2O ha^{-1} was also applied to soil in three split doses for all land-races and check varieties as per the package of practice given by UHS, Bagalkot.

Observations were recorded on growth attributes at 150 days after planting. The plant height was measured from soil surface to the tip of the tallest leaf in the plant and counted the number of tillers per clump as well as number of leaves per clump besides, petiole length was also recorded. Leaf area per clump was calculated by multiplying the product of length of leaf, breadth of leaf and total number of leaves in a clump with a factor 0.72 (Rao and Swamy 1984) [24]. Leaf area index (LAI) was calculated by dividing the total leaf area of the clump by land area occupied with clump. Crop was harvested upon maturity and fresh yield per plot was recorded after cleaning and projected yield per hectare was calculated. The number of mother rhizomes, primary and secondary fingers were counted. The length and girth of mother rhizomes, primary and secondary fingers were recorded by using vernier caliper. Fresh rhizomes of about 200 grams were boiled in water for 45 minutes by adding 0.1 g of baking soda and later dried in a hot air oven at 60^0C for 6-7 days to assess the curing percentage (dry recovery). The curing percentage was calculated by dividing the fresh weight by dry weight and expressed in percentage while, cured yield was worked out by dividing the product of fresh yield and curing percentage by 100.

The dried rhizomes of each treatment were powdered separately and used for extracting curcumin and oleoresin. Curcumin content was extracted with 99 per cent acetone and estimated by spectrophotometric method at 425 nm wavelength following ASTA procedure given by Manjunath *et al*. (1991) [16]. Oleoresin content in known amount of sample was extracted with acetone solvent using soxhlet apparatus and the extracted sample was kept in oven to evaporate the solvent for two hours at 110^0C and the weight of the sample was recorded. The oleoresin content was calculated by dividing the difference between initial and final weights of sample by weight of the sample taken for estimation and expressed in percentage. The values were subjected to statistical analysis for each character as per the method given by Panse and Shukhatme (1967) [20].

Results and Discussion

The growth characters varied significantly among the land-races with regards to plant height, number of leaves per clump, number of tillers per clump, petiole length, leaf area per clump and LAI (Table 2). The maximum plant height of 141.10 cm was recorded in released variety Prabha which was *on par* with land-races TC-8, TC-97, TC-79, TC-42, TC-18, TC-66, TC-27 and TC-36. The more number of tillers per clump (8.40) was observed in landrace TC-8 which was *on par* with landraces TC-26, TC-2, TC-13, TC-24, TC-23, TC-27, TC-35, TC-20, TC-21, TC-42, TC-97, TC-98 and TC-25. Besides, more number of leaves per clump (35.60) was also observed in landrace TC-8 which was *on par* with TC-2, TC-13, TC-26, TC-24, TC-35, TC-23, TC-27, Prabha, TC-21, TC-98, TC-36, TC-97, TC-20, Prathibha, TC-42 and TC-25. The longest petiole (16.45 cm) was observed in Prabha which was *on par* with land-races TC-42, TC-36, TC-21 and TC-8 while, lowest (6.65 cm) was registered in TC-79. However, highest leaf area (307.56 dm^2) and leaf area index (22.78) were registered in TC-8 which were *on par* with TC-27, TC-2, TC-23, TC-35, TC-21, TC-36, TC-13, TC-26, TC-98, TC-42 and TC-97. Whereas, least plant height, number of tillers per clump, numbers of leaves per clump, leaf area and leaf area index (95.35 cm, 4.20, 14.50, 81.92 dm^2 and 6.07, respectively) were observed in the landrace TC-45.

The growth of the plant is governed by the genetic composition of the landrace coupled with the environmental conditions under which the crop is grown. When different land-races are grown under identical conditions, it is the genetic makeup that expresses the morphological differences. The more number of leaves production is also associated with height of plant and tillers production. Since, it is a rhizomatous crop, tillers production increases when horizontal growth of rhizome is more, which is an inherent capacity of an individual. More number of leaves helps in synthesis of carbohydrates and new cells including cell elongation which leads to enlargement of leaf surface thereby increases leaf area and LAI. These results are in close conformity with the findings of Veena (2012) [31]; Kumar *et al*. (2015) [11]; Shashidhar (2015) [27] and Maurya *et al*. (2018) [26]. Charles *et al.* (2015) [4] observed the variation among landraces for growth traits *viz*., maximum plant height of 156.50 cm was recorded in UT-41, number of leaves per plant (11.83) in UT-25, number of tillers per plant (8.84) in UT-30 and leaf area (1042.00 cm^2) in UT-41 and they opined that these variation in morphological traits might be due to genetic makeup of individual genotypes. Siva Kumar *et al*. (2019) [13] recorded the highest plant height (130.78 cm) in PTS-12, more tillers per clump (3.19) in NDH-8 and maximum leaf area (679.49 cm^2) in PTS-8 and they opined that these variation in growth traits might be due to environmental conditions under which the crop was grown. Chaturvedi *et al*. (2010) [5] as well as Naidu and Murthy (2013) [17] observed the varietal variations in turmeric for plant height, number of leaves and tillers. Chaturvedi *et al*. (2010) [5] inferred from their two years mean data that varieties with shorter plants produced less tillers and it was in agreement with the present study whereas, shorter varieties produced more leaves than taller varieties and it was not in line with present study. Pirjade *et al*. (2007) [21] reported that variety Brahmani produced shorter plants (71.96 cm) with lesser tillers (3.05) and leaves (11.95) compared to Krishna (95.53 cm height, 14.15 leaves and 4.55 tillers) and Waigaon (107.22 cm height, 3.7 tillers and 13.7 leaves) and it was in agreement with present study. Rao *et al*. (2006) [23] reported that long duration varieties had more LAI than short duration varieties.

