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Research Article

Evaluation of different turmeric (*Curcuma longa* L.) varieties in Southern Laterites of Kerala

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Abstract
Genetic variability was studied for rhizome yield and its contributing characters among twenty seven turmeric (*Curcuma longa* L.) genotypes. The analysis of variation revealed significant differences among the genotypes for all traits *viz*., plant height, number of tillers, number of primary rhizomes per plant, number of secondary rhizomes per plant, yield per plant, length of mother rhizome, girth of mother rhizome, weight of mother rhizome, length of primary rhizome, girth of primary rhizome, weight of primary rhizome, length of secondary rhizome, girth of secondary rhizome and weight of secondary rhizome. Turmeric variety Shobha recorded the highest fresh rhizome yield which was on par with the yield given by the variety Punjab Haldi II and local type Sadanandapuram local. PCV was higher than GCV for all the characters indicating the influence of environment in the expression of traits, while the difference varied among the traits. High PCV and correspondingly high GCV was recorded for the all the characters studied except girth of mother rhizome and secondary rhizome. High heritability coupled with high GA was observed for all characters except number of primary and secondary rhizomes per plant indicating the additive nature and scope of improvement of these characters by phenotypic selection.

Keywords: Turmeric, *Curcuma longa* L., Variability, Heritability, Genetic advance

INTRODUCTION

Turmeric (*Curcuma longa* L.) (2n=3x=63) is the sacred spice of Asian countries, also known as “Indian saffron” due to its yellow coloured rhizomes which is used as condiment, food preservative, dye, drug and cosmetic in addition to its use in religious ceremonies (Prasath *et al*., 2017). Turmeric is a tropical rhizomatous perennial herb, also known as “hidden Lilly” or “golden spice” or “turmeric of commerce” or “spice of life” (Gopinath and Karthikeyan, 2018). Turmeric, the third important spice crop of India next to chillies and black pepper, belongs to the order Zingiberales and family Zingiberaceae and is native to South East Asia. It is cultivated in India which constitutes 82% of area, China (8%), Myanmar (4%), Nigeria (3%) and Bangladesh (3%) (Moghe *et al*., 2012). In India nearly 40 species of *Curcuma* are known to exist while *Curcuma longa* contributes to 96 per cent of production of turmeric of commerce. India is the major producer, exporter and consumer of turmeric and Indian turmeric is apparently the best in the world due to its inherent qualities and high curcumin content (Prasad and Aggarwal, 2011). In India, it is used in all culinary preparations for its typical color, flavor and antimicrobial properties. Rhizomes are the economically important plant part and it contains a yellow-coloured chemical called curcumin. Turmeric is also used in traditional medicine, cosmetics and as dye in textile industries (Pruthi, 1976). It is commonly used for the treatment of arthritis, heartburn (dyspepsia), joint pain, stomach pain,

haemorrhage, diarrhoea, intestinal gas, stomach bloating, loss of appetite, jaundice, liver problems, *Helicobacter pylori (H. pylori)* infection, irritable bowel syndrome (IBS), gallbladder disorders, high cholesterol, skin inflammation from radiation treatment and fatigue. Dry rhizomes contain about 69.43 per cent carbohydrates, 6.3 per cent protein, 5.1 per cent oil and 3.5 per cent mineral and other important elements (Shakur, 2000). Major constraints in turmeric cultivation are non-availability of requisite high yielding genotypes, slow multiplication rate, average productivity, unsatisfactory quality of available cultivars and loss due to disease during cultivation and storage (Ayer, 2017). Breeding programs for genetic improvement in turmeric need to be based on the agroclimatic condition of the region and diverse genetic backgrounds. The yield of turmeric can be improved by the use of high yielding cultivars suited to the specific agroclimatic conditions of different growing tracts. Presence of ample variability is the pre – requisite of any breeding programme. This study focuses on the evaluation of variability present in the genotypes and identification of superior genotypes suited to the southern laterites of Kerala.

MATERIALS AND METHODS

Twenty seven accessions comprising of released varieties and local genotypes (**Table 1**) of turmeric were evaluated as intercrop in coconut garden at Farming Systems Research Station, Sadananadapuram, Kottarakara, Kerala in a randomized block design with two replications during April, 2019 – February, 2020. The rhizomes were planted in raised beds of (2.5 x 2.5) m^2 size at a spacing of 25 cm x 25 cm**.** The genotypes were evaluated for growth and yield characters such as plant height (cm), number of tillers, number of primary rhizomes per plant, number of secondary rhizomes per plant, length of mother rhizome (cm), girth of mother rhizome (cm), weight of mother rhizome (g), length of primary rhizome (cm), girth of primary rhizome(cm), weight of primary rhizome (g), length of secondary rhizome (cm), girth of secondary rhizome (cm), weight of secondary rhizome (g) and yield per plant (g). The mean values of growth and yield characters were subjected to statistical analysis (ANOVA) as suggested by Panse and Sukhatme (1967) and genetic parameters were worked out using Grapes software (version 1. 14. 02).

