Biological Forum – An International Journal 13(4): 22-25(2021)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Genetic Variability, Heritability Studies of different Genotype in Turmeric (*Curcuma longa*)

***Kanchan Pathak*[1*]*, Vijay Bahadur*[2] *and Netrapal Yadav*[3]**
[1]*M.Sc. Scholar, Department of Horticulture, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.*
[2]*Associate Professor, Department of Horticulture, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.*
[3]*Ph.D. Scholar, Department of Horticulture, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.*

(Corresponding author: Kanchan Pathak)*
(Received 30 July 2021, Accepted 04 October, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The research on 24 genotypes of turmeric was carried out in SHUATS, Naini, Prayagraj to assess the genetic diversity contained in turmeric. The current study demonstrates that qualitative characteristics are beneficial in turmeric breeding and genetic analysis. This experiment was carried out and reproduced three times in R.B.D. The emergence percentage, number of tillers and leaves per plant, leaf length and breadth, plant height and girth, chlorophyll content, length, core diameter, and weight of the mother, primary and secondary rhizomes, number of primary and secondary rhizomes per plant, yield per plant and plot/ha, and curcumin content were all recorded. The weight of the mother rhizome, the length and weight of the primary and secondary rhizomes, the yield per plant and plot all had high phenotypic and genotypic coefficients of variation. Higher heredity (in the broad sense) was seen in the number of tillers per plant, leaf length and breath, plant height and girth, and curcumin content. The length of the mother rhizome, as well as the number and length of primary and secondary rhizomes, were found to have high heritability and genetic gain. The number of tillers per plant, the number and length of secondary rhizomes, the weight of the mother rhizome, and the yield per plant all showed significant genetic advancement and genetic advancement as a percentage of the mean. Reduced phenotypic and genotypic coefficients of variation, heritability (in the broad sense), genetic advancement, and genetic advancement as a percentage of mean were detected in emergence percentage, chlorophyll content, and plant height. The current study discovered variability among different turmeric genotypes, indicating a high potential for crop improvement and/or further manipulation of genetic resources through breeding, as these genotypes are good sources of genes for many desirable traits and could be successfully used to extract better genotypes. High heritability for certain characteristics suggested that a significant part of phenotypic variance was attributable to genotypic variance and, as such, accurate phenotypical expression selection of these qualities could thus be made.

Keywords: Phenotypic Coefficient of Variation, Genotypic Coefficient of Variation, Heritability (Broad sense), Genetic advancement

INTRODUCTION

India is also known as the "Home of Spices" or "Spice Bowl." There are 109 spices grown all over the world. 75 of them are grown in India. Turmeric (*Curcuma longa* L.) is one of India's most significant spice crops, belongs to the Zingiberaceae family, and plays an essential role in the national economy. It most probably evolved on the slopes of hills in the tropical woods of South India's West Coast (Stahl, 1980). India is the world's largest producer, user, and exporter of turmeric, accounting for 76% of global commerce (Chaudhary *et al*., 2006). Andhra Pradesh, followed by Odisha, Tamil Nadu, and Maharashtra, accounts for the lion's share of India's turmeric output (Maurya, 1990).

Turmeric is considered auspicious and is used in religious ceremonies. It is often used in traditional Hindu medicine to alleviate sprains and inflammation induced by injury. Curcumin (1.8-5.4%) and essential oil (2.5-7.2%) are present in the rhizome. Curcumin, which is derived from turmeric, is used as a colorant. Turmeric is frequently utilized in the textile sector as a dye. It is used to make therapeutic oils, ointments, and poultices. It has stomachic, carminative, tonic, blood purifying, and antiseptic properties. Being a cross-pollinated crop, turmeric exhibits considerable variation in different traits.

