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Performance of Turmeric (*Curcuma longa* L.) Genotypes for Growth and Yield under High Altitude and Tribal Zone of Andhra Pradesh

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A B S T R A C T

The present experiment in turmeric was carried out in Randomized Block Design with three replications during *Kharif* 2017 at Horticulture Research Station, Dr. Y.S.R.H.U, Chinthapalli, Visakhapatnam District. Total nineteen genotypes were evaluated including one national and one local check. Among the genotypes studied, CLA-1 recorded the highest plant height (169.2 cm), leaf length (70.53 cm), CLA-5 recorded the highest number of tillers per plant (3.33), var. Roma recorded the highest leaf width (17.68 cm), var. BSR-2 recorded the highest number of leaves per plant (18.33) and highest leaf area (13454.61 cm^2). The maximum yield per plot was observed in CLA-3 (15.10 kg), whereas the minimum was recorded in CLA-10 (8.04 kg). The maximum estimated fresh rhizome yield per hectare was recorded in CLA-3 (50.35 t) and the lowest estimated fresh rhizome yield was recorded in the genotype CLA-10 (26.80 t) when compared to other genotypes under HAT zone conditions.

Introduction

Turmeric (*Curcuma longa* L.) is one of the important spice and also condiment crops grown in India since times immemorial. It is regarded as a symbol of well being and widely used in ceremonies and religious functions. It is an erect, herbaceous perennial belonging to the family *Zingiberaceae* and native to South East Asia. Turmeric of commerce is the dried underground rhizome, valued for its deep yellow colour and pungent aromatic flavour due to the presence of colouring matter ‘‘Curcumin’’ and a volatile oil ‘‘termerole’’. It is also an important condiment which finds a unique place in culinary arts and as colouring agent in textile, food, confectionary, cosmetics and drug industries in the preparation of anticancer medicines.

Turmeric is either grown as a pure crop or inter/mixed crop in coconut, areca nut and

coffee plantations. In India it is being cultivated in more than 20 states in an area of 2.37 lakh ha with an annual production of 11.63 MT and earning 1241.89 crores by exporting 1.16 MT to other countries. In India, it is mainly grown in Telangana, Andhra Pradesh, Odisha, West Bengal, Tamil Nadu, Assam, Maharashtra, Karnataka, Bihar and Kerala. Among these, Telangana occupies 50,000 ha of total area and 2.55 MT of total production of the country. The national productivity of crop is 5 tonnes per hectare. (NHB, 2017-18).

Turmeric is a tropical crop and needs a warm and humid climate with an optimum temperature of 20 to 30^{o}C for normal growth and satisfactory production. It thrives best on sandy loam or alluvial, loose, friable and fertile soil rich in organic matter status and having a pH range of 5.0 to 7.5. Alkaline soil is not suitable for its cultivation. The crop cannot withstand water logging. It grows at all places ranging from sea level to an altitude of 1200 m above mean sea level. As a rain fed crop turmeric needs a well distributed annual rainfall of 250 to 400 cm for successful production. It is grown for underground stem called as rhizomes, which are used to impart flavour and colour to foodstuffs after clearing, drying, polishing and powdering. The rhizome contains yellow colouring component curcumin (3-9%), essential oil (5-9%) and oleoresin (3-13%). Curcumin is gaining more importance in food industries, pharmaceuticals, preservatives and cosmetics. The ban on artificial colour has prompted the use of curcumin as a food colorant. In pharmaceuticals it is valued for the anti-cancerous, anti-inflammatory, antiseptic, antimicrobial and anti proliferative activities.

Genetic improvement may play a vital role in increasing production, productivity and quality parameters. Performance of any crop depends upon its genetic makeup and climatic conditions of the region under which they are grown. Genotype which performs better in one region may not perform well in other regions due to varying climatic conditions. Hence, it is essential to collect and evaluate genotypes in order to select best genotype for a particular agro-climatic condition. Hence, the present investigation was conducted to find a suitable genotype for high altitude and tribal area of Visakhapatnam.