RESULTS AND DISCUSSION

The perusal of analysis of variance data (**Table 2**) revealed significant difference among the turmeric accessions for all the 14 characters studied indicating

Table 1. Source of varieties / accessions of *Curcuma longa* L. used in the present study

S. No.	Variety/ Accession	Source
1	Kanthi	Kerala Agricultural University
2	Shobha	Kerala Agricultural University
3	Varna	Kerala Agricultural University
4	IISR Prabha	Indian Institute of Spices Research, Calicut
5	IISR Prathibha	Indian Institute of Spices Research, Calicut
6	IISR Alleppy Supreme	Indian Institute of Spices Research, Calicut
7	IISR Suvarna	Indian Institute of Spices Research, Calicut
8	IISR Suguna	Indian Institute of Spices Research, Calicut
9	Roma (High Altitude Research Station, Odisha)	Indian Institute of Spices Research, Calicut
10	Suroma (High Altitude Research Station, Odisha)	Indian Institute of Spices Research, Calicut
11	Renga (High Altitude Research Station, Odisha)	Indian Institute of Spices Research, Calicut
12	Resmi (High Altitude Research Station, Odisha)	Indian Institute of Spices Research, Calicut
13	BSR-I (Tamil Nadu Agricultural University)	Indian Institute of Spices Research, Calicut
14	BSR-II (Tamil Nadu Agricultural University)	Indian Institute of Spices Research, Calicut
15	Rajendra Sonia (Tirhut College of Agriculture, Bihar)	Indian Institute of Spices Research, Calicut
16	Mega Turmeric (ICAR Research Complex for NEH Region, Shillong)	Indian Institute of Spices Research, Calicut
17	Punjab Haldi I (Punjab Agricultural University)	Indian Institute of Spices Research, Calicut
18	Punjab Haldi II (Punjab Agricultural University)	Indian Institute of Spices Research, Calicut
19	Pant Peetab (GB Pant University of Agriculture & Technology, Uttarakhand)	Indian Institute of Spices Research, Calicut
20	Duggirala Red (YSR Andhra Pradesh Horticultural University, Jagtial)	Indian Institute of Spices Research, Calicut
21	Narendra Haldi (Narendra Deva University of Agriculture & Technology, Faizabad)	Indian Institute of Spices Research, Calicut
22	TBGRI Local	Palode
23	Kasaragod Local	Kasaragod
24	Kanjikuzhy Local	Kanjikuzhy
25	Kuttipuram Local	Kuttipuram
26	Aluva Local	Aluva
27	Sadanandapuram Local	Sadanandapuram

Table 2. Analysis of variance of different characters in turmeric genotypes

Characters	Mean Sum of Squares		
	Genotype	Replication	Error
Plant height	1373.48 **	2173.35	314.05
Number of tillers	161.31 **	15.86	34.84
Number of primary rhizomes per plant	38.39 **	7.59	12.12
Number of secondary rhizomes per plant	439.77 *	21.75	215.74
Yield per plant	28132.96 **	3585.51	5264.99
Length of Mother rhizome	10.39 **	1.37	0.58
Girth of Mother rhizome	5.25 **	1.68	0.81
Weight of Mother rhizome	1042.96 **	74.74	38.21
Length of Primary rhizome	9.32 **	0.018	0.29
Girth of Primary rhizome	3.39 **	0.65	0.60
Weight of Primary rhizome	55.47 **	0.06	4.23
Length of Secondary rhizome	2.24 **	1.55	0.34
Girth of Secondary rhizome	1.14 **	0.27	0.17
Weight of Secondary rhizome	17.18 **	0.45	1.99

** Significant at 1% level * Significant at 5% level

substantial amount of variability. The mean values (**Table 3**) showed high variation for all the characters. The plant height values varied from 36 to 143 cm, number of tillers from 7 to 39, number of primary rhizomes per plant from 4.9 to 22.63 and number of secondary rhizomes per plant from 9.05 to 59.08. The length, girth and weight of mother rhizomes ranged between 6.94 cm and 94.62 cm, 5.22 cm and 11.98 cm and 3.19 g and 14.55 g ,respectively. The dimensions of primary rhizomes varied from 4.72 to 11.97 cm for length, 3.2 to 9.52 cm for girth and 6.55 to 27.82 g for weight. Similarly the dimensions of secondary rhizome ranged from 2.25 to 6.62 cm for length, 2.63 to 6.14 cm for girth and 1.21 to 15.37 g for weight. The yield per plant varied between 159.37g and 645.31g.

