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Studies on Genetic Variability, Hertability and Genetic Advance in Turmeric (*Curcuma longa* L.)

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A B S T R A C T

The present investigation was carried out to estimate the genetic variability, heritability and genetic advance analysis among 25 genotypes of turmeric for rhizomes yield and its contributing characters. These genotypes were planned in Randomized Block Design with three replications during June, 2017 to March, 2018 at Protected Cultivation Unit of the College of Horticulture and Forestry, Jhalawar, Rajasthan. The analysis of variance indicated presence of considerable variability for all the 21 characters. High genotypic coefficient of variance (GCV) and phenotypic coefficient of variation (PCV) were recorded for per cent fresh weight of secondary rhizomes per plant followed by dry weight of rhizomes per plant, number of tillers per plant and length of mother rhizomes per plant. Therefore, these characters can be improved through selection programme.

Introduction

Turmeric (*Curcuma longa* L.) a perennial herbaceous plant belonging to the family Zingiberaceae under the natural orders Scitaminae. Its native of South East Asia and chromosome number is 2n = 32. The karyomorphological studies concluded that the species seems to be allotetraploid with basic chromosome number of X = 8 (Sato, 1960). It is cultivated for its underground stem called as rhizomes, which are used for medicinal and culinary purpose and also as a cosmetic and a natural dye. It is grown in an area of 233 thousand hectares with an average of annual production of 1190 thousand tones.

It is a principal ingredient in curry powder. Turmeric oleoresin is used in brine pickles and to some extent in non-alcoholic beverages, gelatins, butter and cheese etc. It is used in the preparation of medicinal oils, ointments and poultice. It is also used in stomachic, carminative, tonic, blood purifier and an antiseptic. The aqueous extracts have biopesticidal properties (Prajapati *et al.*, 2014).

Turmeric of commerce is valued for its deep yellow colour and pungent aromatic flavor due to the presence of colouring matter 'curcumin' and a volatile oil 'terminol'. Curcumin content present in turmeric range between 3.5 to 9 %.

Quality of turmeric depends on its size, colour, dry matter content and number of rhizomes per plant etc. Turmeric is cultivated in many parts of countries and has wide range of variability among the different quantitative and qualitative characters. The critical assessment of variability is prerequisite for any efficient breeding programme and provides opportunity to identify the superior genotypes with desirable yield, related traits and quality characters. The turmeric is mainly propagated asexually through rhizomes, some varieties or genotypes produce flowers but these flowers do not set seed. Not much work is carried out on crop improvement of turmeric in India. There is no planned multiplication programmes for planting material. Hence, present investigation was under taken to study the genetic variability present in different genotypes of turmeric.

Materials and Methods

The planting material considered of 25 genotypes / varieties collected from different region of states of India and maintained at the Division of Vegetable Science. College of Horticulture and Forestry, Jhalarapatan City, Jhalawar, Rajasthan, India.

The experiment was laid out in a Randomized Block Design (RBD) with three replications. Each genotype was sown in raised bed of 1×1 m^2 area on June, 2017 to March, 2018. A distance of 45 cm between rows and 20 cm between plants was maintained. All the cultural operations like field preparation, fertigation, irrigation, weeding, plant protection measures etc. were carried out as per recommendations in order to raise a successful crop.

The observation was recorded at maximum growth stage and after harvesting on randomly selected 5 plants in each replication for all the characters *viz.*, plant height (cm), number of tillers per plant, number of leaves per plant, leaf width (cm), leaf length (cm), girth of stem (cm), girth of mother rhizomes per plant (cm), girth of primary rhizomes per plant (cm), girth of secondary rhizomes per plant (cm), length of mother rhizomes per plant (cm), length of primary rhizomes per plant (cm), length of secondary rhizomes per plant (cm), number of mother rhizomes per plant, number of primary rhizomes per plant, number of secondary rhizomes per plant, fresh weight of primary rhizomes per plant (g), fresh weight of secondary rhizomes per plant (g), dry weight of rhizomes per plant (g), days to harvest, curcumin content (%) and yield per plant (g). The curcumin content was estimated by adopting the spectrometer method given by Geethanjali *et al.,* (2016). The data statistically analyzed for variance using the standard procedure by Gomez and Gomez (1983). The genotypic and phenotypic coefficient of variations was analyzed as suggested by Burton and De-Vane (1953). Heritability in broad sense and expected genetic advance as percentage of mean was calculated using the method suggested by Johnson *et al.,* (1955).

