Available online at www.journalijmrr.com

INTERNATIONAL JOURNAL OF MODERN RESEARCH AND REVIEWS

Int. J. Modn. Res. Revs.

Volume 5, Issue 12, pp 1681-1685, December, 2017

ISSN: 2347-8314

STUDIES AND ESTIMATION OF CORRELATION AND PATH COEFFICIENT ANALYSIS IN TURMERIC (*Curcuma longa* L.)

[*1]M.Rajavel and [2]N.Vadivel

[*1]Agricultural Research Station, Bhavanisagar – 638 451, Tamil Nadu Agricultural University.
[2]KVK, Pauparapatty, Dharmapuri - 636 809,Tamil Nadu Agricultural University, Tamil Nadu.

Article History: *Received 11th December,2017, Accepted 30th December, 2017, Published 31st December,2017*

ABSTRACT

A study on evaluation of fifty turmeric genotypes based on the morphological, rhizome, yield and quality traits was carried out at the Agricultural Research Station, Bhavanisagar – 638 451, Tamil Nadu Agricultural University, during cropping seasons of 2015 - 2017. The variability for morphological traits was found to be highly significant. The path analysis studies indicated that the weight of primary rhizome, weight of secondary rhizome, girth of secondary rhizome, breadth of leaf, core diameter and length of leaf were the determinant yield attributes.

Keywords: Days to maturity, primary rhizome, secondary rhizome, turmeric crop, core diameter, rhizome yield

1.INTRODUCTION

Turmeric (*Curcuma longa* L.) belongs to the family Zingiberaceae and is one of the important major ancient and sacred rhizomatous spices grown in India. India is the leading producer, consumer and exporter of turmeric and turmeric products. In India, turmeric is cultivated in an area of 1.65 lakh hectares with annual production of 5.60 lakh tonnes. The annual growth rate of 3.7 per cent in area and 9.1 per cent in production was reported by Peter *et al.* (2006). Turmeric powder and oleoresin are the important sources for colouring and flavouring for many food preparations. Turmeric powder is known to have anti- inflammatory, antidiabetic, antimicrobial and cytotoxic properties, besides anticancer activity. Curcuminoids, the colouring principle in the rhizome consist of three compounds *viz.*, curcumin, bis demethoxy curcumin and demethoxy curcumin. The curcumin content of turmeric is an important quality criterion for judging the export standard. Curcumin content of 5.5% and above is considered as the best for export. High yielding turmeric genotype coupled with high curcumin content is negatively correlated phenomenon and is of rare in occurrence among the genotypes (Velayuthan *et al.*, 1994). Studies on understanding the inheritance pattern in the genotypes of high yield and high curcumin content through the path coefficient analysis. Information on the direct and indirect effects on rhizome yield of turmeric is important which is explicable by path coefficient analysis. The inter relationships of the component characters on yield provides the likely consequences of their selection for simultaneous improvement of desirable characters with yield. In view of above facts the present attempt has been made with objective to understand the cause and effect of different related traits on rhizome yield and quality in turmeric.

Corresponding author:* ***Dr.M.Rajavel,* *Assistant Professor,Agricultural Research Station, Tamil Nadu Agricultural University Bhavanisagar – 638 451.*

2.MATERIALS AND METHODS

The present research programme was carried out at the the Agricultural Research Station, Bhavanisagar – 638 451, Tamil Nadu Agricultural University, during the year 2004 - 2006. Fifty genotypes were selected based on genetic divergence, yield and quality assessed earlier by Vijayalatha (2002) and Arunkumar (2003) for the present study. The field experiments were carried out in the college orchards for evaluation of turmeric genotypes. The field experiment was carried out these genotypes in a randomized block design with two replications. Periodical field observations were recorded for morphological, yield and quality traits. Five plants in each genotype were randomly tagged for biometric observations *viz.*, height of the plant (cm), number of leaves per plant, length and breadth of the leaves (cm), number of tillers per plant, number of mother rhizomes, weight of mother rhizomes (g), girth of mother rhizomes (cm), number of primary rhizomes, weight of primary rhizomes (g), length of primary rhizomes (cm), girth of primary rhizomes (cm),