The highest mean for length, girth and weight of mother rhizome was recorded for the local type Kasargod local. The variety Narendra Haldi exhibited the highest mean values for girth and weight of primary and secondary rhizome, while IISR Alleppey Supreme recorded thr highest mean value for length of primary and secondary rhizomes. The highest mean value for plant height was observed for the variety Mega turmeric, number of tillers for variety Resmi, number of primary rhizomes per plant for the local type TBGRI local and number of secondary rhizomes per plant for the variety IISR Prabha. Variety Shobha recorded the highest yield per plant which was on par with the yield of variety Punjab Haldi II and the local type Sadanandapuram local (**Fig. 1**).

The estimates of mean, coefficient of variation, heritability and genetic advance as per cent of mean (**Table 4**) revealed that for all the characters phenotypic coefficient of variation (PCV) was greater than genotypic coefficient of variation (GCV). The difference between PCV and GCV was less for most of the characters where the traits length of primary rhizome and number of secondary rhizomes per plant recorded the least difference (0.89) and the highest difference (25.31), respectively. The highest PCV and GCV values were noted for the trait weight of mother rhizome (94.33 and 90.94) and the lowest values for girth of secondary rhizome (20.79 and 17.92). High PCV was exhibited by all the characters, whereas high GCV was observed for the characters except girth of mother rhizome and secondary rhizome which showed moderate GCV. The PCV and GCV estimates were in conformity with the findings of Sikhon (2012) for weight of mother and primary rhizomes, Arathy *et al.* (2018) for number of tillers, length of mother rhizome, girth of mother rhizome, girth of primary rhizome, weight of mother rhizome, weight of primary rhizome and fresh rhizome yield per plant, Maurya *et al.* (2018) for number of tillers, number of primary rhizomes per plant, number of secondary rhizomes per plant, weight of primary rhizome and weight of fresh rhizome per plant and Mamatha *et al.* (2020) for number of tillers per plant, girth of mother rhizome and secondary rhizomes.

For selection to be effective heritability estimates along with genetic gain is required. In this study, all the characters exhibited high heritability except for number of primary and secondary rhizomes per plant which showed moderate heritability. The highest heritability was recorded for the trait length of primary rhizome (93.9%) followed by weight of mother rhizome (92.9%).

Table 3. Mean values of biometric characters of different genotypes of turmeric in Southern laterites of Kerala