Only a few attempts have been undertaken thus far to enhance local kinds, and the number of released varieties accessible for commercial cultivation is likewise confined. Among the cultivated varieties of turmeric (*C. longa* L.), rich morphological and genetic variety are reported, possibly due to accumulated vegetative mutations over time (Ghosh *et al.*, 2013). In certain situations, viable seeds permit reproductive reproduction by hybridization and open selection of the pollinated offspring (Sasikumar, 2005). The primary source of variety and effort in characterizing these collections is the genetic improvement of turmeric germplasm collections, carried out in India in particular, because of its economic importance and the greatest genetic diversity found here (Lynrah *et al*., 1998; Singh *et al.,* 2003). There is a lot of genetic variation in this crop when it comes to production and yield contributing characteristics. As a result, there is an urgent need to focus on crop improvement by selecting better kinds of varieties and screening turmeric germplasm to choose top genotypes with higher yield and enhanced quality for direct selection. This study aims to estimate variability, heritability, and predicted genetic progress for various characters, as well as to select the best genotypes with high yield, excellent horticultural, and quality characters for future usage.

MATERIAL AND METHOD

The experiment was carried out at the vegetable studies farm, branch of horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (U.P.) for the duration of 2020-2021. It became specified in Randomized Block Design with 3 replications and twenty-four genotypes, as a result, making a complete 72 plots. There had been 10 rhizomes in every plot. The genotypes were allotted randomly to a unit plot in each replication. A 2m × 1m plot was laid out with plant to plant spacing of 30 cm × 30 cm. The observations were recorded on emergence, variety of tillers and leaves per plant, leaf length and breadth, plant top and girth, chlorophyll content, duration, middle diameter and weight of mom, number of one and secondary rhizomes, number of primary and secondary rhizomes in step with plant, yield per plant and plot/ha, and curcumin content. The analysis of variance was labored out in keeping with the technique recommended through Panse and Sukhatme (1989). The GCV and PCV were worked out in step with Burton and Devane (1953). The statistical evaluation was carried out for each found character in the study with the usage of MS-Excel, SPSS 16.0, and SPAR 2.0 programs. The mean values of facts have been subjected to analysis of variance as defined by Gomez and Gomez (1983).

RESULT AND THE DISCUSSION

For 24 characteristics, the genetic variability metrics of phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h2), and genetic progress as a percentage of mean were investigated. GCV and PCV were significant for emergence percent, number of tillers and leaves per plant, leaf length and breadth, plant height and girth, chlorophyll content, length, core diameter, and weight of mother, primary and secondary rhizomes, number of primary and secondary rhizomes per plant, yield per plant and plot/ha, and curcumin content, chlorophyll content, and emergent percent all had low GCV and PCV, suggesting that those characteristics had low genetic variability (Table 1). All detected similar findings, including those by Prajapati *et al*., (2014); Jalata *et al.,* (2011); Yudhvir *et al.,* (2003); Jalgaonkar *et al*., (1990); Rajyalakhsmi *et al.,* (2013), Rao *et al.,* (2004), Datta *et al.,* (2006).

Table 1: Estimates of PCV, GCV, Heritability and Genetic Advance for different traits in turmeric.