The number of mother rhizomes as well as primary and secondary fingers per plant differed significantly among turmeric land-races and check varieties (Table 3). The highest number of mother rhizomes (7.60) was registered in TC-98 and was *on par* with TC-23, TC-21, TC-27, Prabha, TC-42, TC-36, TC-8 and TC-13. The highest number of primary fingers (24.70) was observed in TC-79 and was *on par* with TC-23, TC-21, TC-36, TC-66, TC-13 and TC-8. The highest number of secondary fingers (34.80) was recorded in TC-23

and was *on par* with TC-66, TC-79, TC-27, TC-98, TC-13, TC-8, TC-20, TC-21, TC-24, TC-36 and TC-2. Whereas, lowest number of mother rhizomes (3.43) was noticed in TC-101 while, primary and secondary fingers in TC-99 (6.40 and 10.10, respectively). The variation in number of mother rhizomes, primary and secondary fingers would be attributed to better growth and vigor of the landraces which enhance the better production of rhizomes and fingers. Charles *et al*. (2015) [4] observed more number of mother rhizomes (34.2 m^{-2}) as well as primary fingers (98.4 m^{-2}) in UT-35 and secondary fingers (364.4 m^{-2}) in UT-25. Similar variation in number of rhizomes was also reported by Venkatesha and Siddalingayya (2016) [32]. Kumar (2018) [10] observed the maximum number of mother rhizomes (4.44) in variety Salem whereas, primary rhizomes (14.56) as well as secondary rhizomes (19.78) in variety Suvarna. Das *et al*. (2020) [6] reported that cultivar Rajendra Sonia recorded highest number of mother rhizomes (1.98) but Prathibha was superior in terms of number of primary fingers (24.00).

The average length and girth of mother rhizomes as well as the average number of primary and secondary fingers per plant differed significantly among landraces and check varieties of turmeric tested (Table 4). The highest average length of mother rhizomes (8.53 cm) was registered in TC-79 which was *on par* with TC-66, TC-101, TC-52, TC-97, TC-35, TC-110, TC-8, TC-34, TC25 and TC-99. The highest average length of primary fingers (8.15 cm) was observed in TC-13 which was *on par* with TC-8, TC-27, TC-18, TC-34, TC-2, Prabha, TC-42, TC-36, TC-97, TC-21, TC-101, TC-52, TC-66, TC-79 and TC-35. Whereas, highest average length of secondary fingers (3.80 cm) was observed in TC-18 and TC-52 and were *on par* with TC-26, TC-8, TC-2, TC-36, TC-27, TC-25, TC-97, TC-21, Prathibha, TC-98 and TC-42. While, lowest average length of mother rhizomes, primary and secondary fingers were recorded in TC-45 (6.56, 5.49 and 2.76, respectively).

The highest average girth of mother rhizomes (3.83 cm) was recorded in TC-52 followed by TC-101, TC-45, TC-97 and TC-110. The highest average girth of primary fingers (2.63 cm) was observed in TC-110 and was *on par* with Prabha, TC-52, TC-34, TC-27 and TC-101. The highest average girth of secondary fingers (2.06 cm) was recorded in Prabha which was *on par* with TC-18, TC-36, TC-13, TC-8, TC-42, TC-2 and TC-97. Whereas, lowest average girth of mother rhizomes (2.67) and primary fingers (1.86) were observed in TC-79 while, secondary fingers (1.32) in TC-45. These variations in length and girth of the rhizomes might be due to heritability and better growth and vigor of rhizomes. Similar findings were reported by Kumar and Yadav (2001) [12] and Kumari *et al*. (2014) [14]. Kumar (2018) [10] noticed the maximum length of mother and primary rhizomes (6.71 and 6.44 cm, respectively) in var. Suvarna whereas, maximum girth of mother, primary and secondary rhizomes (4.11, 2.83 and 2.08 cm, respectively) were recorded in varieties Suroma, Sona and Kedaram, respectively.