Results and Discussion

Mean performance and genetic variability

In the present investigation, significant differences among the genotypes were obtained for all the characters, suggesting thereby the presence of significant variation among the genotypes of these traits. Based on the mean value with respect to characters, the genotype JWRH-5 was the higher yielder followed by JWRH-8 and JWRH-7 (Table 1-4).

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

Genotypes	Plant height (cm)	Number of tillers per plant	Number of leaves per plant	Leaf width (cm)	Leaf length (cm)	Girth of stem (cm)
Krishna	137.69	3.00	20.22	14.66	75.86	5.31
JWRH-1	143.80	4.83	17.31	15.25	84.16	5.95
Laka Dong	146.71	4.73	21.48	17.26	74.30	6.75
JWRH-2	144.13	4.00	20.22	17.15	90.03	5.35
JWRH-10	145.59	2.31	19.25	16.91	83.39	6.38
JWRH -11	142.16	1.06	17.78	17.98	74.40	7.08
GNT-1	150.16	3.80	22.90	18.94	82.27	6.07
JWRH-3	139.86	3.52	20.33	16.69	82.87	5.40
JWRH-4	142.78	3.84	19.67	15.45	83.82	5.88
JWRH-7	161.05	3.88	19.96	16.60	93.73	6.07
JWRH-9	153.26	3.35	20.70	20.05	92.30	6.20
JWRH-6	148.05	4.43	21.18	18.93	80.18	5.93
Patangadi	142.90	3.84	20.18	18.36	79.56	7.01
Erode local	147.00	3.46	21.63	19.84	90.14	6.85
Salem	120.20	1.51	21.22	15.26	70.80	5.19
Belogaum local	125.36	2.55	21.74	15.28	76.58	5.80
JWRH-13	140.75	3.61	22.85	17.25	73.17	4.87
JWRH-12	136.43	2.94	25.30	16.71	79.14	6.61
Keshar	148.16	4.90	21.14	18.32	80.37	6.94
JWRH-17	156.68	3.66	23.47	18.31	84.38	7.36
JWRH-5	162.83	0.66	22.48	19.39	85.44	8.22
JWRH-8	156.33	0.33	21.78	20.22	80.53	8.86
JWRH-14	147.53	3.08	20.70	21.69	73.98	6.17
JWRH-15	145.66	3.06	21.41	15.52	73.48	4.83
JWRH-16	132.36	3.83	21.10	17.39	71.47	4.81
Mean	**144.70**	**3.21**	**21.04**	**17.57**	**80.65**	**6.23**
Range	120.20-162.83	0.33-4.90	17.31-25.30	14.66-21.69	70.80-93.73	4.81-8.86
SE (±)	2.28	0.30	0.66	0.41	0.59	0.29
CD (5%)	6.51	0.86	1.90	1.18	1.70	0.84
CV	2.74	16.45	5.50	4.12	1.28	8.23

Table.2 Mean performance of turmeric genotypes for characters of mother and primary rhizomes

