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Studies on genetic variability, heritability and genetic advance in turmeric [*Curcuma longa* L.] under low hills of Himachal Pradesh

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Abstract

The present investigation “Studies on genetic variability, heritability and genetic advance in turmeric [*Curcuma longa* L.]” under low hills of Himachal Pradesh was carried out at Vegetable Research Farm, Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur (HP) during summer-rainy season, 2019. Twenty-one genotypes were evaluated in Randomized Complete Block Design with three replications to ascertain extent of variability, heritability and genetic advance for yield and other horticultural traits among the genotypes. Analysis of variance showed significant differences among all the genotypes for all the characters under study. Three genotypes namely LC-T-20-18, LC-T-9-18 and LC-T-12-18 were found to be high yielding as well as better from consumer’s point of view. They could be the promising parents for utilization in further breeding programmes. Moderate PCV and GCV were observed for weight of mother rhizome, length of mother rhizome, girth of mother rhizome, number of primary fingers per plant, number of secondary fingers per plant, number of leaves per plant, curcumin content, dry matter content and yield per plot. High heritability estimates were observed for curcumin content, plant height, weight of mother rhizome, leaf length, dry matter content, leaf breadth, length of mother rhizome, number of primary fingers per plant and girth of mother rhizome while, high estimates of genetic gain were observed for weight of mother rhizome, length of mother rhizome, number of primary fingers per plant and girth of mother rhizome.

Keywords: genetic variability, heritability, genetic advance, genetic gain (%)

Introduction

Turmeric is a perennial herb grown for its underground rhizomes. Turmeric (*Curcuma longa* L.) belongs to family zingiberaceae having a chromosome number $2n = 3x = 63$ which implies that it is triploid in nature (Chakravoti 1948, Nair 2000) [5]. The crop is said to be native of South Asia, particularly India. India is the largest producer (93.3% of the world production), consumer and exporter (approximately 90%) of turmeric. Indian turmeric is regarded as the best in the world market because of its high curcumin content. It requires warm and humid climate with a temperature range of 20-30 °C for its successful cultivation. Crop is grown in all kind of soils except alkaline soil having a pH range of 5-7.5. It responds well to high dose of manure and fertilizers. It is used as a condiment, medicine, ornamental material and as a dye for centuries (Anandaraj and Sudharshan, 2011) [1]. Turmeric is credited with insect repellent properties and also it is being used in cosmetic industry (Sasikumar, 2005) [9]. Turmeric is used as a natural food additive, preservative and colouring agent in Asian countries. Crop attract much attention among the peoples because of its medicinal properties (Cousins *et al.*, 2007) [6]. Indian turmeric is regarded as the best in the world market because of its high curcumin content. The area under turmeric in India is 238 thousand hectares with an annual production of 1133 thousand Metric Tonnes (Annonomys, 2017-18) [2]. The major turmeric growing states are Andhra Pradesh, Odisha, Tamil Nadu, Karnataka, Kerala and Gujrat. The area under turmeric in Himachal Pradesh is 0.20 thousand hectare with an annual production of 0.10 thousand Metric Tonnes (Annonomys, 2016-17) [2]. It is mainly exported to countries like UK, USA, Iran, Japan, Saudi Arabia, Netherland, South Africa and Singapore.

Genetic variability is the most important aspect in selecting the best genotype for making rapid improvement in desirable characters and yield as well as to select the most superior parents for breeding programme. Genetic variability leads to greater variation in different quantitative and qualitative parameters. For an effective and successful breeding programme genetic variability is essential. Thus, it becomes imperative to study the level of genetic variability. Effectiveness of selection depends upon the magnitude of genetic variability present in the germplasm and

extent to which it is heritable. Knowledge of coefficient of variation is important in the assessment of genetic variability for desired traits. Heritability is the concept that summarizes how much of the variation in a trait is due to the variation in genetic factors.

Material Methods

The study was carried out at Experimental Farm, Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur, (H.P.). The data for seventeen characters of twenty one genotypes was collected.

Data was analyzed by Randomized Complete Block Design as suggested by Gomez and Gomez (1983) [3]. The parameters like genotypic and phenotypic variation were calculated as per methods of Burton and De Vane (1953) [4]. All the cultural practices and plant protection measures as per package of practices were followed from time to time to ensure a good crop stand.