Materials and Methods

The experimental site was located in the Horticulture Research Station, Chinthapalli, Andhra Pradesh. The location falls under Agro-climatic zone of High Altitude and Tribal Zone with an average annual rainfall from South-west monsoon of more than 1200 mm, maximum temperature range 17 to 35 ºC, minimum temperature range from 3 to 24ºC and is located at an altitude of 933 m MSL. The geographical situation is 17^{0}.13' N latitude and 84^{0}.33' E longitudes. The experiment was laid out in a Randomised Block Design with 19 treatments and 3 replications. The planting was done on raised beds spaced row to row 30 cm with plant to plant distance of 25 cm and the net plot size was 3 x 1 m^2. The soil of the experimental field was alluvial and it was endowed with good drainage. Recommended package of practices and plant protection measures were followed to raise a healthy crop.

The observations were recorded for growth and yield parameters *viz*., plant height (cm), number of tillers and leaves per plant, leaf length and width (cm), leaf area per plant (cm^2), number of mother, primary and secondary rhizomes per plant, length of the mother, primary and secondary rhizome per plant, yield per plot (kg) and estimated fresh rhizome yield per hectare (t). The data were analysed as per statistical procedure given by Verma *et al.*, (1987).

Results and Discussion

In the present investigation, different turmeric genotypes measured at 150 days after planting varied significant variation with regard to plant height, number of tillers per plant, number of leaves per plant, leaf area per plant. Among the cultivars studied, CLA-1 recorded the highest plant height (169.2 cm) followed by NDH-98 (155.00 cm), Roma (151.66 cm) and CLA-5 (147.6 cm), whereas the lowest plant height was recorded in CLA-12 (91.16 cm) followed by CLA-11 (92.83 cm) and CLA-2 (103.66 cm). The longest leaf was recorded in CLA-1 (70.53 cm), followed by Roma (69.90 cm) and BSR-2 (64.40 cm), whereas the shortest leaf was observed in CLA-12 (39.17 cm) followed by CLA-14 (45.40 cm) and CLA-8 (45.67 cm). The maximum number of tillers recorded in CLA-5 (3.33) followed by CLA-2 (3.13) and CLA-1 (2.86), whereas the lowest number of tillers recorded in NDH-98 (1.00) followed by CLA-4 (1.40) and CLA-10 (1.80). In leaf width Roma (17.89 cm), CLA-11 (17.88 cm) and CLA-13 (17.68 cm) were found to be significantly more wider leaves than chinthapalli Local (17.23 cm). The highest number of leaves per plant was recorded in IISR- Prathibha (19.00) followed by BSR-2 (18.33) and CLA-5 (18.06) and Chinthapalli Local (18.00) and all these were on par with one another.

The lowest number of leaves per plant was recorded in CLA-4 (12.46) followed by CLA-10 (13.86) and CLA-3 (14.26) and it was observed that Chinthapalli Local (13703.96 cm^2) recorded the highest leaf area followed by BSR-2 (13454.61 cm^2) and these two were on par with each other (Table 1) under HAT zone conditions. The plant height, increased the number of leaves and leaf area leads to better photosynthesis of carbohydrates and their utilization by way of building up of new cells and thereby higher levels of growth, while the lowest plant height (91.16 cm) recorded in CLA-12 might be due to uptake of nutrients at lower rate resulted in lower plant growth under HAT zone conditions. Such variations in growth among different cultivars of turmeric were reported by several workers *Viz.,* Anusuya *et al.,* (2004), Jadhav *et al.,* (2009), Deshmukh *et al.,* (2009) and Ravindrakumar *et al.,* (2015) in turmeric grown under different conditions.