Characters	Range	Mean ± SE(m)	Coefficients of variability (%)		Heritability (%)	Genetic advance	Genetic Gain as % of mean
			Phenotypic	Genotypic			
1. Emergence (%)	10.27-9.48	9.63±0.18	3.39	0.86	6.40	0.06	0.57
2. No. of tillers per plant	6.11-2.62	4.30±0.30	26.40	23.48	79.10	2.37	55.11
3. No. of leaves per plant	11.73-8.40	9.79±0.67	12.90	5.24	16.50	0.55	5.62
4. Leaf length (cm)	81.47-44.03	65.28±2.45	17.79	16.55	86.60	26.55	40.68
5. Leaf breadth (cm)	17.05-10.87	13.89±0.69	14.07	11.15	62.80	3.24	23.32
6. Plant height (cm)	170.07-148.08	161.28±2.76	4.47	3.35	56.00	10.66	6.61
7. Plant girth (cm)	12.07-7.47	9.30 ±0.15	12.78	12.46	95.10	2.98	32.06
8.chlorphyll content	51.43-27.13	35.94±4.49	22.09	4.51	4.20	0.88	2.44
9. i) Length of mother rhizome (cm)	14.23-2.50	5.67±1.41	53.30	31.45	34.80	2.78	49.00
iii) Core diameter of mother rhizome (cm)	4.10-1.67	2.48±0.30	28.61	19.46	46.30	0.87	34.94
iv) Weight of mother rhizome (g)	233.33-9.67	38.31±23.89	143.07	93.82	43.00	62.23	162.44
10 i) No. of primary rhizome per plant	7.07-1.37	3.67±0.79	50.80	34.72	46.70	2.30	62.66
ii) Length of primary rhizome (cm)	7.13-1.33	4.88±0.48	34.90	30.41	76.00	3.42	69.98
iii) Core diameter of primary rhizome (cm)	2.53-1.19	1.73±0.23	26.08	11.61	19.80	0.24	13.64
iv) Weight of primary rhizome (g)	19.27-2.83	9.59±3.32	67.80	31.65	21.80	3.74	39.01
11. i) No. of secondary rhizome per plant	17.27-0.00	5.14±1.35	87.86	75.08	73.00	8.71	169.40
ii) Length of secondary rhizome (cm)	4.73-0.00	2.08±0.40	68.30	59.49	75.80	2.85	136.77
iii) Core diameter of secondary rhizome (cm)	1.67-0.30	1.02±0.28	54.41	26.97	24.60	0.36	35.28
iv) Weight of secondary rhizome (g)	13.93-0.00	2.61±1.75	145.87	87.54	36.00	3.61	138.68
12. i) Yield per plant (g)	384.67-37.33	135.12±50.85	76.34	39.73	27.10	73.76	54.59
ii) Yield per plot (kg)	3.84-0.37	1.35±0.51	76.55	39.85	27.10	0.74	54.78
iii) Yield per hectare (q)-Converted	77.28-7.83	27.15±10.21	76.27	39.65	27.00	14.77	54.42
13. Curcumin content (%)	5.66-2.13	3.75±0.27	28.71	25.78	80.70	2.29	61.12

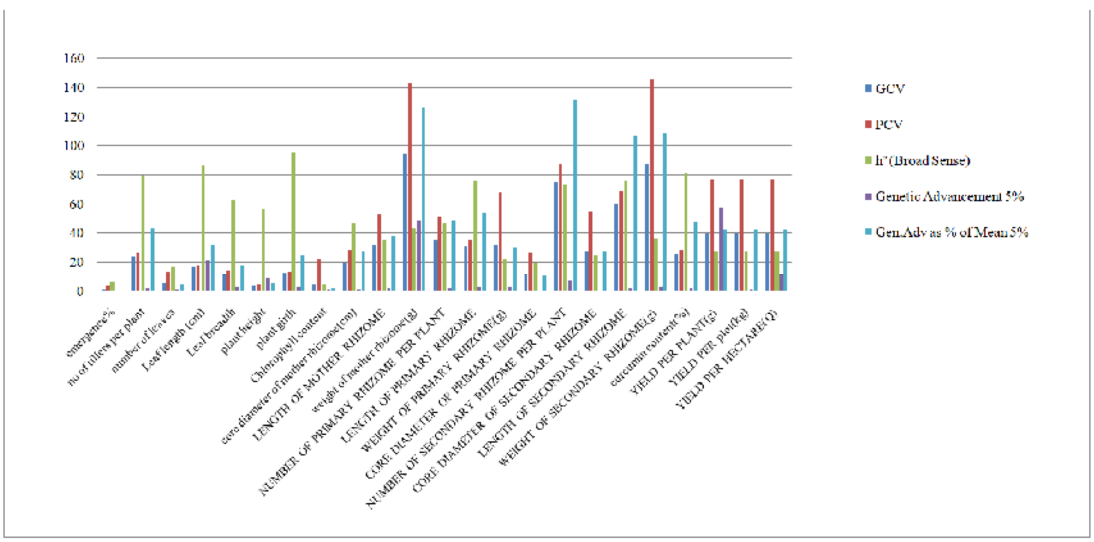
The genotypic and phenotypic coefficients of the version were determined to be 93.82% (G) for the individual weight of the mother rhizome and 144.87% (P) for the weight of the secondary rhizome followed by weight of secondary rhizome 87.54% (G), weight of mother rhizome 43.26% (P), variety of secondary rhizomes 75.08% (G), 87.86% (P), duration of secondary rhizome 59.49% (G), yield in line with plot 76.55% (P), indicating the predominance of additive gene action in the inheritance of this character, revealing the likelihood of favorable reaction to selection with the assistance of this individual. The presence of a low genotypic coefficient of variation as well as a phenotypic coefficient of variation in the inheritance of various characters indicated the predominance of a non-additive form of gene action within the inheritance of those characters.

