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Character association and path coefficient analysis in turmeric (*Curcuma longa* L.)

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Abstract
Eight turmeric genotypes collected from different resources were evaluated for growth, yield and quality at College of Horticulture, Department of Spices and Plantation Crops, Coimbatore, Tamil Nadu India. The data recorded on different characters were subjected to work out correlation and path analysis to investigate the association, direct and indirect contribution of various characters on fresh rhizome yield per plant. Rhizome yield exhibited highly significant positive association with weight of secondary rhizomes followed by number of secondary rhizomes, weight of mother rhizomes, primary rhizome length, number of tillers, mother rhizome length, weight of primary rhizome, number of mother rhizomes, leaf area both at genotypic and phenotypic level. The numbers of primary rhizomes were positive but not significant with all the characters. The study revealed that selection for more mother rhizome length registered the highest positive direct effect of number of leaves, number of mother rhizomes, secondary rhizome length, curcumin content, essential oil content, number of secondary rhizomes, plant height, and weight of mother rhizomes would be more effective for further improvement of rhizome yield in turmeric as they have maximum positive direct effect as well as highly significant positive association with fresh rhizome yield per plant.

Keywords: Turmeric, Genotype, Rhizome, Correlation and Path

Introduction
Turmeric (*Curcuma longa* L. Syn *Curcuma domestica* Val.) is a herbaceous plant belonging to the family Zingiberaceae and order Sacitaminae. It's chromosome number is 2n = 32. India is known as the land of spices and they are popular for their flavour and medicinal properties both domestic and international market. Turmeric believed to be originated in South-East Asia and some species are naturalized in north eastern regions of India and Java.
It is cultivated for its underground rhizomes which are mainly used as spices, condiments, dye stuff in drug and cosmetic industry. It forms an important adjuvant in Indian culinary as it tends colour and aroma to various dishes. Further, turmeric has lots of medicinal properties. Traditionally it is used in Indian system of medicine as stomachic, carminative, blood purifier, vermicide and antiseptic. Wound healing property of turmeric is well known to Indians since long. The turmeric rhizome contains a variety of pigments among which 'curcumin' is the major pigment responsible for colour which varies from 3.5 to 9.0 per cent in different varieties.
Yield of the economic component is a very complex character and it is the result of interaction of a number of factors inherent both in plant and the environment in which the plant is grown. Therefore, variability exist within each component trait must be exploited by selection to realize maximum gain in rhizome yield. Correlation and path coefficient analyses together gives a clear cut picture of interrelationships and relative contribution of independent characters on dependent variable which enables to a plant breeder to apply suitable selection procedures for crop improvement. The present investigation was, therefore, conducted to find out the major yield contributing traits in turmeric.

Material and Methods
Eight turmeric accessions were received from different resources and those were evaluated at research farm of Horticulture, Department of Spices and Plantation Crops, Coimbatore, Tamil Nadu India. The experiment was laid out in randomized block design having three replication with the each two rows of three meter length with 45cm and 20cm inter and intra row spacing, respectively. The recommended agronomic practices and plant protection measures were followed timely for the successful raising of the crop. Five competitive plants were randomly selected and tagged after leaving the one plant in each border row in every plot of all the replications to record the observations on rhizome yield and other morphological traits.

The mean value of these plants was computed and used for statistical analysis.

Correlation coefficient analysis

Simple correlation coefficients between yield and yield components and intercorrelation among the various components were calculated using the formula suggested by Panse and Sukhatme (1967) [7].

$$\text{Correlation coeffient 'r'} = \frac{\text{Cov. (X.Y)}}{\sqrt{\text{(Var X) (Var Y)}}}$$

Where,

r = Simple correlation coefficient between variable X and Y

Cov. (X.Y) = Simple covariance between X and Y

V (x) = Variance of X

V (y) = Variance of Y

The significance of genotypic correlation coefficient was tested by referring to the standard table given by Snedecor and Cockhran (1967) [9].