The genotype CLA-12 consistently showed poor growth in terms of plant height, number of tillers and number of leaves. Among the rhizome parameters, no significant variation was found with number of mother rhizomes per plant. Significantly higher number of primary rhizomes per plant was found in CLA-5 (7.93) followed by NDH-98 (7.40) and CLA-3 (6.73), whereas the highest number of secondary rhizomes per plant was found in CLA-5 (23.73), followed by CLA-1 (18.53) and CLA-3 (17.33).

The maximum length of mother rhizome was found in NDH-98 (12.07 cm) followed by CLA-4 (7.83 cm) and CLA-10 (7.67 cm). The highest length of primary rhizome was recorded in CLA-7 (9.47 cm) followed by CLA-10 (9.40 cm) and CLA-4 (9.40 cm) and length of secondary rhizome was recorded in CLA-3 (4.20 cm) followed by CLA-2 (3.87 cm) and CLA-12 (3.40 cm) (Table 2). Considerable variation with respect to yield and yield attributing characters like number of mother rhizomes, length of mother rhizome, number of primary rhizomes, length of primary rhizome, number of secondary rhizomes, length of secondary rhizome per plant was reported and acknowledged with earlier studies of Deshmukh *et al.,* (2009), Chaturvedi *et al.,* (2009), Veena (2012), Siddalingayya *et al.,* (2014), Ravindrakumar *et al.,* (2015) and Mohan *et al.,* (2017).

Table.1 Mean performance of turmeric genotypes for different plant growth characters

S. No	Genotypes	Plant height (cm)	Number of tillers per plant	Number of leaves per plant	Leaf length (cm)	Leaf width (cm)	Leaf area per plant (cm^2)
1.	CLA-1	169.20	2.86	15.06	70.53	16.87	12887.73
2.	CLA-2	103.66	3.13	16.06	47.49	12.63	6941.20
3.	CLA-3	107.13	2.06	14.26	46.53	13.69	6539.24
4.	CLA-4	132.63	1.40	12.46	57.80	16.50	8483.32
5.	CLA-5	147.60	3.33	18.06	57.00	15.19	11290.25
6.	CLA-6	141.83	1.93	16.46	60.40	14.91	10691.59
7.	CLA-7	109.93	2.66	17.93	46.87	14.37	8690.58
6.	CLA-8	103.92	2.86	17.93	45.67	14.71	8671.10
9.	CLA-9	103.76	2.46	17.80	46.20	14.35	8574.82
10.	CLA-10	122.53	1.80	13.86	54.93	14.47	8037.17
11.	BSR-2	138.06	2.60	18.33	64.40	15.93	13454.61
12.	CLA-11	92.83	2.66	16.33	47.33	17.88	9936.89
13.	CLA-12	91.16	2.00	15.53	39.17	12.20	5362.86
14.	CLA-13	137.13	1.86	16.60	61.60	17.68	13040.13
15.	CLA-14	114.00	2.40	16.40	45.40	12.80	6849.75
16.	NDH-98	155.00	1.00	16.13	60.53	16.57	11753.53
17.	Roma	151.66	2.26	14.60	69.90	17.89	13129.63
18.	IISR-Prathibha	140.23	2.13	19.00	60.07	15.20	12417.09
19.	Chinthapalli Local	139.42	2.53	18.00	62.00	17.23	13703.96
	SE(m) ±	5.12	0.29	1.34	1.68	0.72	123.42
	CD at 5%	10.44	0.60	2.74	4.84	2.08	354.00