rhizome to core diameters (cm), number of secondary rhizomes, weight of secondary rhizomes (g), length of secondary rhizomes (cm), girth of secondary rhizomes (cm), rhizome yield (kg / area), curing percentage and for the qualitative traits *viz.*, curcumin content (per cent), oleoresin content (per cent) and essential oil content (per cent) respectively. The estimated genotypic correlation coefficients were partitioned into direct and indirect effects for all characters to rhizome yield as per the procedure given by Wright (1921) and later adopted by Dewey and Lu (1959).

3.RESULTS AND DISCUSSION

The results of path co efficient analysis showing direct and indirect effects of 25 different characters on rhizome yield are presented (Table 1; Figure 1). Direct Effect

The characters namely, length of primary rhizomes (0.586), height of the plant (0.536), length of secondary rhizomes (0.525), rhizome diameter (0.472), length of the leaf (0.426), days to maturity (0.400), breadth of the leaf (0.382), core diameter (0.380), number of tillers (0.371), girth of secondary rhizomes (0.348), number of secondary rhizomes (0.310), weight of secondary rhizomes (0.289), number of leaves (0.259), length of primary rhizomes (0.249), girth of primary rhizome (0.245) and oleoresin content (0.130) had positive direct effect on rhizome yield. Whereas the curing percentage (-0.430), girth of mother rhizomes (-0.265), essential oil content (-0.235), number of primary rhizomes (-0.132), curcumin content (-0.127), number of mother rhizomes (-0.110), sprouting percentage (-0.081), weight of mother rhizomes (-0.067) and rhizome core ratio (-0.046) had negative effect on rhizome yield.

Indirect effect

Sprouting percentage: The rhizome yield was exerted positive indirect effect through core diameter (0.164) was significant. The negative indirect effect was non significant.

Plant height: The rhizome yield had positive indirect effect through length of primary rhizome (0.383), number of mother rhizomes (0.186), length of the leaf (0.161), curing percentage (0.151), number of tillers (0.149) and girth of secondary rhizome (0.148). The significant negative indirect effect was observed in core diameter (-0.378).

Number of leaves: The rhizome yield registered significant positive indirect effect through length of primary rhizome (0.254), girth of secondary rhizome (0.178) and curing percentage (0.169). The negative indirect effect was expressed in girth of primary rhizome (-0.130) and core diameter (-0.432).

Leaf length: Rhizome yield had positive indirect effect exerted through length of primary rhizome (0.370), girth of secondary rhizome (0.163), number of rhizomes (0.197) and number of tillers (0.133). The negative indirect effect was expressed in girth of primary rhizome (-0.154), height of the plant (-0.165) and core diameter (-0.402).

Leaf breadth: The positive indirect effect was expressed in length of primary rhizome (0.405), girth of secondary rhizome (0.162) and number of tillers (0.129). The negative indirect was exhibited in number of mother rhizomes (-0.145) and core diameter (-0.375).

Number of tillers per plant:The rhizome yield was exhibited positive indirect effect through length of primary rhizome (0.290), girth of secondary rhizome (0.172), height of the plant (0.150), length of the leaf (0.131) and breadth of the leaf (0.113). The negative indirect effect was exerted in girth of primary rhizome (-0. 085) and core diameter (-0.407).

Days to maturity: The rhizome yield was expressed positive indirect effect through curing percentage (0.378), length of primary rhizome (0.342) and girth of secondary rhizome (0.152). The negative indirect effect was exhibited in essential oil content (-0.123) and core diameter (-0.430).

Number of mother rhizomes: The rhizome yield had positive indirect effect through curcumin content (0.182) and curing percentage (0.167).