The fresh and cured yields of rhizomes and curing percentage differed significantly among landraces and check varieties of turmeric tested (Table 5). The landrace TC-8 recorded highest fresh rhizome yield per plot (19.04 kg) and computed fresh rhizome yield per hectare (52.88 t) which were *on par* with TC-13, TC-18, TC-36, TC-27, Prabha, TC-2, TC-21, TC-42, TC-79, TC-35, TC-98, TC-24, TC-23 and TC-26 while, least fresh rhizome yield per plot (5.03 kg) and computed fresh rhizome yield per hectare (13.96 t) were observed in TC-45. An increased fresh rhizome yield could be attributed to the maximum plant height, number of tillers, leaves, leaf area, LAI, dry matter production and its distribution into various plant parts and these characters had direct positive relationship with yield. Further, the highest rhizome yield might also related to the weight of mother rhizomes, primary and secondary fingers. Thus, it could be concluded that yield of rhizome was mainly dependent on vigor of the plant and resultant of yield components. Siva Kumar *et al.* (2019) [13] reported that landrace NDH-98 recorded highest yield (53.76 t ha^{-1}) followed by NDH-8 (41.36 t ha^{-1}) and variation in yield was governed by the genetic composition of the genotype coupled with the environmental condition under which the crop was grown. When different genotypes were grown under identical conditions, it is the genetic makeup that expresses the morphological differences. The highest fresh rhizome yield (37.61 t ha^{-1}) was recorded in Roma followed by Rajendra Sonia (28.38 t ha^{-1}) and Suranjana (27.05 t ha^{-1}) while, the lowest yield was recorded in IISR Alleppy Supreme (17.84 t ha^{-1}) and variation in yield among the turmeric varieties grown under same agro-climatic conditions could be attributed to the genetic factor. The study indicated that the long duration genotypes produced higher fresh rhizome yield over medium and short duration genotypes due to maintenance of maximum leaf area index reported by Kumar *et al.* (2015) [11]. In the present study, few medium duration land-races also recorded higher yield due to maintenance of more LAI.

Curing percentage is an important factor, as the fresh rhizome has to be cured to obtain marketable turmeric. Curing percentage varied from 19.85 to 27.71 per cent among the tested landraces and check varieties (Table 5). The landrace TC-52 registered highest curing percentage of 27.71 per cent, which was *on par* with TC-26, TC-27, TC-101, TC-97, TC-45, TC-99, TC-23, TC-42 and TC-8 while, lowest (19.85%) was recorded in Prabha. Among land-races and released varieties tested, TC-8 produced highest cured rhizome yield (13.17 t ha^{-1}) and was *on par* with TC-27, TC-36, TC-18, TC-13, TC-2, TC-21, TC-42, TC-35, TC-79, TC-24, TC-98, TC-26 and Prabha whereas, lowest (3.58 t ha^{-1}) was documented in TC-45 (Table 5). The differences in curing percentage of landraces might be attributed to differential moisture content of rhizomes, dry matter accumulation, soil properties, crop duration, nutrient management and genetic characters of individual landraces. Rao (1965) [25] and Aiyadurai (1966) [1] opined that, variation in curing percentage was largely related to varietal characters, mostly genetic factors rather than environmental conditions under which they were grown. Similar variation in curing percentage was also reported by Jadhao *et al*. (2005) [8] and Laxmi *et al*. (2017) [15]. Venkatesha and Siddalingayya (2016) [32] reported highest curing percentage in 'Salem' (25.70%) followed by 'CLT-325' (24.51%) and 'Erode Local' (24.16%) whereas lowest curing percentage in 'Rajapuri' (19.74%) and they opined that variations in curing percentage was largely governed by varietal characters, genetic factors and environment conditions under which they were grown. Kumar *et al.* (2015) [11] recorded highest curing percentage of 24.8 per cent in Roma followed by Rashmi (22.6%) and Suranjana (21.8%) whereas, lowest (16.5%) was recorded in Narendra Haldi-1 and they said that variation in curing percentage might be due to increased dry matter production in long duration genotypes

which might have increased the curing percentage. The present investigation is also in conformity of these findings.