Variability for different characters was estimated as suggested by Burton and Devane (1953) [4]. Coefficients of variability (phenotypic and genotypic), Heritability, Genetic advance, Genetic gain.

Results and Discussion

The ANOVA depicted high significant differences among all the genotypes for various horticultural traits under study. Highest plant height was observed in LC-T-19-18 (154.27 cm) while smallest height was recorded for LC-T-17-18 (108.07 cm). Leaf breadth among the genotypes ranging from 15.07-20.73 cm being maximum in genotype LC-T-11-18 (20.73 cm) and minimum in LC-T-17-18 (15.07 cm). Maximum leaf length was observed in LC-T-11-18 (67.87 cm) and minimum leaf length was observed in LC-T-17-18 (50.20 cm). Highest number of tillers per plant were observed for Palam Pitamber (2.53) while minimum number of tillers per plant were observed for LC-T-17-18 (1.40). Maximum

number of leaves per plant were recorded in LC-T-14-18 (10.93). Genotype LC-T-1-18 (12.93 cm) gave the maximum length of mother rhizome. Girth of mother rhizome were maximum in LC-T-1-18 (7.57 cm) and minimum in LC-T-20-18 (2.67 cm). Weight of mother rhizome were maximum in LC-T-1-18 (160.56 g) and minimum in LC-T-20-18 (80.85 g). Maximum length of primary rhizome LC-T-20-18 (9.46 cm) minimum length of primary rhizome was observed for LC-T-18-18 (5.23 cm). Maximum girth of primary rhizome was recorded in LC-T-20-18 (3.10 cm) while minimum girth of primary rhizome was observed in LC-T-18-18 (1.64 cm). Maximum number of primary fingers were observed in genotype LC-T-19-18 (9.80) while minimum in genotype LC-T-18-18 (2.27). Maximum length of secondary rhizomes was recorded in LC-T-13-18 (4.20 cm). Girth of secondary rhizome was recorded minimum in LC-T-5-18 (1.72 cm) and maximum in LC-T-13-18 (2.99 cm). Highest number of secondary fingers per plant were produced in LC-T-19-18 (16.93) genotype. Genotype LC-T-15-18 (25.27 %) recorded the maximum value for dry matter content. Curcumin content were observed maximum in genotype LC-T-20-18 (4.95 %) and minimum in LC-T-1-18 (2.68 %). Maximum yield per plot was recorded in LC-T-20-18 (5.04 kg).

Parameters of variability

Table 2 shows estimates of different of parameters of variability. Moderate phenotypic coefficient of variation and genotypic coefficient of variation were observed for weight of mother rhizome length of mother rhizome, girth of mother rhizome, number of primary fingers per plant, number of secondary fingers per plant, number of leaves per plant, curcumin content, dry matter content and yield per plot while low magnitude of phenotypic coefficient of variation and genotypic coefficient of variation were observed for girth of primary rhizome, leaf breadth, leaf length and plant height.

Table 1: Different growth and yield attributing components of turmeric cultivars.