Weight of mother rhizomes: Rhizome yield expressed positive indirect effect through length of primary rhizome (0.186), girth of secondary rhizome (0.159) and curcumin content (0.128). The negative indirect effect was exhibited in girth of primary rhizome (-0.120), core diameter and curing percentage (-0.123) and number of mother rhizomes (-0.153).

Girth of mother rhizomes

The rhizome yield was exhibited positive indirect effect through number of mother rhizome (0.161) and core diameter (0.114). The negative indirect effect was exerted in length of primary rhizome (-0.081) and curing percentage (-0.173).

Number of primary rhizomes: The rhizome yield was exerted positive indirect effect through core diameter (0.250) and oleoresin content (0.120). The negative indirect effect was expressed in girth of secondary rhizome (-0.144).

Weight of primary rhizomes: The rhizome yield had positive indirect effect through length of primary rhizome (0.451), girth of secondary rhizome (0.285), number of mother rhizomes (0.126) and weight of secondary rhizome (0.114). The negative indirect was exerted girth of primary rhizome (-0.203) and core diameter (-0.388).

Length of primary rhizomes: The rhizome yield was expressed positive indirect effect through girth of secondary rhizome (0.270), curing percentage (0.125), length of the leaf (0.118), breadth of leaf (0.114) and rhizome diameter (0.096). The negative indirect effect was exhibited in weight of primary rhizome (-0.120), height of the plant (-0.125), girth of primary rhizome (-0.207) and core diameter (-0.471).

Girth of primary rhizomes: The rhizome yield was exhibited positive indirect effect through length of primary rhizome (0.478), girth of secondary rhizome (0.349), length of leaf (0.114), number of mother rhizome and rhizome diameter (0.102). The negative indirect effect were exerted in weight of primary rhizome (-0.125) and core diameter (-0.504).

Number of secondary rhizomes: The rhizome yield was expressed positive indirect effect through length of primary rhizomes (0.101).

Weight of secondary rhizomes: The rhizome yield was expressed positive indirect effect through length of primary rhizome (0.436) and girth of secondary rhizome (0.306). The negative indirect effect were exhibited in weight of primary rhizome (-0.152), girth of primary rhizome (-0.191) and core diameter (-0.353).

Length of secondary rhizomes: The rhizome yield was exhibited positive indirect effect through length of primary rhizome (0.517), girth of secondary rhizome (0.349), curing percentage (0.240) and length of the leaf (0.101). The negative indirect effect was expressed in height of the plant (-0.113), weight of primary rhizomes (-0.117), girth of primary rhizomes (-0.185) and core diameter (-0.441).

Girth of secondary rhizomes: The rhizome yield was exerted positive indirect effect through length of primary rhizome (0.344) and rhizome diameter (0.103). The negative indirect effect were exhibited in girth of primary rhizome (-0.192) and core diameter (-0.454).

Rhizome diameter: The rhizome yield had positive indirect effect through core diameter (0.513), length of primary rhizome (0.381), girth of secondary rhizome (0.319), curing percentage (0.220), girth of primary rhizome (0.175) and number of mother rhizome (0.109).

Core diameter: The rhizome yield was exhibited positive indirect effect through length of primary rhizome (0.452), girth of secondary rhizome (0.341), curing percentage (0.178), number of tillers (0.126), rhizome diameter (0.124), length of the leaf (0.123) and breadth of the leaf (0.102). The negative indirect effect were expressed in height of the plant (-0.118) and girth of primary rhizome (-0.209).

Rhizome core ratio: The rhizome yield was exerted positive indirect effect through core diameter (0.482) and girth of primary rhizome (0.153). The negative indirect effect were exhibited in number of tillers (-0.119), girth of secondary rhizome (-0.215) and length of primary rhizome (-0.281).

Essential oil content: The rhizome yield was expressed positive indirect effect through curcumin content (0.168). The negative indirect effect was exerted in number of mother rhizomes (-0.105), oleoresin content (-0.118) and curing percentage (-0.296).