Significant differences were observed among different landraces and check varieties with respect to curcumin and oleoresin contents (Figure 1). Curcumin content in different landraces and check varieties varied from 2.85 to 6.23 per cent. The highest curcumin content (6.23%) was reported in Prathibha which was *on par* with TC-21, TC-23, Prahba, TC-27, TC-18 and TC-25 while, lowest curcumin content (2.85%) was recorded in TC-66. Oleoresin content varied from 8.03 to 13.33 per cent among different landraces and check varieties tested. The Prathibha recorded higher oleoresin content (13.33%) which was *on par* with TC-27, Prabha, TC-45, TC-99, TC-26 and TC-110 while, least oleoresin content (8.03%) was documented in TC-25. Oleoresin content is highly sensitive to micro and macro changes in environment whereas, variation in curcumin content might be due to variation in soil organic carbon, available nitrogen and manganese contents of soil in different agro-climatic conditions. Anusuya (2004) [3] recorded the highest curcumin content in Suroma under Arabhavi condition. Hrideek *et al*. (2006) [7] recorded maximum curcumin content in turmeric variety Prabha (5.56%) under Western Ghat conditions. Kumar *et al*. (2015) [11] recorded very high level of curcumin content (6.30%) in Roma and in contrary, the same genotype recorded low level of curcumin in earlier reports. They also observed the similar differences in Rajendra Sonia, which was reported to have 4.23 per cent curcumin content, while in the next year study, the same genotype recorded curcumin content of 6.10 per cent. This variation was probably attributed to influence of climate, soil and nutrition, while the variation in curcumin content among the genotypes under similar climatic conditions might be due to genetic factor. Das *et al*. (2020) [6] recorded highest curcumin content (5.20%) in Alleppy Supreme and oleoresin content (11.90%) in Prathibha followed by Rajendra Sonia (4.10 and 11.29%, respectively).

Table 1: List of turmeric landraces used for the present study

SI. No.	Village	Farmers Name	Local Name	Landrace Number	Soil Type	Special Characters
01	Thamadahalli (Chamarajanagara)	Madappa S/o Gurumallappa	TM-291	COHB/JV/TC-2	Red	Medium growth, mother rhizomes are sympodial bold with stunted reddish fingers
02	Udigala (Chamarajanagara)	Kumara S/o Mahadevappa	UKM119	COHB/JV/TC-8	Red	Medium growth, bold mother rhizomes with prominent reddish fingers
03	Shivapura Yelle (Chamarajanagara)	Manju S/o Nanjundaswamy	MNS	COHB/JV/TC-13	Red	Robust growth, bold mother rhizomes with reddish fingers
04	Ramasamudra (Chamarajanagara)	Somanna S/o Mahadevappa	R/1/T	COHB/JV/TC-18	Medium black	Medium growth, bold mother rhizomes with smaller fingers
05	Lakkur (Chamarajanagara)	Nanjappa S/o Channappa	L44T	COHB/JV/TC-20	Red sandy	Medium growth, bold mother rhizomes with large sized fingers
06	Lakkur (Chamarajanagara)	Basavannyapa	L1T	COHB/JV/TC-21	Red sandy	Robust growth, bold rhizomes with good number of medium fingers
07	Angala (Chamarajanagara)	Rajappa S/o Basavarajappa	ARB	COHB/JV/TC-23	Red sandy	Robust growth, bold rhizome with medium sized fingers
08	Raghavapura (Chamarajanagara)	Doddanarasiah S/o Mugaiah	RMD 12	COHB/JV/TC-24	Red sandy	Modest growth, whitish to yellow coloured bold rhizomes
09	Terkanambi Village (Chamarajanagara)	Subbappa S/o Basappadevaru	T_V-1-T	COHB/JV/TC-25	Red sandy	Robust growth, bold rhizomes with small sized fingers
10	Terkanambi Village (Chamarajanagara)	Ganesha	T_V-2-T	COHB/JV/TC-26	Red sandy	Robust growth, bold rhizomes with less number of small fingers
11	Vijayapura (Chamarajanagara)	Balusubramanyya	V-30-T	COHB/JV/TC-27	Red sandy	Uniform growth, bold mother rhizomes with more number of fingers
12	Patterahalli (Chamarajanagara)	Local	Local	COHB/JV/TC-34	Red sandy	Bold fingers, whitish to yellow coloured fingers
13	Devanur (Mysuru)	Savitha Ranganath	DSR119	COHB/JV/TC-35	Red	Robust growth, bold rhizomes with big sized fingers
14	Devanur (Mysuru)	Sri Raju (DattaRaju)	DR12	COHB/JV/TC-36	Deep red	Robust growth with prominent rhizomes with bigger sized fingers
15	Doddakowlande (Mysuru)	Javed Ahamed	DJA170	COHB/JV/TC-42	Medium black	Moderate growth, bold rhizomes with small fingers
16	KonapuradaYelle (Mysuru)	K.G. Prasanna Kumar S/o Guru Siddiah	KYP208	COHB/JB/TC-45	Red soil	Moderate growth, stunted rhizomes with small sized fingers
17	Mallinathapura (Mandya)	Vishwanath	MV	COHB/JV/TC-52	Red sandy loam	Medium crop, slightly stunted rhizomes with more number of small fingers
18	Sundehalli (Uttar Kannada)	Vital Nagu Nayak	Local	COHB/JV/TC-66	Red laterite	Mother rhizomes are bright orange yellow rhizomes
19	Yellapura (Uttar Kannada)	Shankar Narayan Bhat	Local	COHB/JV/TC-79	Red laterite	Mother rhizomes are t orange yellow in colour with slender fingers
20	Sanganakeri (Belgaum)	Ravi S/o Tuljappa	RTS	COHB/JV/TC-97	Black cotton	Mother rhizomes are bold with prominent fingers which are reddish in color and posses good aroma
21	Sanganakeri Basaligonde (Belgaum)	Badigera Vittalvama Surya Vamshi	BVS	COHB/JV/TC-98	Black cotton	Mother rhizomes are stunted with reddish coloured fingers

