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Genetic Variability, Heritability and Genetic Advance Studies in Turmeric (*Curcuma longa* L.) Under High Altitudearea of Andhra Pradesh

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ABSTRACT

The study was carried out to assess the genetic variability, heritability and genetic advance for different characters in 13 diverse genotypes of turmeric. The experiment was carried out in the Randomized Complete Block Design with threereplications during *kharif* 2016-17. Analysis of variance revealed that there was a significant difference among genotypes for all the characters studied. Maximum rhizome yield per plant was observed in NDH-98 (567.73 g/plant) followed by NDH-79 (371.32 g/plant). Maximum fresh rhizome yields were recorded by NDH-98 (66.17 t/ha) and highest dry recovery was also recorded in NDH-98 (22.85 %) over the other entries. Higher magnitudes of GCV and PCV occurred for fresh rhizome yield per plant, fresh rhizome yield per hectare and dry recovery percentage indicated a greater extent of variability that could be ascribed to genotype. High heritability estimates in conjunction with high genetic advance were observed for leaf width, leaf area, fresh rhizome yield per plant, fresh rhizome yield per hectare, dry recovery percentage and dry rhizome yield per hectare.

Keywords Turmeric, Genetic variability, Heritability, Genetic advance.

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INTRODUCTION

Turmeric (*Curcuma longa* L.) is one of the most extensively cultivated spice crops are grown in India because of agro-climatic suitability and rich genetic diversity. Turmeric is also known as the "golden spice" (Ravindran *et al*. 2007). In India, turmeric is being cultivated in more than 20 states in an area of 1.93 lakh ha with an annual production of 10.52 MT. Turmeric occupies 5.46% of spice area and shares 14.875% of spice production. In India, turmeric is extensively cultivated in Telangana, Andhra Pradesh, Odisha, West Bengal, Tamil Nadu, Assam, Maharashtra, Karnataka, Bihar and Kerala. In Andhra Pradesh, it is being cultivated in an area of 16,600 hectares with an annual production of 13,4100 MT of turmeric (Anonymous 2017).

Turmeric has strong associations with the socio-cultural life of the people of the Indian subcontinent. This plant with the orange-yellow rhizome was regarded as the "herb of the Sun" by the people of the Vedic period (Ravindran *et al*. 2007). Turmeric has attracted much attention all over the world due to its significant medicinal properties (Cousins *et al*. 2007). Turmeric has antiinflammatory, hepatoprotective, antitumor, antiviral, wound healing and anti-cancerous properties and is also beneficial in treating gastrointestinal and respiratory disorders (Polasa *et al*. 1994, Joe *et al*. 2004).

The average productivity of the crop in eastern ghat region of Visakhapatnam is very low as against the state average productivity (8.0 t/ha). The low productivity in this region is mainly due to the lack of suitable cultivar and the package of practices for particular agro-climatic conditions. Very limited attempts have been made on the evaluation of turmeric genotypes under eastern ghat region zone conditions. More number of cultivars available in turmeric and considerable variability exists with regard to morphological, yield and quality characters and several attempts have been made to assess this variability (Chaudhary *et al.* 2006, Rajyalakshmi *et al*. 2013).

The performance of any crop or variety mainly depends upon its genetic makeup. Further, the performance of the crop depends upon climatic conditions of the region under which the crop or variety grown. As a result, genotypes which perform well in one region might not perform well in other regions of varying climatic. Hence, it is highly necessary to collect and evaluate all the available genotypes to select suitable and high yielding genotypes for a particulara-gro-climatic condition. In view of the importance of turmeric, research on this crop is highly necessary to find out the suitability of various genotypes for a particular region.

Characterization of available germplasm is a necessary step to facilitate breeding efforts; it especially benefits a plant breeder in choosing proper parental materials (Sarutayophat *et al*. 2007). To improve yield potentials in an existing crop, an understanding of the variability is important to formulate and accelerate breeding program (Johnson *et al.* 1955). Corresponding heritability, genetic advance and genotypic and phenotypic coefficient of variation within a crop will facilitate in the selection of superior genotypes which is proportional to the amount of genetic variability exist and the extent to which the characters are inherited. Since many economic traits are quantitative in nature and highly influenced by the environment, the progress of breeding is governed by the character of genetic and non-genetic variations, it will be useful to partition the overall variability into its heritable and non-heritable components to know whether the superiority of selection is inherited by the progenies. Effective selection of genotypes for desirable traits is determined by the estimates of heritability coupled with genetic advance. Therefore, the present investigation was undertaken to evaluate promising genotypes under high altitude and tribal zone of Visakhapatnam, Andhra Pradesh and to estimate the variability, heritability and genetic advance in 13 turmeric genotypes.