Oleoresin content: The rhizome yield was exhibited positive indirect effect through curcumin content (0.230), length of primary rhizome (0.166), rhizome diameter (0.134) and girth of secondary rhizome (0.117). The negative indirect effect was expressed in curing percentage (-0.163) and core diameter (-0.197).

Curcumin content: The rhizome yield was exerted positive indirect effect through number of tillers (0.101), core diameter (0.050), height of the plant (0.030), girth of primary rhizome and essential oil content (0.022), breadth of the leaf (0.019), weight of primary rhizome (0.016), length of secondary rhizome (0.014), number of primary rhizome (0.012) and rhizome core ratio (0.006). While the negative indirect effect were exhibited in oleoresin content (-0.179), number of mother rhizomes (-0.223) and curing percentage (-0.291).

Curing percentage: The rhizome yield was exhibited positive indirect effect through curcumin content (0.223), core diameter (0.179) and number of mother rhizomes (0.161), while the negative indirect effect were expressed in length of primary rhizome (-0.121) and curcumin content (-0.223).

The estimate of correlation co-efficient reveals only the relationship between yield and yield components, but did not show the direct and indirect effects of different yield components on the yield *per se*. This is because the attributes which are in association do not exist by themselves but linked to other components. In this situation, path analysis serves as a tool for separating the total correlations into direct and indirect effects of different characters influencing the rhizome yield.

Among the twenty five characters subjected for the path analysis indicated direct significant positive direct influence on rhizome yield with girth of primary rhizome, height of the plant, length of secondary rhizome, rhizome diameter, length of leaf, days to maturity, breadth of leaf, core diameter, number of tillers, girth of secondary rhizome, number of secondary rhizomes, weight of secondary rhizomes, number of leaves, weight of primary rhizomes, length of primary rhizome showed positive direct influence on rhizome yield.

The negative direct effect was noticed for girth of mother rhizome, essential oil content, number of primary rhizomes, curing percentage, number of mother rhizomes, sprouting percentage, weight of mother rhizomes and rhizome core ratio with rhizome yield. The residual value obtained in the path study indicated that nearly 70 percent of the yield attributes were covered related to rhizome yield and hence selection criteria based on this study would be reliable. In order to get the developmental relations, the cause and effect of relationship between yield *per se* and nine yield components depict the relative importance of each factors involved in contributing to the rhizome yield (Lal *et al.*, 1986 and Pujari *et al.*, 1987). From the traced out pathways, the foregoing discussion indicated that the traits number of tillers, number of primary rhizomes, number of secondary rhizomes, weight of mother rhizomes, weight of primary rhizomes, weight of secondary rhizomes and curing percentage may be accorded due weightage in the selection programme, since all these characters exhibited positive and direct influence on rhizome yield. The above traits also contributed indirectly through height of the plant, girth of primary and secondary rhizome etc. at many instance. Path analysis studies of Prabhakaran (1991), Shanmugasundaram (1998), Hazra *et al.* (2000), Abraham and Latha (2003), Velmurugan and Chezhiyan (2003) and Tomar *et al.* (2005) in turmeric are in confirmation with the present view. On the contrary, Pathania *et al.* (1981) and Geetha and Prabhakaran (1987) demonstrated a greater direct contribution of plant height to rhizome yield, which might be due to the variation in the environment in which it was grown. It is also evident from the study that direct selection can be made on girth of secondary rhizomes, weight of secondary rhizomes and leaf dimensions, as they are true components relating to yield and selection on these will be rewarding. This is supported by the earlier works of Nandi *et al.* (1992) and Maurya *et al.* (1998).