Path coefficient analysis

Path coefficient analysis was carried out as suggested by Dewey and Lu (1959) by partitioning the simple correlation coefficients into direct and indirect effects. The direct and indirect effects were ranked based on the scales of Lenka and Misra (1973) [5] as given below

Negligible	:	0.00 to 0.09
Low	:	0.10 to 0.19
Moderate	:	0.20 to 0.29
High	:	0.30 to 0.99
Very high	:	> 1.00

Results and Discussion

The phenotypic and genotypic correlations were estimated among seventeen characters to determine the nature of association existing between rhizome yield per plant and its component characters and the results are presented in Table 1 & 2. Rhizome yield exhibited highly significant positive association with The fresh rhizome yield per plant had positive correlation with all characters studied and is in highly significant correlation with weight of secondary rhizomes (0.994, 0.969) followed by number of secondary rhizomes (0.973, 0.973), weight of mother rhizomes (0.948, 0.933), primary rhizome length (0.922, 0.923), number of tillers (0.901, 0.898), mother rhizome length (0.894, 0.897), weight of primary rhizome (0.892, 0.888), number of mother rhizomes (0.878, 0.877), leaf area (0.876, 0.880). Secondary rhizome length (0.865, 0.869), plant height (0.856, 0.747) both at genotypic and phenotypic level.

The rhizome yield showed positive significant association with weight of secondary rhizome, number of secondary rhizomes, weight of mother rhizome, primary rhizome length, number of tillers, mother rhizome length, weight of primary rhizome, number of leaves, number of mother rhizomes, leaf area, secondary rhizome length, plant height while, the curcumin content, oleoresin and essential oil content exhibited negative correlation among the genotypes of turmeric. Significant correlation of the rhizome yield suggests the scope of direct and indirect effective selections for further improvement. These characters emerged a most important associate of rhizome yield in turmeric. The earlier reports of Subramanian (1986) [10], Geetha and Prabhakaran (1987) [4], Pandey *et al.* (2002) [6], Vijayalatha (2002) [14], Vijaya (2003) [13] and Arunkumar (2003) [2] in turmeric are in line with present findings.

Path analysis

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 Table 3.

The mother rhizome length registered the highest positive direct effect of (1.09051) and number of leaves (1.33071), number of mother rhizomes (0.95420), secondary rhizome length (0.59428), curcumin content (0.41064), essential oil content (0.32637), number of secondary rhizomes (0.21707), plant height (0.05965), and weight of mother rhizomes (0.02168) exhibited positive direct effects. Number of tillers (-2.13506) had the highest negative direct effect followed by primary rhizome length (-0.66814), oleoresin content (-0.59424), number of primary rhizomes (-0.08413). The lowest negative direct effect of weight of primary rhizomes (-0.03557), followed by leaf area (-0.0004).

Among the seventeen characters subjected for the path analysis indicated very high direct significant positive influence on rhizome yield number of leaves and mother rhizome length while, number of mother rhizomes, secondary rhizome length, curcumin content and essential oil content showed high positive direct influence on rhizome yield. The moderate direct effect on rhizome yield was registered by number of secondary rhizomes.

The negative direct effect was noticed for number of tillers, primary rhizome length, oleoresin, weight of primary rhizomes, weight of secondary rhizomes and leaf area. The residual value obtained in the path study indicated that, the yield attributes were covered related to rhizome yield and hence selection criteria based on this study would be reliable. Path analysis studies of Shanmugasundaram (1998) [8], Abraham and Latha (2003) [1], Velmurugan and Chezhiyan (2003) [12] and Tomar *et al.,* (2005) [11] in turmeric are in confirmation with the present view.

Considering both correlation and path analysis together, it could be concluded that number of leaves, mother rhizome length, number of mother rhizomes and secondary rhizome length would be the appropriate selection parameters for improvement of rhizome yield in turmeric.

Weight of secondary rhizome, number of secondary rhizomes, weight of mother rhizome, primary rhizome length, number of tillers, weight of primary rhizome, leaf area, and plant height may also be taken as a selection parameter for improvement of yield as it had exerted positive correlation in the present study based on correlation analysis.