MATERIALS AND METHODS

The field experiment was conducted to assess the genetic variability, heritability and genetic advance for differenttraits in 13 diverse genotypes of turmeric. The experiment was laid out in the Randomized complete Block Design with three replications during *kharif* 2016-17 at Horticultural Research Station, Chintapalli, Andhra Pradesh, India. The location falls under Agro-climatic zone of High Altitude and Tribal Zone with the average annual rainfall of more than 1300 mm, maximum temperature range 17 to 35ºC, the minimum temperature varies from 3 to 24ºC and is located at an altitude of 933 m MSL. The geographical condition of the experimental site is 170.13' N latitude and 840.33' E longitudes. The soil of the experimental field was alluvial and it had been endowed with good drainage. The experiment was laid out in Completely Randomized Block Design with 13 treatments and 3 replications. The planting was done on raised beds with row to row spacing 30 cm, the plant to plant distance of 25 cm and the net plot size was 3 x 1 m^2. Recommended package of practices and plant protection measures were followed according to the package of practices given by Dr YSR Horticultural University to raise a healthy crop. The data had recorded from five randomly selected plants from each treatment in each replication. Mean data were

Table 1. Analysis of variance for 9 characters in turmeric (Mean squares are given).

Source	DF	1	2	3	4	5	6	7	8	9
Replication	2	370.44	0.13	2843.85	13.96	38379.23	357.14	80.52	2.00	2.24
Treatment	12	7274.08**	11.46**	1839.78**	161.24**	172057.82**	339473.22**	3930.32**	445.77**	303.64**
Error	86	3285.62	5.82	1561.65	27.06	55709.07	36811.54	707.83	16.06	30.34

used for statistical analysis for eighteendiverse traits i.e., plant height (cm), number of tillers, leaf length (cm), leaf width (cm), leaf area (cm^2), fresh rhizomes yield per plant (g), Fresh rhizome yield/ha (t/ha), dry recovery (%) and dry rhizome yield per hectare. The mean values were subjected to statistical analysis of data for each character as per the method is given by Panse and Shukhatme (1985).

The analysis of variance was carried out and was used for calculating other genetic parameters. The genetic parameters viz., Genotypic Coefficients of Variation (GCV) and Phenotypic Coefficients of Variation (PCV) were calculated as per the formula suggested by Comstock and Robinson (1952). Heritability in the broad sense and expected genetic advance were calculated as per formula is given by Allard (1960) , Johnson *et al*. (1955) respectively.

Robinson *et al.* (1949) categorized heritability (%) into low (0-30%), moderate (30-60%) and high (above 60%). Higher heritability indicates the least environmental influence on the characters. The genetic advance was categorized into low (1-10%), moderate (11-20%) and high (>20%) as suggested by Johnson *et al*. (1955). High GA indicates that additive genes govern the character and low GA shows that non-additive gene action is involved. Heritability along with GA helps us in predicting the gene action and the method of breeding to be practiced.

RESULTS AND DISCUSSION

The analysis of variance revealed that there was significant variation among the 13 turmeric genotypes (Table 1) for 9 characters studied. The mean sum of squares was non-significant for replication i.e., there is no difference among replications.

Among the genotypes studied PTS-12 recorded the highest plant height (130.97 cm) followed NDH-79 (127.70 cm) and NDH-98 (120.08 cm) and these were on par with each other whereas SLP 389/1 wad the shortest plant (Table 2). The genotype Prathibha

Table 2. Mean performance of turmeric genotypes for growth and yield characters.

Treatments	Plant height (cm)	No. of tillers per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh rhizome yield/plant (g)	Fresh rhizome yield/ha (t)	Dry recovery	Dry rhizome yield/ha (t)
ACC-48	101.89	3.17	35.51	13.51	397.33	295.54	33.28	14.35	4.78
ACC-79	112.75	2.00	32.29	12.15	400.67	223.79	36.77	14.69	5.40
SLP 389/1	84.53	2.27	38.51	9.91	491.70	190.91	28.33	20.66	5.85
NDH-8	95.32	3.20	43.09	14.99	433.43	337.82	48.56	12.52	6.08
NDH-79	127.70	2.33	32.97	10.48	441.43	371.32	44.59	13.96	6.23
NDH-98	120.08	2.00	37.04	15.75	470.53	567.73	66.17	23.07	15.26
PTS-12	130.97	2.87	47.43	15.26	478.63	318.17	34.82	21.01	7.32
PTS-8	97.59	3.00	54.18	15.48	629.57	273.65	42.84	22.73	9.74
PTS-55	113.96	2.53	51.13	16.99	458.50	266.51	43.49	18.31	7.96
TCP-64	91.69	1.87	44.86	14.00	330.93	224.36	29.32	20.08	5.89
Prathibha	100.41	3.67	38.47	12.36	456.83	229.35	50.64	21.20	10.73
Chintapalli local	111.29	3.20	48.82	14.21	416.67	246.03	31.84	19.42	6.18
BRS-2	96.03	2.87	36.42	12.22	414.93	252.35	43.80	18.16	7.95
CD @ 5%	19.84	0.84	13.67	1.8	81.67	66.39	9.21	1.39	1.91
SE (m)	6.76	0.28	4.66	0.61	27.82	22.61	3.14	0.47	0.65
CV	10.99	18.31	19.39	7.79	10.76	13.41	13.21	4.43	14.67

Table 3. Mean, range, coefficients of phenotypic and genotypic variation, heritability and genetic advance per cent of mean of ten characters in turmeric.