Genotype	Plant height	Leaf breadth	Leaf Length	Number of tillers/plant	Number of leaves/plant	Length of mother rhizome	Girth of mother rhizome	Weight of mother rhizome	Length of primary rhizome	Girth of primary rhizome
LC-T-1-18	124.93	17.00	60.27	2.21	9.27	12.93	7.57	160.56	8.44	3.03
LC-T-2-18	123.93	16.60	58.60	2.00	6.07	5.97	3.66	84.09	6.27	2.86
LC-T-3-18	133.33	18.20	62.27	1.47	5.13	6.33	4.01	98.18	6.02	2.46
LC-T-4-18	130.73	19.33	65.00	1.73	9.47	9.34	5.75	155.68	5.97	2.31
LC-T-5-18	133.13	19.00	64.80	2.00	6.13	6.32	3.73	91.38	6.15	2.69
LC-T-6-18	141.47	15.53	55.87	2.00	6.93	7.70	4.44	136.69	6.09	2.46
LC-T-7-18	138.13	15.20	51.93	1.93	6.20	6.47	4.07	118.56	5.85	2.19
LC-T-8-18	134.80	16.33	58.60	2.27	6.20	10.02	5.94	159.85	6.37	2.93
LC-T-9-18	138.73	18.13	62.07	2.00	7.20	6.41	4.06	104.51	6.83	2.95
LC-T-10-18	147.20	19.73	65.80	1.80	7.87	5.40	3.35	82.32	6.22	2.76
LC-T-11-18	134.13	20.73	67.87	2.00	9.87	6.06	3.73	90.87	6.34	2.90
LC-T-12-18	125.93	18.27	62.87	2.47	10.87	8.59	5.41	148.19	5.71	2.13
LC-T-13-18	127.20	19.33	65.20	2.07	7.07	5.45	3.48	82.40	6.54	2.94
LC-T-14-18	131.40	16.20	58.07	2.40	10.93	9.20	5.67	155.47	6.20	2.75
LC-T-15-18	135.87	18.33	64.47	2.07	10.00	9.05	5.66	150.93	6.12	2.67
LC-T-16-18	139.60	18.60	64.73	2.13	7.87	5.77	3.56	86.45	6.95	2.97
LC-T-17-18	108.07	15.07	50.20	1.40	7.20	5.45	3.52	84.21	6.01	2.42
LC-T-18-18	137.87	16.67	60.20	1.73	6.87	5.21	3.25	81.22	5.23	1.64
LC-T-19-18	154.27	18.67	64.80	1.80	8.27	5.91	3.62	88.81	6.29	2.87
LC-T-20-18	134.53	16.13	57.87	2.47	9.47	5.21	2.67	80.85	9.46	3.10
Palam Pitamber	143.20	18.60	64.60	2.53	9.60	6.32	3.94	91.95	6.93	2.96
Mean	133.21	17.70	61.24	2.02	8.02	7.10	4.34	111.10	6.47	2.67
C.D.(0.05)	2.36	0.81	1.72	0.48	1.08	1.12	0.89	9.77	0.78	0.23

Table 1: Different growth and yield attributing components of turmeric cultivars.

Genotype	Number of primary fingers/ plant	Length of secondary rhizome	Girth of secondary rhizome	Number of secondary fingers/ plant	Dry matter content	Curcumin content	Yield/ plot
LC-T-1-18	2.87	3.66	2.62	6.33	24.13 (5.01)	2.68 (1.92)	4.19
LC-T-2-18	5.00	3.61	2.55	10.60	15.37 (4.05)	3.79 (2.19)	4.71
LC-T-3-18	6.33	2.81	2.04	12.07	18.37 (4.40)	4.00 (2.24)	3.66
LC-T-4-18	7.47	3.29	2.25	11.67	23.17 (4.91)	2.99 (2)	3.93
LC-T-5-18	6.53	2.44	1.72	11.53	17.50 (4.30)	3.77 (2.18)	3.84
LC-T-6-18	5.93	2.91	2.07	10.07	14.00 (3.87)	4.67 (2.38)	3.80
LC-T-7-18	6.00	3.23	2.15	8.13	19.40 (4.52)	3.82 (2.20)	4.01
LC-T-8-18	7.80	2.77	1.94	11.53	21.90 (4.79)	2.91 (1.98)	4.28
LC-T-9-18	6.20	2.79	1.99	11.73	16.13 (4.14)	4.15 (2.27)	4.97
LC-T-10-18	5.60	3.43	2.43	8.53	15.33 (4.04)	4.34 (2.31)	3.42
LC-T-11-18	7.87	3.26	2.22	9.93	16.23 (4.15)	3.05 (2.01)	4.40
LC-T-12-18	5.20	2.81	2.06	8.73	20.50 (4.64)	3.35 (2.09)	4.94
LC-T-13-18	6.87	4.20	2.99	9.60	16.30 (4.16)	4.66 (2.38)	2.69
LC-T-14-18	8.00	3.41	2.27	12.87	21.43 (4.73)	3.81 (2.19)	4.90
LC-T-15-18	6.47	2.77	1.98	9.60	25.27 (5.13)	3.49 (2.12)	4.13
LC-T-16-18	7.07	4.06	2.72	11.33	20.43 (4.63)	4.81 (2.41)	3.61
LC-T-17-18	8.07	3.45	2.47	8.27	21.43 (4.74)	3.79 (2.19)	2.80
LC-T-18-18	6.00	3.07	2.07	11.80	19.77 (4.56)	4.58 (2.36)	2.81
LC-T-19-18	9.80	3.95	2.71	16.93	24.37 (5.04)	3.06 (2.02)	3.75
LC-T-20-18	2.27	3.45	2.52	10.80	14.60 (3.95)	4.95 (2.44)	5.04
Palam Pitamber	8.27	2.90	2.06	13.20	21.93 (4.79)	2.88 (2.02)	4.62
Mean	6.46	3.25	2.28	10.73	19.41	3.79	4.02
C.D.(0.05)	1.07	0.75	0.27	2.67	1.40	0.04	0.85