Table 1: Genotypic correlation coefficients in turmeric genotypes

SI.NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1.000	0.886**	0.886**	0.858**	0.694	0.821*	0.897**	0.892**	0.931**	0.933**	1.010	0.905**	0.917**	-0.199	0.152	0.065	0.856**
2		1.000	0.994**	0.990**	0.766*	0.575	0.857**	0.931**	0.818*	0.763*	0.821*	0.751*	0.888**	-0.323	-0.089	-0.159	0.890**
3			1.000	0.992**	0.812**	0.534	0.875**	0.921**	0.838**	0.788*	0.839**	0.754*	0.913**	-0.379	-0.106	-0.148	0.901**
4				1.000	0.819*	0.605	0.847**	0.874**	0.811*	0.742*	0.831*	0.712*	0.882**	-0.328	-0.138	-0.184	0.876**
5					1.000	0.320	0.873**	0.638	0.803*	0.704	0.849**	0.697	0.900**	-0.479	-0.297	-0.295	0.878**
6						1.000	0.418	0.457	0.546	0.487	0.582	0.385	0.419	0.280	0.176	0.032	0.418
7							1.000	0.877**	0.957**	0.904**	0.934**	0.882**	0.985**	-0.469	-0.138	-0.231	0.973**
8								1.000	0.851**	0.852**	0.823*	0.841**	0.897**	-0.315	0.090	-0.009	0.894**
9									1.000	0.979**	0.949**	0.809*	0.949**	-0.315	0.047	-0.045	0.922**
10										1.000	0.904**	0.788*	0.910**	-0.297	0.173	0.103	0.865**
11											1.000	0.912**	0.967**	-0.200	0.123	0.028	0.948**
12												1.000	0.916**	-0.286	0.101	-0.013	0.892**
13													1.000	-0.396	-0.012	-0.074	0.994**
14														1.000	0.734*	0.616	-0.333
15															1.000	0.948**	-0.025
16																1.000	-0.125
17																	1.000

***Significant at 5% level **Significant at 1% level**

1-Plant height (cm)**, 2**-No.of leaves/pl**, 3**-No.of tillers**, 4**-Leaf area (cm^2)**, 5**-No. Of mother rhizomes**, 6**-No. Of primary rhizomes**, 7**-No.of secondary rhizomes**, 8**-Mother rhizome length(cm)**, 9**-Primary rhizome length(cm)**, 10**-Secondary rhizome length (cm)**, 11**-Wt. Of mother rhizome (kg/plant)**, 12**-Wt. Of primary rhizome (kg/plant)**, 13**-Wt. Of secondary rhizome (kg/plant)**, 14**-Curcumin content**, 15**-Oleoresin content**, 16**-Essential oil content **and 17**-Rhizome yield/plant

Table 2: Phenotypic correlation coefficients in turmeric genotypes

SI.NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1.000	0.712*	0.711*	0.738*	0.577	0.683	0.750*	0.761*	0.841*	0.822*	0.798*	0.774*	0.759*	-0.073	0.236	0.109	0.747*
2		1.000	0.994**	0.987**	0.768*	0.579	0.858**	0.929**	0.810*	0.761*	0.813*	0.745*	0.865**	-0.311	-0.071	-0.150	0.888**
3			1.000	0.989**	0.813*	0.539	0.875**	0.919**	0.828*	0.784*	0.830*	0.749*	0.888**	-0.367	-0.088	-0.139	0.898**
4				1.000	0.820*	0.612	0.850**	0.878**	0.815*	0.751*	0.822*	0.714*	0.863**	-0.304	-0.103	-0.166	0.880**
5					1.000	0.328	0.873**	0.642	0.796*	0.705	0.840**	0.694	0.877**	-0.464	-0.272	-0.284	0.877**
6						1.000	0.427	0.467	0.554	0.498	0.581	0.394	0.420	0.289	0.194	0.043	0.430
7							1.000	0.879**	0.950**	0.904**	0.923**	0.876**	0.960**	-0.448	-0.109	-0.216	0.973**
8								1.000	0.853**	0.856**	0.814*	0.839**	0.877**	-0.291	0.117	0.005	0.897**
9									1.000	0.979**	0.925**	0.809*	0.922**	-0.274	0.093	-0.020	0.923**
10										1.000	0.888**	0.789*	0.889**	-0.264	0.207	0.120	0.869**
11											1.000	0.893**	0.953**	-0.184	0.137	0.037	0.933**
12												1.000	0.877	-0.259	0.130	0.004	0.888**
13													1.000	-0.359	0.019	-0.056	0.969**
14														1.000	0.738*	0.620	-0.306
15															1.000	0.945	0.010
16																1.000	-0.106
17																	1.000