22	Arabhavi (Belgaum)	College of Horticulture, Arabhavi, (PSMA)	APSMA-1	COHB/JV/TC-99	Black cotton	Mother rhizomes are bold with prominent fingers which are reddish in color and posses good aroma
23	Arabhavi (Belgaum)	College of Horticulture, Arabhavi, PSMA	APSMA-3	COHB/JV/TC-101	Black cotton	Mother rhizomes are bold and prominent fingers with reddish in color and good aroma
24	UAHS, KVK (Shivamogga)	KVK	Bidar local	COHB/JV/TC-110	Red sandy loam	Medium height, bold rhizomes with small profused fingers
25	COH(S), UHS(B) (Sirsi)	PSMA(S)	Prabha-IISR	COHB/JV/TC-107	Red laterite	Profuse growth, small bold rhizomes with reddish fingers
26	UAHS, KVK (Shivamogga)	KVK	Prathibha	COHB/JV/TC-105	Red sandy loam	Medium growth, small slightly bold rhizomes with orange fingers

Table 2: Growth parameters of different turmeric landraces

Landraces	Plant height (cm)	Number of tillers/clump	Number of leaves/clump	Petiole length (cm)	Leaf area (dm^2)	LAI
TC-2	113.40^{bcdefg}	7.90^{abc}	34.30^{ab}	11.15^{bcde}	253.87^{abc}	18.80^{abc}
TC-8	128.00^{ab}	8.40^{a}	35.60^{a}	12.80^{abc}	307.56^{a}	22.78^{a}
TC-13	112.55^{bcdefg}	7.90^{abc}	33.70^{ab}	11.20^{bcde}	230.31^{abcde}	17.06^{abcde}
TC-18	125.90^{abc}	5.30^{efgh}	25.30^{bcdefg}	9.60^{cdef}	204.67^{bcdef}	15.16^{bcdef}
TC-20	112.90^{bcdefg}	7.00^{abcde}	27.50^{abcdef}	11.15^{bcde}	206.25^{bcdef}	15.28^{bcdef}
TC-21	117.90^{bcdef}	6.90^{abcdef}	30.00^{abcde}	12.98^{abc}	231.33^{abcde}	17.14^{abcde}
TC-23	118.90^{bcde}	7.50^{abcd}	31.80^{abcd}	11.60^{bcde}	238.65^{abcd}	17.68^{abcd}
TC-24	103.60^{defg}	7.70^{abcd}	32.30^{abcd}	8.75^{def}	199.99^{bcdef}	14.81^{bcdef}
TC-25	118.00^{bcdef}	6.40^{abcdefg}	25.70^{abcdefg}	11.90^{bcd}	185.26^{bcdef}	13.72^{bcdef}
TC-26	113.60^{bcdefg}	8.20^{ab}	33.40^{abc}	10.85^{bcde}	224.87^{abcde}	16.66^{abcde}
TC-27	122.50^{abcd}	7.50^{abcd}	31.00^{abcd}	11.75^{bcd}	263.68^{ab}	19.53^{ab}
TC-34	97.40^{efg}	5.20^{efgh}	23.50^{cdefgh}	9.30^{cdef}	130.57^{fg}	9.67^{fg}
TC-35	118.70^{bced}	7.40^{abcd}	32.10^{abcd}	11.80^{bcd}	233.14^{abcde}	17.27^{abcde}
TC-36	120.30^{abcd}	6.20^{bcdefgh}	28.80^{abcdef}	13.55^{ab}	230.41^{abcde}	17.07^{abcde}
TC-42	126.10^{abc}	6.90^{abcdef}	26.70^{abcdefg}	13.70^{ab}	218.24^{abcdef}	16.17^{abcdef}
TC-45	95.35^{g}	4.20^{h}	14.50^{h}	9.85^{bcdef}	81.92^{g}	6.07^{g}
TC-52	113.70^{bcdefg}	4.90^{fgh}	23.30^{defgh}	10.25^{bcdef}	171.78^{cdefg}	12.72^{cdefg}
TC-66	124.40^{abcd}	4.30^{h}	17.30^{gh}	7.71^{ef}	143.69^{efg}	10.64^{efg}
TC-79	126.75^{abc}	4.40^{gh}	20.70^{efgh}	6.65^{f}	177.36^{bcdef}	13.14^{bcdef}
TC-97	127.80^{ab}	6.80^{abcdef}	28.60^{abcdef}	11.25^{bcde}	217.65^{abcdef}	16.12^{abcdef}
TC-98	118.30^{bcedf}	6.70^{abcdef}	29.80^{abcdef}	10.90^{bcde}	222.86^{abcde}	16.51^{abcde}
TC-99	111.90^{bcdefg}	5.30^{efgh}	20.00^{fgh}	9.86^{bcdef}	153.57^{defg}	11.38^{defg}
TC-101	114.25^{bcdefg}	4.60^{gh}	17.10^{gh}	11.12^{bcde}	146.97^{efg}	10.89^{efg}
TC-110	105.80^{cdefg}	5.70^{defgh}	25.00^{bcdefg}	11.76^{bcd}	154.94^{defg}	11.48^{defg}
Prathibha	96.50^{fg}	5.90^{cdefgh}	26.90^{abcdefg}	9.35^{cdef}	165.60^{cdefg}	12.27^{cdefg}
Prabha	141.10^{a}	6.20^{bcdefgh}	30.20^{abcde}	16.45^{a}	185.25^{bcdef}	13.72^{bcdef}
S.Em ±	7.52	0.72	3.41	1.34	31.13	2.31
CD at 5%	21.91	2.09	9.92	3.90	90.66	6.72