Table 1. Path coefficient analysis for yield and yield attributing traits in fifty elite turmeric

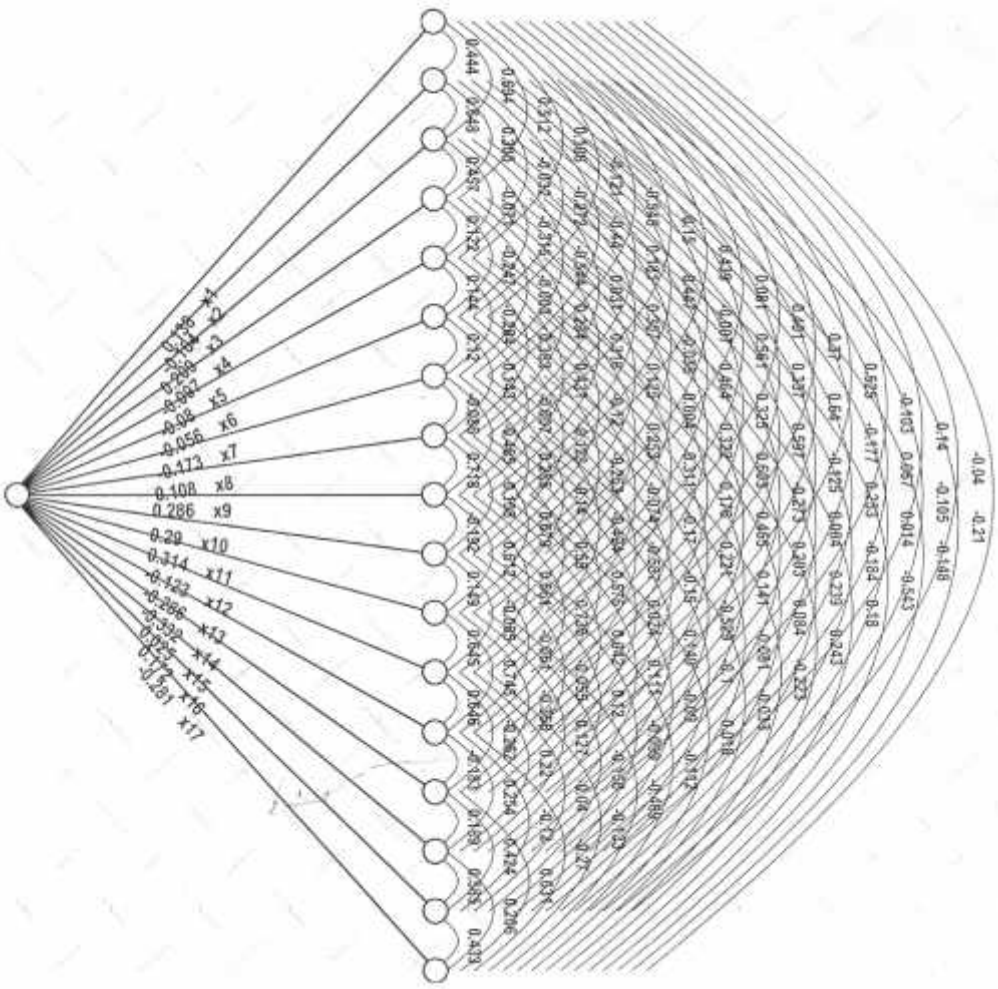
Characters	1	2	3	4	5	6	7	8	9	10	11	12	13
X_1	0.002	0.089	-0.013	-0.060	-0.059	-0.075	0.001	-0.003	-0.001	-0.003	0.011	0.064	-0.181
X_2	-0.001	-0.216	0.023	0.161	0.092	0.149	-0.005	0.186	0.001	0.010	0.022	-0.039	0.383
X_3	-0.001	-0.112	0.045	0.113	0.080	0.135	-0.003	-0.032	0.001	0.016	0.010	-0.036	0.254
X_4	-0.001	-0.165	0.024	0.211	0.087	0.133	-0.004	0.197	-0.001	0.010	0.040	-0.055	0.370
X_5	-0.001	-0.107	0.019	0.098	0.187	0.129	-0.005	-0.145	-0.001	0.014	0.013	-0.054	0.405
X_6	0.001	0.150	0.029	0.131	0.113	0.214	-0.004	-0.053	-0.001	0.019	0.017	-0.002	0.290
X_7	-0.001	-0.123	0.016	0.091	0.091	0.097	-0.009	-0.072	-0.001	0.015	0.019	-0.051	0.342
X_8	0.001	0.061	0.002	-0.063	0.041	0.017	-0.001	-0.659	-0.008	0.015	-0.014	0.034	-0.062
X_9	0.000	0.015	-0.002	0.024	0.033	-0.019	-0.001	-0.153	-0.001	-0.009	0.031	-0.068	0.186
X_{10}	0.001	0.035	-0.012	-0.033	-0.044	-0.067	0.002	0.161	0.002	-0.060	-0.011	-0.029	-0.081
X_{11}	-0.001	0.040	-0.004	-0.072	-0.021	-0.031	0.002	-0.079	-0.001	-0.005	-0.117	0.014	-0.088
X_{12}	-0.001	-0.048	0.009	0.066	0.057	0.002	0.005	0.126	-0.003	-0.010	0.010	-0.176	0.451