The phenotypic coefficients of variability (PCV) were high (>30%) for weight of secondary rhizome (145.87). weight of mother rhizome (143.07), number of secondary rhizome (87.86), yield per plot (76.55), yield per plant (76.34), yield per hectare (76.27), length of secondary rhizome (68.30), weight of primary rhizome (67.80),core diameter of secondary rhizome (54.41), length of mother rhizome (53.30), number of primary rhizome (50.80), length of primary rhizome (34.90) whereas, moderate (15-30%) phenotypic coefficients of variability (PCV) were recorded for curcumin content (28.71), core diameter of mother rhizome (28.61), number of tillers per plant (26.40), core diameter of primary rhizome (26.08), chlorophyll content (22.09), and leaf length (17.79) whereas phenotypic coefficients of variability (PCV) were low (<15%) in magnitude for leaf breadth (14.07), number of leaves (12.90), plant girth (12.78), plant height (4.47) and emergence percent (3.39). The genotypic coefficients of variability (GCV) were high (>30%) for weight of mother rhizome (93.82), number of secondary rhizome (75.08), weight of secondary rhizome (87.54), length of secondary rhizome (59.49), yield per plot (39.85), yield per plant (39.73), yield per hectare (39.65), number of primary rhizome (34.72), weight of primary rhizome (31.65), length of mother rhizome (31.45), length of primary rhizome (30.41) whereas, moderate genotypic coefficient of variability (GCV) moderate (15-30%) were recorded for core diameter of secondary rhizome (26.97), curcumin content (25.78), number of tillers per plant (23.48), core diameter of mother rhizome (19.46), leaf length (16.55) whereas, low (<15%) genotypic coefficient of variability(GCV) were recorded for plant girth (12.46), core diameter of primary rhizome (11.61), leaf breadth (11.15), number of leaves (5.24), chlorophyll content (4.51), plant height (3.35), and emergence percent (0.86).

The heritability estimates (in the broad sense) for the investigated characteristics ranged from high degree plant girth (95.10 percent) to chlorophyll content (4.20 percent). This has increased the chances of selection consistency in the current content under consideration. Because it is wide sense heredity, it must be used with precaution in its direct application while making the selection. The genetic progress in the current study revealed a wide range of emergence percent (0.45) to secondary rhizome number (132.18).

These findings, which show high values for predicted genetic progress together with high heritability estimates, suggest that the improvement might be successfully achieved by selection in these characteristics on phenotypic values. The high heritability along with the high genetic advance seen for leaf length, curcumin content, and plant girth revealed that these features were primarily dominated by the additive gene effect and that improvement of these traits might be achieved by phenotypic selection.

Graph 1. Estimates of phenotypic and genotypic coefficients of variability, heritability and genetic advance for different traits in turmeric.



CONCLUSION

Finally, because there is so much genetic variation, breeders may successfully organise breeding plans for enhanced traits. Understanding heritability and genetic progress, in addition to genetic variability, analyses the relative degree to which a characteristic is handed on to its offspring, allowing the breeder in selecting an adequate breeding plan to reach the objective efficiently. The genotypes NDH-98, NDH-68, NDH-74, NDH29, and NDH-55 were determined to be promising for future improvement programmes based on genetic and phenotypic diversity, heritability (h2), and genetic advancement contributing characteristics. As a result, these genotypes may be taken into consideration when selecting selection indices for improving turmeric output.

Acknowledgements. The author expresses his thankful gratitude to Dr. Vijay Bahadur Professor & Head, Department of Horticulture, SHUATS, Prayagraj for providing necessary facilities to carry out the research work successfully.
Conflict of Interest. None.

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How to cite this article: Pathak, K., Bahadur, V. and Yadav, N. (2021). Genetic Variability, Heritability of different Genotype in Turmeric (*Curcuma longa*). *Biological Forum – An International Journal*, *13*(4): 22-25.