Table 3: Average number of mother rhizomes, primary and secondary fingers per plant in different turmeric landraces

Landraces	Mother rhizomes	Primary fingers	Secondary fingers
TC-2	5.50^{cdefghi}	15.50^{cdefg}	25.50^{abcdefg}
TC-8	6.20^{abcde}	19.30^{abcde}	29.70^{abcd}
TC-13	6.00^{abcdef}	20.50^{abcd}	29.90^{abcd}
TC-18	5.60^{cdefghi}	11.90^{fghij}	14.70^{hijk}
TC-20	5.50^{cdefghi}	16.80^{bcdefg}	29.60^{abcde}
TC-21	6.70^{abc}	21.00^{abc}	28.80^{abcde}
TC-23	7.30^{ab}	22.00^{ab}	34.80^{a}
TC-24	5.80^{bcdefg}	18.10^{bcde}	27.00^{abcdef}
TC-25	4.57^{efghij}	9.13^{hij}	12.63^{ijk}
TC-26	5.70^{bcdefgh}	15.90^{cdefg}	21.50^{cdefghi}
TC-27	6.60^{abc}	18.60^{bcde}	32.40^{ab}
TC-34	4.90^{defghij}	11.30^{ghij}	20.20^{efghij}
TC-35	4.40^{fghij}	14.50^{efghi}	19.20^{fghijk}
TC-36	6.10^{abcde}	20.80^{abc}	25.50^{abcdefg}
TC-42	6.20^{abcde}	14.80^{defgh}	21.20^{defghi}
TC-45	5.20^{cdefghi}	11.60^{fghij}	23.60^{bcdefgh}
TC-52	4.00^{ij}	11.13^{ghij}	11.38^{jk}
TC-66	4.20^{ghij}	20.70^{abcd}	34.20^{a}
TC-79	4.20^{ghij}	24.70^{a}	33.90^{a}
TC-97	4.30^{ghij}	11.20^{ghij}	16.80^{ghijk}
TC-98	7.60^{a}	17.30^{bcdef}	30.70^{abc}

TC-99	4.10^{hij}	6.40^{j}	10.10^{k}
TC-101	3.43^{j}	8.47^{j}	11.53^{jk}
TC-110	4.60^{efghij}	8.60^{ij}	15.00^{hijk}
Prathibha	4.30^{ghij}	8.40^{j}	11.50^{jk}
Prabha	6.30^{abcd}	15.40^{cdefg}	18.10^{fghijk}
S.Em ±	0.58	2.03	3.26
CD at 5%	1.70	5.90	9.50

Table 4: Average length and girth of mother rhizomes, primary and secondary fingers in different turmeric landraces