X_{13}	-0.001	-0.125	0.017	0.118	0.114	0.094	-0.003	0.062	-0.003	0.007	0.016	-0.120	0.661
X_{14}	-0.001	-0.083	0.021	0.114	0.078	0.063	-0.003	0.102	0.001	0.000	0.032	-0.125	0.478
X_{15}	-0.001	-0.025	0.000	-0.005	0.009	-0.004	-0.001	-0.030	0.004	0.009	-0.015	-0.013	0.101
X_{16}	-0.001	-0.049	0.009	0.061	0.052	0.016	-0.002	0.024	-0.002	-0.007	0.017	-0.152	0.436
X_{17}	-0.001	-0.113	0.021	0.101	0.092	0.082	-0.004	-0.052	-0.002	0.008	0.019	-0.117	0.517
X_{18}	-0.001	-0.062	0.015	0.066	0.058	0.071	-0.003	-0.059	-0.001	0.003	0.033	-0.097	0.344
X_{19}	0.001	-0.081	0.016	0.085	0.063	0.059	-0.005	0.109	-0.001	0.006	0.030	-0.076	0.381
X_{20}	-0.001	-0.118	0.028	0.123	0.102	0.126	-0.006	0.080	-0.001	0.010	0.042	-0.010	0.452
X_{21}	0.001	0.078	-0.023	-0.096	-0.094	-0.119	0.003	0.051	-0.002	-0.011	-0.039	0.068	-0.281
X_{22}	-0.001	0.019	0.007	0.018	0.037	0.028	0.002	-0.105	-0.001	0.001	0.022	0.009	-0.047
X_{23}	0.000	-0.031	0.001	0.032	0.055	0.058	-0.001	0.027	-0.002	-0.010	0.045	-0.025	0.166
X_{24}	0.001	0.030	-0.006	-0.027	0.019	0.101	0.002	-0.223	-0.002	-0.005	0.012	0.016	-0.053
X_{25}	0.001	0.048	-0.011	-0.003	-0.029	-0.031	0.005	0.161	-0.001	-0.015	0.004	0.004	-0.121