S. No.	Genotypes	PH (cm)	NT	NP	NS	YPP (g/plant)	MR_L (cm)	MR_G (cm)	MR_W (g)	PR_L (cm)	PR_G (cm)	PR_W (g)	SR_L (cm)	SR_G (cm)	SR_W (g)
1	Kanthi	85	12	10.54	43.13	440.47	4.35	7.68	12.15	11.92	4.02	13.27	6.22	3.79	6.54
2	Sobha	82.25	12.3	8.94	46.06	645.31	6.35	7.35	19.78	10.25	7.23	15.03	5.93	3.10	4.01
3	Varna	66	7	7.89	42.67	566.66	4.55	7.43	15.18	10.80	5.15	19.52	4.28	3.40	4.08
4	IISR Prabha	107.5	9.34	6.82	59.08	529.17	5.88	9.03	18.04	10.98	5.43	20.54	4.25	4.20	8.79
5	IISR Prathibha	120	31.22	16.25	36.92	437.5	4.43	6.59	11.94	7.01	5.61	11.82	3.60	3.65	3.08
6	IISR Alleppey Supreme	107	20	7.75	9.60	443.75	6.68	9.48	27.63	11.98	4.83	24.23	6.63	4.50	8.76
7	IISR Suvarna	99	11.7	6.40	35.52	518.75	5.88	9.00	12.35	5.53	5.05	8.99	2.90	3.90	2.52
8	IISR Suguna	76.5	19.17	6.50	32.00	307.14	6.18	7.90	19.02	7.75	4.85	13.86	5.28	4.38	5.77
9	Roma	88.67	12.67	6.04	9.40	159.38	4.70	7.83	10.05	7.64	5.92	16.38	4.97	4.40	4.35
10	Suroma	103.5	14.5	5.42	12.65	354.58	8.51	7.96	12.08	8.53	5.53	14.49	4.16	3.99	3.26
11	Renga	112	10.67	6.32	23.81	473.44	9.55	10.53	78.85	7.03	4.68	14.91	4.70	4.50	9.07
12	Resmi	62.5	39	9.14	17.50	473.61	6.13	8.79	23.91	5.30	6.05	20.86	3.45	4.23	5.22
13	BSR 1	132.5	12.5	8.78	39.31	485.28	9.15	10.75	63.29	7.30	5.33	14.11	3.98	4.78	5.33
14	BSR 2	125	13	11.83	27.95	387.5	5.17	6.69	11.71	7.70	3.99	9.12	3.04	2.63	1.97
15	Rajendra Sonia	52.5	8.5	5.23	17.90	477.5	3.20	5.22	6.94	6.30	3.20	6.56	2.25	2.90	1.22
16	Mega Turmeric	143	30.5	11.88	23.46	434.69	4.95	7.70	13.28	5.60	5.28	10.57	3.15	3.98	3.64
17	Punjab Haldi 1	92.5	15	4.90	10.20	212.5	4.55	6.32	7.83	7.15	3.43	7.60	4.00	3.15	3.52
18	Punjab Haldi 2	116.63	17.3	6.52	38.25	597.75	7.05	8.80	23.06	7.33	4.38	9.31	4.28	3.28	3.30
19	Pant Peetab	62	15.22	7.52	51.13	456.25	6.03	6.93	13.15	11.05	3.83	11.22	4.48	2.98	3.12
20	Duggirala Red	85.5	21.67	8.45	46.77	465.97	7.85	9.35	48.59	5.89	5.44	12.39	3.34	4.12	5.44
21	Narendra Haldi	36	9	5.38	13.50	250	4.78	5.53	9.71	9.53	9.53	27.83	5.63	6.14	15.38
22	TBGRI local	105	37.5	22.63	32.13	453	4.98	7.33	12.44	5.50	4.95	9.66	3.00	3.43	2.65
23	Kasargod local	68.5	8	6.81	19.25	328.13	14.55	11.99	94.63	5.71	5.54	11.84	3.70	4.59	6.38
24	Kanjikuzhi local	106	19	9.46	52.28	261.08	8.27	10.31	55.04	6.48	6.48	14.73	3.69	3.23	3.86
25	Kuttipuram local	120	16.5	13.64	21.70	390.97	6.03	6.73	17.26	4.73	4.40	8.95	3.60	4.42	7.28
26	Aluva local	122.5	26.5	19.15	30.92	359.91	4.72	7.04	12.03	6.55	3.95	6.96	4.00	3.14	2.91
27	Sadananadapuram local	82.5	28.5	12.75	9.05	580	5.53	7.45	15.62	6.80	6.80	10.99	4.28	4.38	5.04
	Mean	94.82	17.71	9.37	29.71	425.57	6.29	8.06	24.65	7.71	5.22	13.54	4.18	3.89	5.05
	S. E. (m)	12.53	4.17	2.46	10.39	51.31	0.54	0.64	4.37	0.38	0.55	1.45	0.41	0.29	0.99
	C. D. (5%)	36.42	12.13	7.16	30.19	149.15	1.57	1.85	12.71	1.12	1.59	4.25	1.19	0.84	2.90

PH – Plant height NT – Number of tillers; NP – Number of primary rhizomes per plant;;NS – Number of secondary rhizomes per plant YPP – Yield per plant; MR_L – Length of mother rhizome; MR_G – Girth of mother rhizome;;MR_W – Weight of mother rhizome; PR_L – Length of primary rhizome; PR_G – Girth of primary rhizome; PR_W – Weight of primary rhizome; SR_L – Length of secondary rhizome; SR_G – Girth of secondary rhizome; SR_W – Weight of secondary rhizome

Similar results were reported by Sikhon (2012) for the dimensions of primary and secondary rhizomes, length and weight of mother rhizome, yield per plant and Luiram *et al.* (2018) for number of primary rhizomes per plant, rhizome yield and Krishna *et al.* (2019) for plant height, number of tillers, length of mother rhizome and fresh rhizome yield per plant. Genetic advance as per cent of mean was high for all the characters indicating high genetic gain for these traits under selection. High heritability coupled with high GA was observed for all characters except number of primary and secondary rhizomes per plant indicating the additive nature so that phenotypic selection will be effective for those characters. The finding is supported by the reports of Salimath *et al.* (2017) for plant height, number of tillers per plant, number of primary fingers per plant, number of secondary fingers, weight of mother rhizome, weight of primary fingers, length of primary fingers and length of secondary rhizome,