Sl. No	Characters	Range	Mean	GCV (%)	PCV (%)	Heritability (%)	Genetic advance as % mean
1	Plant height	84.53-130.97	106.48	11.75	16.09	53.33	17.67
2	Number of tillers	1.87-3.67	2.69	18.12	25.76	49.48	26.26
3	Leaf length (cm)	32.29-54.18	41.59	13.04	23.37	31.13	14.99
4	Leaf width (cm)	9.91-16.99	13.64	14.85	16.77	78.44	27.10
5	Leaf area (cm^2)	330.93-629.57	447.78	14.13	17.76	63.31	23.17
6	Fresh rhizome yield/plant (g)	190.91-567.73	292.12	32.33	35.00	85.33	61.52
7	Fresh rhizome yield/ha(t)	28.33-66.17	41.11	24.24	27.61	77.11	43.86
8	Dry recovery %	12.52-23.07	18.67	36.94	39.75	86.37	70.72
9	Dry rhizome yield/ha (t)	4.78-15.26	7.66	18.88	19.39	94.78	37.86

had more tillers (3.67) per plant followed by ACC-48 (3.17) and PTS-8 (3.00) and all these genotypes were at par with each other. PTS- 8 recorded the longest leaf length (54.18 cm) and PTS-55 recorded the highest leaf width 16.99 cm) when compared to other genotypes. The leaf area was highest in PTS-8 (629.57 cm^2) while the lowest leaf area was recorded in TCP-64 (330.93). The variation among genotypes for growth traits are in close conformity with the findings of Rohit *et al*. 2018,Vamshi *et al*. 2019.

A significant difference among 13 turmeric genotypes for fresh rhizome yield and dry recovery percentage was observed. The maximum fresh rhizome yield per plant was recorded in genotype NDH-98 (567.73 g) followed by NDH-79 (371.32 g). The minimum was recorded in genotype SLP 389/1 (190.91 g) followed by ACC-79 (223.79 g). The maximum estimated fresh yield per hectare was recorded in NDH-98 (66.17 t/ha) followed by Prathibha (50.64 t/ha) whereas SLP 389/1 was recorded the lowest yield per hectare (28.33 t/ha). NDH-98 was significantly superior for dry recover percentage (23.07 %) over all other genotypes. The maximum dry rhizome yield per hectare was also recorded in NDH-98 (15.26 t/ha) followed by Prathibha (10.73 t/ha).

The growth and yield are governed by the genetic composition of the genotype coupled with the environmental conditions under which the crop is grown. When different genotypes are grown under identical conditions, it is the genetic makeup that expresses the morphological differences. Similar variations were observed in turmeric under different agro-climatic conditions by Veena 2012, Shashidhar *et al.* 2017.

The extent of variability present in the turmeric genotypes was measured in terms of genetic parameters viz., genotypic and phenotypic coefficients of variation, heritability in broad sense and genetic advance along with mean and range of different characters are presented in Table 3.

In the present investigation, for the majority of the characters, the magnitude of GCV and PCV were closer, suggesting the greater contribution of genotype rather than the environment. So, the selection can be very well based on phenotypic values. Such a closer PCV and GCV for different characters were earlier reported by Vijay *et al.* (2016),Vamshi *et al.* (2019).

The phenotypic coefficient of variation (PCV) was observed to be generally greater in values than the genotypic coefficient of variation (GCV) in all characters studied (Table 3), which indicated the additive effect of the environment on the expression of the trait (Verma *et al.* 2014). Higher magnitudes of GCV and PCV occurred for fresh rhizome yield per plant, fresh rhizome yield per hectare and dry recovery percentage indicated a greater extent of variability that could be ascribed to genotype. These results indicated that the characters with higher magnitudes of coefficient of variation offer a better opportunity for improvement through selection. These results are in agreement with the findings of Vijay *et al.* (2016), Prajapathi *et al.* (2014).

The variability existing in a population is the sum total of heritable and non-heritable components. A high value of heritability indicates that the phenotype of that trait strongly reflects its genotype. In the present investigation, the heritability estimates were moderate for plant height, number of tillers and leaf length and high for remaining all characters studied. High heritability for growth and yield attributes in turmeric were reported by many workers (Vijay *et al.* 2016 , Prajapathi *et al*. 2014).

The environment has the least influence for the characters with high heritability and there could be greater correspondence between phenotypes and breeding value while selecting individuals. High heritability estimates indicate the effectiveness of selection based on good phenotypic performance but do not necessarily mean high genetic gain for the particular character. In the present investigation, high heritability estimates in conjunction with high genetic advance were observed for leaf width, leaf area, fresh rhizome yield per plant, fresh rhizome yield per hectare, dry recovery percentage and dry rhizome yield per hectare. Similar results were reported by Singh and Ramakrishna (2014) for leaf area, dry recovery, yield per hectare and leaf width. Hence, improvement of rhizome yield per plant in turmeric would be effective through phenotypic selection for these characters.

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