Landraces	Length (cm)			Girth (cm)		
	Mother rhizomes	Primary fingers	Secondary fingers	Mother rhizomes	Primary fingers	Secondary fingers
TC-2	7.66^{bcdef}	7.79^{ab}	3.68^{abc}	3.44^{cdefg}	2.37^{d}	1.86^{abc}
TC-8	7.88^{abcde}	7.99^{ab}	3.68^{abc}	3.48^{cdefg}	2.38^{d}	1.87^{abc}
TC-13	7.63^{bcdef}	8.15^{a}	3.30^{defg}	3.47^{cdefg}	2.38^{d}	1.87^{abc}
TC-18	7.40^{cdefg}	7.94^{ab}	3.80^{a}	3.46^{cdefg}	2.41^{cd}	1.90^{ab}
TC-20	6.83^{gh}	6.83^{de}	2.98^{ghi}	3.25^{fghij}	2.08^{fghi}	1.39^{gh}
TC-21	6.99^{fgh}	7.54^{abcd}	3.52^{abcd}	3.24^{ghij}	2.06^{ghij}	1.68^{cdef}
TC-23	7.40^{cdefgh}	6.78^{de}	3.04^{fghi}	3.02^{jk}	2.16^{efgh}	1.57^{fg}
TC-24	7.13^{efgh}	7.16^{bcd}	3.44^{bcde}	2.94^{k}	2.06^{hijk}	1.63^{ef}
TC-25	7.81^{abcde}	6.79^{de}	3.56^{abcd}	3.54^{bcde}	2.37^{d}	1.78^{bcdef}
TC-26	6.77^{gh}	6.91^{cde}	3.75^{ab}	3.13^{ijk}	2.11^{fghi}	1.72^{bcdef}
TC-27	7.48^{cdefg}	7.94^{ab}	3.58^{abcd}	3.37^{efghi}	2.43^{abcd}	1.81^{bcde}
TC-34	7.86^{abcde}	7.88^{ab}	3.27^{defg}	3.38^{efghi}	2.44^{ad}	1.64^{bcde}
TC-35	7.93^{abcd}	7.40^{abcd}	3.37^{cdef}	3.35^{defgh}	2.38^{abcd}	1.81^{def}
TC-36	7.30^{defgh}	7.60^{abcd}	3.67^{abc}	3.16^{hijk}	2.32^{de}	1.88^{abc}
TC-42	7.37^{cdefg}	7.72^{abc}	3.48^{abcd}	3.44^{cdefg}	2.33^{de}	1.86^{abc}
TC-45	6.56^{h}	5.49^{f}	2.76^{i}	3.78^{ab}	1.92^{ijk}	1.32^{h}
TC-52	8.09^{abc}	7.47^{abcd}	3.80^{a}	3.83^{a}	2.60^{abc}	1.69^{bcdef}
TC-66	8.31^{ab}	7.44^{abcd}	2.78^{i}	2.68^{l}	1.88^{jk}	1.36^{gh}
TC-79	8.53^{a}	7.43^{abcd}	2.90^{hi}	2.67^{l}	1.86^{k}	1.38^{gh}
TC-97	8.02^{abcd}	7.58^{abcd}	3.55^{abcd}	3.65^{abc}	2.35^{d}	1.85^{abcd}
TC-98	7.27^{defgh}	7.26^{bcd}	3.50^{abcd}	3.28^{fghi}	2.26^{defg}	1.76^{bcdef}
TC-99	7.77^{abcde}	6.20^{ef}	2.84^{hi}	3.43^{cdefg}	1.99^{hijk}	1.37^{gh}
TC-101	8.28^{ab}	7.48^{abcd}	3.36^{cdef}	3.81^{a}	2.43^{abcd}	1.76^{bcdef}
TC-110	7.92^{abcd}	6.76^{de}	3.14^{efgh}	3.63^{abcd}	2.63^{a}	1.84^{bcd}
Prathibha	7.63^{bcdef}	6.81^{de}	3.51^{abcd}	3.35^{efghi}	2.27^{def}	1.80^{bcde}
Prabha	7.16^{efgh}	7.73^{abc}	3.39^{cde}	3.50^{cdef}	2.62^{ab}	2.06^{a}
S.Em ±	0.26	0.29	0.12	0.09	0.07	0.07
CD at 5%	0.76	0.86	0.34	0.25	0.20	0.21

Table 5: Yield and curing percentage of different turmeric landraces

Landraces	Fresh yield (kg plot^{-1})	Computed fresh yield (t ha^{-1})	Cured yield (t ha^{-1})	Curing percentage (%)
TC-2	15.86^{abcd}	44.06^{abcd}	10.86^{abcd}	24.55^{bcdef}
TC-8	19.04^{a}	52.88^{a}	13.17^{a}	24.83^{abcdef}
TC-13	17.44^{ab}	48.44^{ab}	11.15^{abc}	22.67^{efghi}
TC-18	16.95^{abc}	47.09^{abc}	11.27^{ab}	23.88^{bcdefg}
TC-20	7.57^{efgh}	21.02^{efgh}	4.49^{fg}	21.40^{ghi}
TC-21	15.58^{abcd}	43.29 ^{abcd}	10.69^{abcd}	24.59^{bcdef}
TC-23	12.54^{abcdefg}	34.83^{abcdefg}	7.24^{bcdefg}	25.06^{ahi}
TC-24	13.50^{abcdefg}	37.50^{abcdefg}	8.97^{abcdef}	23.91^{bcdefg}
TC-25	6.82^{gh}	18.94^{gh}	4.62^{fg}	23.86^{bcdefgh}
TC-26	12.14^{abcdefgh}	33.73^{abcdefgh}	8.84^{abcdef}	26.23^{ab}
TC-27	16.60^{abc}	46.10^{abc}	11.91^{ab}	26.01^{abc}
TC-34	11.11^{bcdefgh}	30.87^{bcdefgh}	7.01^{bcdefg}	22.72^{efghi}
TC-35	14.09^{abcdef}	39.14^{abcdef}	9.05^{abcdef}	23.13^{cdefgh}
TC-36	16.75^{abc}	46.52^{abc}	11.31^{ab}	24.27^{bcdefg}
TC-42	15.12^{abcd}	41.99^{abcd}	10.10^{abcde}	24.95^{abcdef}
TC-45	5.03^{h}	13.96^{h}	3.58^{g}	25.69^{abcde}
TC-52	7.22^{fgh}	20.06^{fgh}	5.62^{efg}	27.71^{a}
TC-66	9.23^{defgh}	25.64^{defgh}	5.98^{defg}	23.27^{bcdefgh}
TC-79	14.59^{abcde}	40.52^{abcde}	9.05^{abcdef}	22.37^{fghi}
TC-97	10.77^{bcdefgh}	29.92^{bcdefgh}	7.77^{bcdefg}	25.82^{abcd}
TC-98	13.62^{abcdefg}	37.83^{abcdefg}	8.95^{abcdef}	23.78^{bcdefgh}
TC-99	7.20^{fgh}	19.99^{fgh}	5.07^{fg}	25.45^{abcde}
TC-101	6.61^{gh}	18.35^{gh}	4.79^{fg}	25.88^{abcd}
TC-110	9.76^{cdefgh}	27.10^{cdefgh}	6.24^{cdefg}	22.88^{defghi}