Table 1 continued

Characters	14	15	16	17	18	19	20	21	22	23	24	25	26
X_1	0.050	-0.025	-0.050	0.039	-0.021	0.033	0.164	-0.029	-0.002	-0.002	0.050	-0.033	-0.081
X_2	-0.110	0.028	0.030	-0.060	0.148	0.062	-0.378	0.022	-0.006	-0.045	-0.073	0.151	0.536**
X_3	-0.130	0.000	0.029	-0.053	0.178	0.060	-0.432	0.032	0.011	-0.007	-0.064	0.169	0.259
X_4	-0.154	-0.006	0.038	-0.054	0.163	0.067	-0.402	0.028	0.006	-0.047	-0.067	0.008	0.426**
X_5	-0.118	0.011	0.037	-0.055	0.162	0.056	-0.375	0.031	0.014	-0.091	0.052	0.105	0.382**
X_6	-0.085	-0.005	0.010	-0.043	0.172	0.046	-0.407	0.034	0.009	-0.084	0.022	0.099	0.371**
X_7	-0.093	0.033	0.033	-0.053	0.152	0.090	-0.430	0.019	-0.016	-0.023	-0.106	0.378	0.400**
X_8	0.044	0.011	-0.005	-0.009	0.046	-0.028	0.084	0.005	0.011	0.013	0.182	0.167	-0.110
X_9	-0.120	-0.033	0.060	-0.024	0.159	0.016	-0.123	0.016	0.009	-0.061	0.128	-0.123	-0.067
X_{10}	0.000	-0.036	0.016	0.016	-0.029	-0.015	0.114	-0.011	-0.001	-0.051	0.045	-0.173	-0.265
X_{11}	0.078	0.030	-0.010	0.018	-0.144	-0.043	0.250	-0.021	-0.013	0.120	-0.054	0.025	-0.132
X_{12}	-0.203	0.018	0.114	-0.075	0.285	0.072	-0.388	0.024	-0.004	-0.045	-0.047	0.017	0.249**
X_{13}	-0.207	0.037	0.084	-0.089	0.270	0.096	-0.471	0.026	0.005	-0.078	-0.042	0.125	0.586**
X_{14}	-0.286	-0.050	0.088	-0.073	0.349	0.102	-0.504	0.033	0.003	-0.043	-0.040	-0.008	0.245**
X_{15}	0.059	0.241	0.015	-0.012	-0.054	0.005	0.039	-0.008	-0.009	-0.027	-0.052	0.087	0.310**
X_{16}	-0.191	0.027	0.133	-0.077	0.306	0.063	-0.353	0.023	-0.005	-0.070	0.010	0.023	0.289**
X_{17}	-0.185	0.025	0.091	-0.113	0.349	0.087	-0.441	0.027	-0.003	-0.040	-0.063	0.240	0.525**
X_{18}	-0.192	-0.025	0.079	-0.076	0.518	0.103	-0.454	0.026	0.003	-0.071	-0.017	0.087	0.348**
X_{19}	0.175	0.007	0.050	0.059	0.319	0.166	0.513	0.007	-0.008	-0.059	-0.071	0.220	0.472**
X_{20}	-0.209	-0.014	0.068	-0.072	0.341	0.124	-0.690	0.043	0.001	-0.089	-0.038	0.178	0.380**
X_{21}	0.153	0.030	-0.050	0.050	-0.215	-0.019	0.482	-0.062	-0.014	0.081	-0.053	0.031	-0.046
X_{22}	-0.014	-0.032	-0.009	0.004	0.023	-0.019	-0.013	0.012	0.069	-0.118	0.168	-0.296	-0.235
X_{23}	-0.039	0.021	0.030	-0.014	0.117	0.134	-0.197	0.016	0.026	-0.312	0.230	-0.163	0.130
X_{24}	0.022	-0.024	0.002	0.014	-0.016	-0.023	0.050	0.006	0.022	-0.179	0.524	-0.291	-0.127
X_{25}	-0.004	-0.031	-0.005	0.040	-0.067	-0.054	0.179	0.003	0.030	-0.074	0.223	-0.683	-0.430

*** Significant at 5 per cent level; Residual effect = 0.1562; ** Significant at 1 per cent level**

X_1Sprouting percentage Curing percentage; X_2Height of the plantX_8l X_3Number of leaves; X_4Length of the leaf; X_5Breadth of the leaf X_6Number of tillers; X_7Days to maturity; X_8Number of mother rhizomes; X_9Weight of mother rhizomes; X_{10}Girth of mother rhizomes; X_{11}Number of primary rhizomes; X_{12}Weight of primary rhizomes; X_{13}Length of primary rhizomes; X_{14}Girth of primary rhizomes; X_{15}Number of secondary rhizomes; X_{16}Weight of secondary rhizomes; X_{17}Length of secondary rhizomes; X_{18}Girth of secondary rhizomes; X_{19}Rhizome diameter; X_{20}Core diameter; X_{21}Rhizome core ratio; X_{22}Essential oil content; X_{23}Oleoresin content; X_{24}Curcumin content; X_{25}Curing percentage; X_{26}Yield