Table.2 Yield and yield attributing characters of different turmeric genotypes

S.NO	Genotypes	Number of mother rhizomes	Length of mother rhizome	Number of primary rhizomes	Length of primary rhizome	Number of secondary rhizomes	Length of secondary rhizome	Yield per plot (kg)	Estimated fresh rhizome yield per ha (t)
1.	CLA-1	1.40	7.33	5.73	7.60	18.53	2.73	10.87	36.24
2.	CLA-2	1.93	5.90	5.80	9.13	13.20	3.87	11.24	37.49
3.	CLA-3	1.73	5.73	6.73	9.20	17.33	4.20	15.10	50.35
4.	CLA-4	1.40	7.83	4.53	9.40	12.40	3.07	8.43	28.10
5.	CLA-5	1.47	7.40	7.93	9.23	23.73	3.20	14.54	48.49
6.	CLA-6	1.67	7.00	5.77	8.13	12.73	3.07	8.56	28.55
7.	CLA-7	1.87	5.80	5.43	9.47	13.67	3.30	12.15	40.52
6.	CLA-8	1.53	5.53	5.13	8.33	11.00	3.38	9.51	31.70
9.	CLA-9	1.53	5.03	5.60	8.20	15.27	2.80	10.17	33.90
10.	CLA-10	1.37	7.67	5.10	9.40	10.20	2.80	8.04	26.80
11.	BSR-2	1.60	6.47	5.47	8.67	16.27	3.20	9.17	30.56
12.	CLA-11	1.47	5.77	4.37	9.33	7.80	3.37	8.39	27.97
13.	CLA-12	1.53	4.80	5.33	9.00	12.40	3.40	10.33	34.44
14.	CLA-13	1.80	6.23	4.93	7.90	12.73	3.20	10.47	34.92
15.	CLA-14	1.53	6.00	4.93	8.67	13.60	3.20	9.35	31.19
16.	NDH-98	1.00	12.07	7.40	7.47	15.67	2.83	10.99	36.65
17.	Roma	1.60	6.87	5.87	8.07	14.93	3.00	8.76	29.21
18.	IISR-Prathibha	1.87	6.97	6.00	8.60	14.00	2.93	8.65	28.84
19.	Chintapalli Local	1.20	6.20	5.60	8.13	13.93	2.87	7.71	25.86
	SE(m) ±	0.17	0.30	0.38	0.39	0.59	0.28	0.93	3.10
	CD at 5%	NS	0.86	1.09	1.14	1.69	N.S	2.70	8.94

Higher production of mother, primary and secondary rhizomes may be due to better growth and vigour in some genotypes, as a result yield might be highly influenced by these traits. The rhizome growth was also attributed to better absorption of nutrients from the soil.

The maximum yield per plot was observed in CLA-3 (15.10 kg), whereas the minimum was recorded in CLA-10 (8.04 kg). The maximum estimated fresh rhizome yield per hectare was recorded in CLA-3 (50.35 t), which was followed by CLA-5 (48.49 t) and these two were on par with each other. The lowest estimated fresh rhizome yield was recorded in the genotype CLA-10 (26.80 t). It might be attributed to the active photosynthesis favouring accumulation and assimilation of carbohydrates, as this genotype had recorded higher values for plant height, number of leaves and leaf area. These results are in collaborated with the earlier works of Yadav (2002), Pirjade *et al.*, (2007) and Jadhav *et al.,* (2009) in turmeric with regard to the relationship between yield and growth parameters. The yield is governed by genetic and environmental factors and varies with the genotypes which are in collaboration with the findings of Sheshagiri and Uthaiaha (1994). The yield of any crop majorly depends on the vigour of the plant as indicated by various growth parameters like plant height, number of leaves and rhizome characters. The best growth normally results in high yield and is influenced by genetic and environmental factors too under which the crop is grown

From the present investigation it was concluded that among the nineteen genotypes, the maximum yield per plot was observed in CLA-3 (15.10 kg) followed by CLA-5 (14.54 kg) whereas the minimum was recorded in CLA-10 (8.04 kg) and for fresh rhizome yield per hectare, CLA-3 (50.35 t), CLA-5 (48.49 t) and CLA-7 (40.52 t) were excelled than both the checks *i.e.* IISR Prathibha (28.84 t) and Chinthapalli Local (25.86 t),. Hence, these genotypes can be adopted for commercial cultivation after further testing.

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