Table 2: Estimation of mean, range genotypic co-efficient of variance, phenotypic co-efficient of variance, heritability and genetic advance over percent mean of growth and yield traits of Turmeric.

Characters	Range	Mean Range \pm SE(m)	Coefficients of variability (%)		Heritability (%)	Genetic advance	Genetic gain (%)
			Genotypic	Phenotypic			
Plant height	108.07-154.27	133.21 \pm 0.82	7.043	7.123	97.781	19.256	14.347
Leaf Length	50.20-67.87	61.24 \pm 0.60	7.531	7.718	95.207	9.270	15.138
Leaf Breadth	15.07-20.73	17.70 \pm 0.28	8.907	9.325	91.246	3.102	17.528
Number of leaves	5.13-10.93	8.02 \pm 0.38	20.954	22.483	86.856	3.227	40.228
Number of tillers/ plant	1.40-2.53	2.02 \pm 0.48	12.755	19.106	44.568	0.355	17.541
Length of mother rhizome	5.21-12.93	7.10 \pm 0.39	27.984	29.566	89.584	3.874	54.562
Girth of mother rhizome	2.67-7.57	4.34 \pm 0.08	26.733	29.438	82.466	2.169	50.010
Weight of mother rhizome	80.85-160.56	111.10 \pm 3.41	28.185	28.681	96.572	63.393	57.058
Length of primary rhizome	5.23-9.46	6.47 \pm 0.27	13.682	15.492	77.997	1.612	24.892
Girth of primary rhizome	1.64-3.10	2.67 \pm 0.08	13.455	14.425	87.001	0.689	25.853
Number of primary fingers/ plant	2.27-9.80	6.46 \pm 0.37	26.300	28.123	87.455	3.272	50.666
Length of secondary rhizome	2.44-4.20	3.25 \pm 0.26	12.145	18.428	43.431	0.536	16.488
Girth of secondary rhizome	1.72-2.99	2.28 \pm 0.09	13.454	15.223	78.108	0.558	24.495
Number of secondary fingers/ plant	6.33-16.93	10.73 \pm 0.93	18.986	24.198	61.562	3.292	30.687
Dry matter	14.00-25.27	19.41 \pm 0.49	17.634	18.163	94.259	6.845	35.268
Curcumin content	0.68-2.95	1.79 \pm 0.02	39.235	39.266	99.842	1.445	80.761
Yield/ plot	2.69-5.04	4.02 \pm 0.30	16.140	20.574	61.540	1.050	26.083

Heritability and genetic gain

High heritability estimates were observed for curcumin content, plant height, weight of mother rhizome, leaf length, dry matter content, leaf breadth, length of mother rhizome, number of primary fingers per plant, girth of primary rhizome, number of leaves per plant and girth of mother rhizome, while moderate estimates of heritability were recorded for girth of secondary rhizome, length of primary rhizome and number of secondary fingers per plant. High genetic gain was noticed for weight of mother rhizome, length of mother rhizome, and number of primary fingers per plant and girth of mother rhizome while moderate genetic gain was observed for number of leaves per plant, curcumin content, dry matter content, number of secondary fingers per plant, yield per plot and girth of primary rhizome. Low estimates of genetic gain was observed for plant height, leaf length, length of secondary rhizome, leaf breadth, number of tillers per

plant, girth of secondary rhizome and length of primary rhizome.

Conclusions

On the basis of overall performance, out of 21 genotype LC-T-20-18 was found superior for yield per plot and other important characters. The estimates of PCV were highest for length of mother rhizome and GCV for weight of mother rhizome among all the genotypes. High heritability was observed for weight of mother rhizome, length of mother rhizome, number of primary fingers per plant and girth of mother rhizome.

Genetic gain was observed high for weight of mother rhizome, length of mother rhizome, number of primary fingers per plant and girth of mother rhizome.

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