	Mother rhizomes			Primary rhizomes			
Genotypes	Number per plant	Girth (cm)	Length (cm)	Number per plant	Girth (cm)	Length (cm)	Fresh weight per plant (g)
Krishna	0.96	2.74	5.06	6.33	2.74	6.68	250.49
JWRH-1	1.07	2.04	3.51	6.96	2.04	6.94	128.85
Laka Dong	1.01	2.00	5.47	7.33	2.00	6.43	240.26
JWRH-2	1.05	2.72	6.46	7.93	1.86	7.66	210.26
JWRH-10	1.12	2.45	4.99	6.76	2.29	8.29	175.74
JWRH -11	1.01	4.70	12.04	9.80	2.44	7.01	180.22
GNT-1	1.23	3.37	3.81	9.43	2.20	6.69	226.66
JWRH-3	1.10	1.70	6.12	10.82	1.73	7.96	158.63
JWRH-4	1.05	2.61	4.57	6.73	2.61	9.14	243.48
JWRH-7	1.04	2.98	4.59	5.83	2.98	6.82	287.06
JWRH-9	1.06	2.12	4.77	10.56	2.09	6.78	178.51
JWRH-6	1.10	2.05	4.81	6.46	2.40	6.71	337.43
Patangadi	1.16	2.20	5.49	7.52	2.20	7.08	203.33
Erode local	1.03	3.41	5.76	10.63	2.10	8.20	248.85
Salem	1.21	2.60	3.99	4.96	2.60	5.99	128.59
Belogaum local	1.21	2.83	4.18	7.82	2.61	6.01	102.83
JWRH-13	1.10	3.80	6.36	5.98	2.23	8.47	288.33
JWRH-12	1.39	2.78	6.16	5.73	2.56	7.35	121.96
Keshar	1.09	1.93	5.53	6.20	2.45	8.34	210.11
JWRH-17	1.10	2.14	5.33	10.86	2.07	6.80	203.70
JWRH-5	1.14	3.81	10.06	9.96	2.70	7.96	265.95
JWRH-8	1.00	3.74	10.37	11.59	2.77	7.23	221.78
JWRH-14	1.02	2.64	5.37	5.87	2.64	8.60	210.48
JWRH-15	1.40	3.40	6.50	5.74	2.41	7.84	140.15
JWRH-16	1.30	1.68	5.55	6.28	2.01	6.88	230.38
Mean	1.12	2.74	5.87	7.76	2.35	7.35	207.76
Range	0.96-1.40	1.68-4.70	3.51-12.04	4.96-11.59	1.73-2.98	5.99-9.14	102.83-337.43
SE (±)	0.03	0.23	0.38	0.35	0.19	0.34	8.64
CD (5%)	0.08	0.65	1.09	1.01	0.56	0.97	24.58
CV	4.64	14.61	11.29	7.92	14.61	8.10	7.20

Table.3 Mean performance of turmeric genotypes for characters of secondary rhizomes and days to harvest

Genotypes	Secondary rhizomes				
	Number per plant	Girth (cm)	Length (cm)	Fresh weight per plant (g)	Days to harvest
Krishna	10.51	2.36	5.19	122.48	251.52
JWRH-1	12.81	2.52	6.60	190.11	247.33
Laka Dong	16.73	1.98	5.84	136.99	245.74
JWRH-2	9.72	1.63	5.41	100.41	264.79
JWRH-10	12.96	1.88	5.43	309.33	253.74
JWRH -11	14.36	1.67	4.17	105.26	259.66
GNT-1	14.33	1.60	6.10	145.29	221.47
JWRH-3	16.14	1.75	6.66	162.16	266.58
JWRH-4	12.16	2.66	7.55	253.52	250.33
JWRH-7	10.48	2.65	5.60	220.37	250.7
JWRH-9	15.80	2.04	4.75	103.62	261.33
JWRH-6	14.71	2.40	6.08	148.59	257.45
Patangadi	17.04	2.15	7.60	213.66	228.66
Erode local	12.81	1.77	5.36	168.44	218
Salem	6.02	1.85	2.75	98.44	234.21
Belogaum local	8.81	2.49	6.81	106.85	248.78
JWRH-13	12.02	2.74	6.83	155.11	246.66
JWRH-12	9.97	2.42	6.09	286.03	229.82
Keshar	10.06	2.40	6.43	121.40	233.04
JWRH-17	16.31	1.85	4.46	105.67	240.74
JWRH-5	14.41	1.88	4.92	65.31	220.66
JWRH-8	21.02	1.88	5.28	110.07	247
JWRH-14	13.73	2.41	6.92	117.48	246.85
JWRH-15	11.06	2.44	5.87	225.41	267.44
JWRH-16	11.44	2.09	6.57	245.22	219.77
Mean	**13.01**	**2.14**	**5.81**	**160.69**	**244.49**
Range	6.02-21.02	1.60-2.74	2.75-7.60	65.31-309.33	218.00-267.44
SE (±)	0.81	0.16	0.47	5.57	3.50
CD (5%)	2.31	0.48	1.35	16.71	9.96
CV	10.84	13.64	14.24	6.33	2.48

Table.4 Mean performance of turmeric genotypes for yield and different quality characters