***Significant at 5% level **Significant at 1% level**

1-Plant height (cm)**, 2**-No.of leaves/pl**, 3**-No.of tillers**, 4**-Leaf area (cm^2)**, 5**-No. Of mother rhizomes**, 6**-No. Of primary rhizomes**, 7**-No.of secondary rhizomes**, 8**-Mother rhizome length(cm)**, 9**-Primary rhizome length(cm)**, 10**-Secondary rhizome length (cm)**, 11**-Wt. Of mother rhizome (kg/plant)**, 12**-Wt. Of primary rhizome (kg/plant)**, 13**-Wt. Of secondary rhizome (kg/plant)**, 14**-Curcumin content**, 15**-Oleoresin content**, 16**-Essential oil content **and 17**-Rhizome yield/plant

Table 3: Path coefficient analysis in turmeric genotypes

SI.NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	0.05965	1.17847	-1.89192	-0.00003	0.66230	-0.06906	0.19474	0.97277	-0.62203	0.55447	0.02190	-0.03219	-0.02238	-0.08153	-0.09011	0.02129	0.856**
2	0.05282	1.33071	-2.12212	-0.00004	0.73133	-0.04835	0.18609	1.01476	-0.54669	0.45343	0.01780	-0.02671	-0.02167	-0.13269	0.05312	-0.05179	0.890**
3	0.05285	1.32265	-2.13506	-0.00004	0.77439	-0.04494	0.18997	1.00453	-0.55962	0.46803	0.01818	-0.02683	-0.02228	-0.15579	0.06327	-0.04831	0.901**
4	0.05117	1.31780	-2.11849	-0.00004	0.78175	-0.05086	0.18376	0.95347	-0.54177	0.44124	0.01802	-0.02531	-0.02154	-0.13476	0.08205	-0.06015	0.876**
5	0.04140	1.01990	-1.73272	-0.00003	0.95420	-0.02695	0.18940	0.69604	-0.53634	0.41833	0.01840	-0.02480	-0.02197	-0.19669	0.17621	-0.09619	0.878**
6	0.04896	0.76483	-1.14064	-0.00002	0.30563	-0.08413	0.09075	0.49867	-0.36501	0.28965	0.01262	-0.01368	-0.01022	0.11510	-0.10459	0.01058	0.418
7	0.05351	1.14075	-1.86846	-0.00003	0.83255	-0.03517	0.21707	0.95619	-0.63916	0.53752	0.02025	-0.03136	-0.02404	-0.19274	0.08189	-0.07547	0.973**
8	0.05321	1.23828	-1.96673	-0.00003	0.60904	-0.03847	0.19034	1.09051	-0.56885	0.50649	0.01785	-0.02993	-0.02189	-0.12930	-0.05331	-0.00306	0.894**
9	0.05553	1.08883	-1.78829	-0.00003	0.76597	-0.04596	0.20766	0.92844	-0.66814	0.58152	0.02056	-0.02878	-0.02317	-0.12922	-0.02795	-0.01463	0.922**
10	0.05565	1.01530	-1.68147	-0.00003	0.67169	-0.04100	0.19634	0.92940	-0.65380	0.59428	0.01960	-0.02802	-0.02222	-0.12184	-0.10288	0.03377	0.865**
11	0.06026	1.09291	-1.79079	-0.00003	0.81003	-0.04899	0.20277	0.89782	-0.63381	0.53745	0.02168	-0.03245	-0.02359	-0.08208	-0.07289	0.00923	0.948**
12	0.05398	0.99915	-1.61054	-0.00003	0.66538	-0.03236	0.19139	0.91763	-0.54069	0.46813	0.01978	-0.03557	-0.02235	-0.11764	-0.05973	-0.00418	0.892**
13	0.05470	1.18152	-1.94911	-0.00003	0.85880	-0.03524	0.21382	0.97819	-0.63433	0.54108	0.02095	-0.03258	-0.02441	-0.16254	0.00733	-0.02421	0.994**
14	-0.01184	-0.43000	0.81002	0.00001	-0.45704	-0.02358	-0.10189	-0.34338	0.21025	-0.17633	-0.00433	0.01019	0.00966	0.41064	-0.43646	0.20114	-0.333
15	0.00905	-0.11895	0.22732	0.00001	-0.28295	-0.01481	-0.02992	0.09782	-0.03143	0.10289	0.00266	-0.00358	0.00030	0.30160	-0.59424	0.30956	-0.025
16	0.00389	-0.21118	0.31605	0.00001	-0.28122	-0.00273	-0.05020	-0.01023	0.02995	0.06150	0.00061	0.00046	0.00181	0.25307	-0.56363	0.32637	-0.125