Prathibha	7.23^{fgh}	20.07^{fgh}	4.45^{fg}	22.23^{fghi}
Prabha	15.88^{abcd}	44.12^{abcd}	8.84^{abcdef}	19.85^{i}
S.Em ±	2.47	6.87	1.70	1.05
CD at 5%	7.20	20.00	4.96	3.06

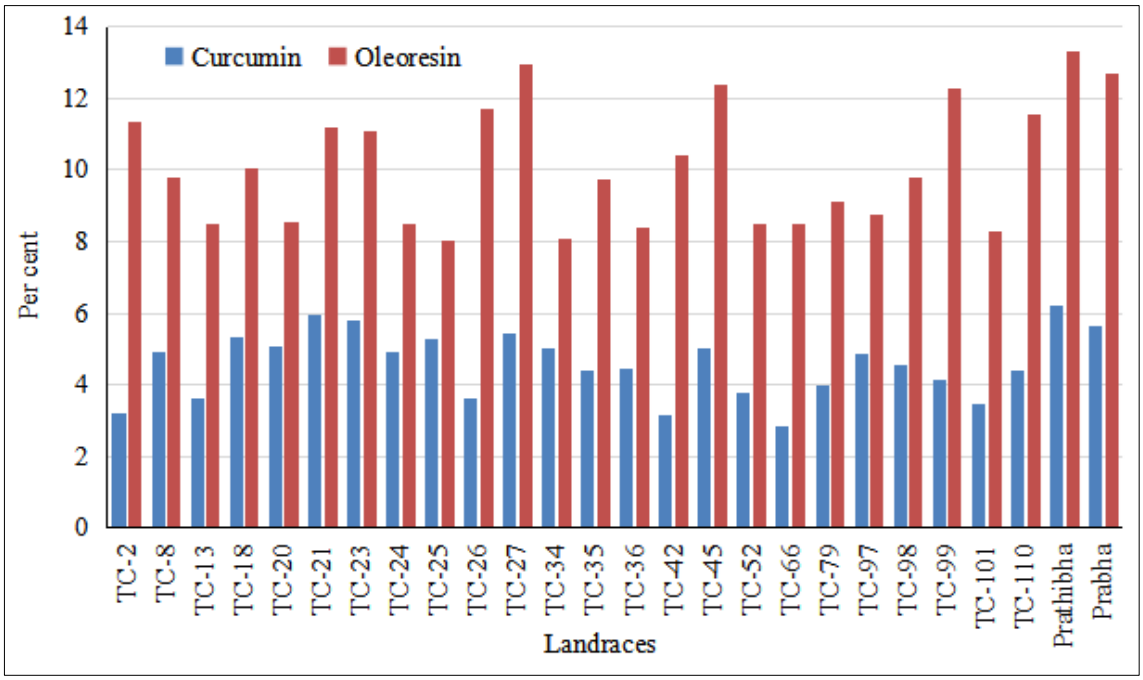

Fig 1: Curcumin and Oleoresin contents (%) in different turmeric landraces

Conclusion

Based on the results obtained from the present investigation, it can be concluded that the landrace TC-8 performed better than the check varieties with respect to growth parameters like number of tillers per clump, number of leaves per clump, leaf area and LAI including yield components like fresh rhizome yield and cured rhizome yield. Even though check variety Prathibha recorded highest curcumin and oleoresin contents but curcumin yield per hectare was found more in the landrace TC-8. Hence, TC-8 can be considered as the best cultivar for the Eastern dry zone of Karnataka.

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