Genotypes	Yield per plant (g)	Dry weight of rhizomes per plant (g)	Curcumin content (%)
Krishna	449.16	56.43	2.02
JWRH-1	428.82	87.01	2.12
Laka Dong	390.20	81.65	2.05
JWRH-2	445.20	93.39	1.60
JWRH-10	518.63	94.14	2.14
JWRH -11	514.29	105.68	1.69
GNT-1	423.64	112.04	3.44
JWRH-3	375.31	24.68	2.24
JWRH-4	538.92	124.49	2.16
JWRH-7	549.66	123.44	4.15
JWRH-9	281.49	70.55	1.78
JWRH-6	434.16	35.54	1.66
Patangadi	475.15	100.27	2.80
Erode local	512.61	121.66	2.65
Salem	292.48	74.36	2.64
Belogaum local	528.33	119.33	2.83
JWRH-13	457.06	104.97	2.05
JWRH-12	422.71	101.33	2.41
Keshar	510.78	107.48	2.60
JWRH-17	510.41	101.40	2.67
JWRH-5	825.06	200.90	2.39
JWRH-8	698.00	188.46	1.93
JWRH-14	510.50	120.03	3.15
JWRH-15	465.69	114.05	2.12
JWRH-16	284.08	56.40	1.74
Mean	**473.69**	**100.79**	**2.36**
Range	281.49-825.06	24.68-200.90	1.60-4.15
SE (±)	4.16	2.41	0.05
CD (5%)	11.83	6.88	0.14
CV	1.52	4.15	3.66

Table 1.5 Estimates of phenotypic and genotypic coefficients of variability, heritability, genetic advance and genetic gain for different characters in turmeric

S.No.	Characters	Coefficients of variability (%)		Heritability (%)	Genetic advance	Genetic gain (%)
		GCV	PCV			
1	Plant height (cm)	6.60	7.15	85.31	18.18	12.56
2	Number of tillers per plant	37.01	40.50	83.50	2.23	69.67
3	Number of leaves per plant	7.36	9.18	64.10	2.55	12.14
4	Leaf width (cm)	10.16	10.96	85.90	3.41	19.39
5	Leaf length (cm)	8.02	8.13	97.50	13.17	16.33
6	Girth of stem (cm)	15.51	17.56	78.01	1.76	28.22
7	Girth of mother rhizomes per plant (cm)	26.57	30.33	76.82	1.31	47.97
8	Girth of primary rhizomes per plant (cm)	10.57	18.03	34.34	0.30	12.76
9	Girth of secondary rhizomes per plant (cm)	14.62	20.00	53.51	0.47	22.03
10	Length of mother rhizomes per plant (cm)	34.34	36.15	90.24	3.95	67.20
11	Length of primary rhizomes per plant (cm)	10.42	13.20	62.30	1.24	16.96
12	Length of secondary rhizomes per plant (cm)	17.06	22.22	58.94	1.56	26.98
13	Number of mother rhizomes per plant	9.96	10.99	82.20	0.20	18.61
14	Number of primary rhizomes per plant	25.79	26.98	91.47	3.94	50.79
15	Number of secondary rhizomes per plant	23.85	26.20	82.91	5.82	44.74
16	Fresh weight of primary rhizomes per plant (g)	27.55	28.47	93.60	114.08	54.91
17	Fresh weight of secondary rhizomes per plant (g)	40.46	40.96	97.68	132.34	82.36
18	Dry weight of rhizomes per plant (g)	38.65	38.88	98.96	79.80	79.18
19	Days to harvest	6.01	6.50	85.44	28.00	11.45
20	Curcumin content (%)	25.33	25.60	98.00	1.22	51.66
21	Yield per plant (g)	24.69	24.74	99.62	240.53	50.77

Among all the characters, high phenotypic and genotypic coefficient of variation was recorded for per cent fresh weight of secondary rhizomes per plant followed by dry weight of rhizomes per plant, number of tillers per plant and length of mother rhizomes per plant. These results are in conformity with the results of pervious work Singh *et al.*, (2003). However, the low estimates of PCV observed for characters like length of primary rhizomes per plant, number of mother rhizomes per plant, leaf length and width, number of leaves per plant, plant height and days to harvest indicated that the genotypes used had less genetic variability for these characters. While, girth of primary and secondary rhizomes per plant, length of primary rhizomes per plant, leaf width and leaf length, number of mother rhizomes per plant, number of leaves per plant, plant height and days to harvest, GCV were low.

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