Residual effect : 0.315 Diagonal entries in italics indicate direct effects of the relevant factors.

1-Plant height (cm)**, 2-**No.of leaves/pl**, 3-**No.of tillers**, 4-**Leaf area (cm^2)**, 5-**No. Of mother rhizomes**, 6-**No. Of primary rhizomes**, 7-**No.of secondary rhizomes**, 8-**Mother rhizome length(cm)**, 9-**Primary rhizome length(cm)**, 10-**Secondary rhizome length (cm)**, 11-**Wt. Of mother rhizome (kg/plant)**, 12-**Wt. Of primary rhizome (kg/plant)**, 13-**Wt. Of secondary rhizome (kg/plant)**, 14-**Curcumin content**, 15-**Oleoresin content**, 16-**Essential oil content **and 17-**Rhizome yield/plant**.**

References

1. Abraham Z, Latha M. Correlation and path analysis in ginger (*Zingiber officinale* Rosc.). J. Spices Aromatic Crops. 2003; 12(2):187-189.
2. Arunkumar R. Evaluation of turmeric accessions for yield, quality and shoot borer resistance. Ph.D., (Hort.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 2003.
3. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crossed wheat grass seed production. Agron. J. 1959; 51:515-518.
4. Geetha V, Prabhakaran PV. Genotypic variability, correlation and path coefficient analysis in turmeric. Agric. Res. J. Kerala. 1987; 25(2):249-254.
5. Lenka D, Mishra B. Path coefficient analysis of yield in rice varieties. Indian J Agric. Sci. 1973; 43:376-379.
6. Pandey VS, Pandey VP, Singh T, Srivastava AK. Genetic variability and correlation studies in turmeric (*Curcuma longa* L.) In: National Seminar on Strategies for Increasing Production and Export of Spices, 2002, held at Indain Institute of Spices Research, Calicut, Kerala, 2002, 24-26
7. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, New Delhi. 1967, 134-192.
8. Shanmugasundaram KA. 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, 1998.
9. Snedecor GW, Cockhran CWG. Statistical methods. The Iowa State University Press, IOWA, U.S.A, 1967.
10. Subramanian S. Studies on growth and development of turmeric (*Curcuma longa* L.). M. Sc., (Ag.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 1986.
11. Tomar NS, Nair SK, Gupta CR. Character association and path analysis for yield components in turmeric (*Curcuma longa* L.). J. Spices Aromatic Crops. 2005; 14(1):75-77.
12. Velmurugan M, Chezhiyan N. Correlation studies in turmeric. In: National Seminar on New Perspective in Spices, Medicinal and Aromatic plants, 27-29 November 2003, held at ICAR Research complex on Goa, 2003.
13. Vijaya T. Evaluation of turmeric (*Curcuma longa* L.) genotypes under open and coconut shade conditions. M. Sc., (Hort.) Thesis, submitted to Tamil Nadu Agricultural University, Coimbatore, 2003.
14. Vijayalatha KR. Genetic divergence, multivariate analysis and molecular markers in turmeric (*Curcuma longa* L.). Ph.D., (Hort.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 2002.