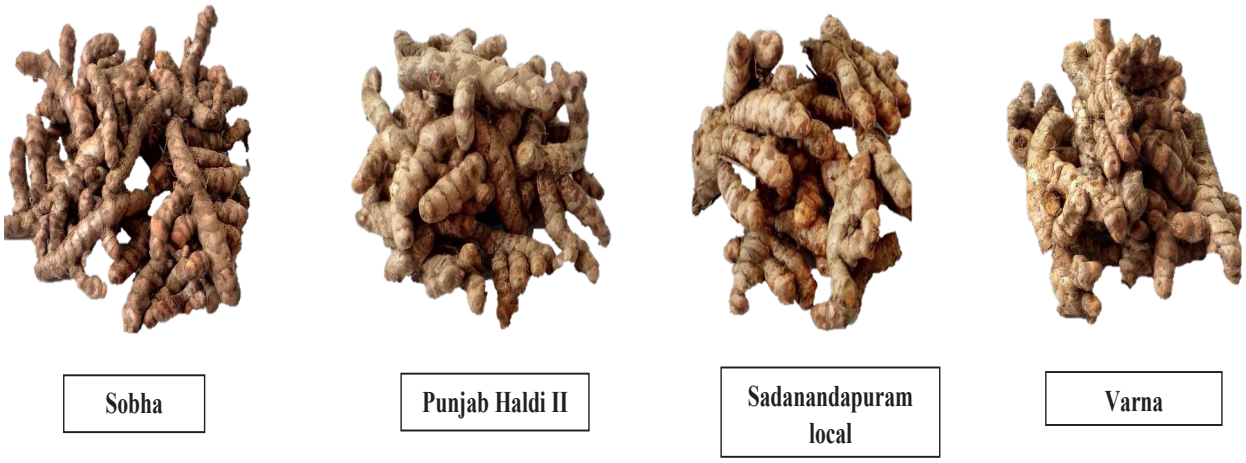

Fig. 1. Rhizomes of superior genotypes of turmeric

Table 4. Genetic parameters of different characters in turmeric genotypes

Character	Mean	PCV (%)	GCV (%)	H^2 (%)	GA (%)
Plant height (cm)	94.82	30.64	24.27	62.8	39.62
Number of tillers	17.71	55.91	44.89	64.5	74.26
Number of primary rhizomes per plant	9.37	53.66	38.69	52	57.49
Number of secondary rhizomes per plant	29.71	60.94	35.63	34.2	42.9
Yield per plant (g)	425.57	30.36	25.13	68.5	42.83
Length of Mother rhizome (cm)	6.29	37.22	35.19	89.4	68.57
Girth of Mother rhizome (cm)	8.06	21.59	18.47	73.2	32.55
Weight of Mother rhizome (g)	24.65	94.33	90.94	92.9	98.59
Length of Primary rhizome (cm)	7.71	28.42	27.53	93.9	54.94
Girth of Primary rhizome (cm)	5.22	27.11	22.68	69.9	39.07
Weight of Primary rhizome (g)	13.54	40.34	37.37	85.8	71.32
Length of Secondary rhizome (cm)	4.18	27.17	23.36	74	41.39
Girth of Secondary rhizome (cm)	3.89	20.79	17.92	74.4	31.84
Weight of Secondary rhizome (g)	5.05	61.28	54.55	79.2	95.02

Vinodhini *et al.* (2018) for plant height, number of tillers, yield per plant, length of mother rhizome, girth of mother rhizome, girth of primary rhizome and girth of secondary rhizome, Krishna *et al.* (2019) for plant height, length of mother rhizome and rhizome yield per plant. Moderate heritability with high genetic advance was observed for the traits number of primary rhizomes per plant and number of secondary rhizomes per plant which indicates that they can be improved by indirect selection.

Based on the above findings, yield recorded by the turmeric varieties Shobha, Punjab Haldi II, local genotype Sadanandapuram local was found to be on par and superior to all other varieties. Hence, these varieties can be recommended for cultivation in the Southern laterites of Kerala. The results also revealed ample variability among the genotypes for all the characters studied along with high values of genetic parameters for most of the characters implying that they can be included in crop improvement programs.

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