Characters

1. Height of the plant
2. Number of leaves
3. Number of tillers
4. Days to maturity
5. Weight of mother rhizome
6. Girth of mother rhizome
7. Number of primary rhizome
8. Weight of primary rhizome
9. Girth of primary rhizome
10. Number of secondary rhizome
11. Length of secondary rhizome
12. Girth of secondary rhizome
13. Core diameter
14. Essential oil content
15. Curcumin content
16. Curing percentage

4.REFERENCES

Abraham, Z. and Latha, M. 2003. Correlation and path analysis in ginger (*Zingiber officinale* Rosc.). *J. Spices and Aromatic Crops,* **12(2):** 187-189.

Arunkumar, R. 2003. Evaluation of turmeric accessions for yield, quality and shoot borer resistance. Ph.D., Thesis submitted to Tamil Nadu Agricultural University, Coimbatore.

Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crossed wheat grass seed production. *Agron. J.,* **51:** 515-518.

Geetha, V. and Prabhakaran, P.V. 1987. Genotypic variability, correlation and path coefficient analysis in turmeric. *Agric. Res. J. Kerala,* **25(2):** 249-254.

Hazra, P., A. Roy and Bandhopadhyay, A. 2000. Growth characters as rhizome yield components of turmeric (*Curcuma longa* L.). *Crop Res.,* **19(2):** 235-240.

Lal, S.D., A. Shah and Phogat, K.P.S. 1986. Path analysis of productivity in turmeric. *Prog. Hort.,* **18 (1-2):** 101-103.

Nandi, A., D. Lenka and Singh, D.N. 1992. Path analysis in turmeric. *Indian Cocoa, Arecanut and Spices J.,* **17(2):** 54-55.

Peter, K.V., E.V. Nybe and Miniraj, N. 2006. Area and production of spices. *Survey of Indian Agriculture.* The Hindu, Kasturi Publishers, Mount Road, Chennai –2.

Pathania, N.K., P.K. Arya and Korla, K.B. 1981. Path analysis in turmeric (*Curcuma longa* L.). *Madras Agric. J.,* **68(10):** 675-678.

Prabhakaran, P.V.1991. Factor analysis in turmeric. *J. Indian Agric. Res.,* **12(2):** 151 155.

Pujari, P.P., R.B. Patil and Sakpal, R.T. 1987. Studies on growth yield and quality components in different turmeric varieties. *Indian Cocoa and Arecanut Spices J.,* **11(1):** 15-17.

Shanmugasundaram, K.A. 1998. Evaluation and selection for certain quantitative and qualitative characters in turmeric (*Curcuma domestica* Vel.). M.Sc., (Hort.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore.

Tomar, N.S., S. K. Nair and Gupta, C.R. 2005. Character association and path analysis for yield components in turmeric (*Curcuma longa* L.). *J. Spices and Aromatic Crops,* **14(1):** 75-77.

Velayuthan, K.C., V.K. Muralidharan,, V.A. Amalraj, R.S. Rana, B. Singh and Thomas, T.A. 1994. *Genetic resources of Curcuma.* National Bureau of Plant Genetic. Resources, Regional Station, ICAR Thrissur, Kerala.

Vijayalatha, K.R. 2002. Genetic divergence, multivariate analysis and molecular markers in turmeric (*Curcuma longa* L.). Ph.D., (Hort.) Thesis. Tamil Nadu Agricultural University, Coimbatore.

Wright, S. 1921. Correlation and causation. *J. Agric. Res.,* **20:** 557-585.

*****