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CORRELATION AND PATH COEFFICIENT ANALYSIS AMONG THE GROWTH, QUALITY AND YIELD CHARACTERS IN TURMERIC

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Abstract

The present investigation entitled was carried out in randomized block design with three replications during 2013-14 and 2014-15 to study the magnitude of association among the growth, yield its attributing characters and quality parameters. The study revealed that rhizome yield had positive and significant correlation with weight of fresh rhizome, weight of primary rhizomes per plant, plant height, plant girth, weight of mother rhizome, weight of secondary rhizomes per plant, length of mother rhizome, number of secondary rhizomes per plant, number of leaves per plant and width of mother rhizome in all environments (E_1, E_2, E_3, E_4). At phenotypic level weight of fresh rhizome per plant exerted highest positive direct effect on rhizome yield followed by plant height, weight of primary rhizomes per plant, length of mother rhizome, number of tertiary rhizomes per plant and weight of mother rhizome. However, width of mother rhizome exerted highest negative direct effect on rhizome yield followed by number of secondary rhizome per plant and number of tillers per clump.

Key words : Turmeric, yield, quality parameters, correlation and path coefficient.

Introduction

Turmeric (*Cucuma longa* L.) is the native of Indo-Malayan region and belongs to the family Zingiberaceae. It is erect, herbaceous, perennial plant but is grown as an annual. It possesses an underground stem or rhizome which is thick and rounded with short blunt fingers. The leaves are tall, thin, light green in colour, lanceolate with a long stalk. Flowers are also borne in cone shaped spikes in the tuft of leaves. The spikes consist of a great number of thin, greenish-white, ovate bracts.

Turmeric is valued globally as a condiment, food colourant, dye, drugs and medicine. The rhizome contains yellow colouring component curcumin (3-9%), essential oil (5-6%) and oleoresin (6-13%). Curcumin is gaining more importance in food industries, pharmaceuticals, preservatives and cosmetics. The ban on artificial colour has prompted the use of curcumin as a food colourant. In pharmaceuticals it is valued for the anti cancerous, anti inflammatory, antiseptic, antimicrobial and antiproliferative activities (Srimal, 1997).

Turmeric being most important to growers, consumers and industries, there is pressing need to increase its productivity and quality to fulfil the increasing demands throughout nation and abroad. Genetic improvement may play a vital role in increasing production and productivity. The magnitude of genetic variability forms the basis for crop improvement. The estimation of correlation coefficient among yield and its components is necessary to understand the direction of selection and maximize yield in the shortest period. The selection pressure can easily be exerted on any of the character which reflects close association with yield as they help in the construction of selection indices and also permits the prediction of correlation responses. Path coefficient analysis helps in partitioning the correlation into direct and indirect effects of various yield components on yield. Therefore, correlation studies coupled with path coefficient is a powerful tool to study the character association and their final impact on yield, which helps the selection procedure accordingly.

Materials and Methods

The experiments were conducted at Main Experiment Station of Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) India, which is situated at between 24.47° N latitude and 82.12°E longitude having an elevation of 113 meters above the mean sea level. The second location Lal Bahadur Shastri Krishi Vigayn

Kendra, Gopalgram, Gonda (U.P.), India is situated on 27.12°N latitude and 82.85°E longitude having an elevation of 119 meter above the mean sea level. Geographically both places fall in northeast gangetic alluvial plains of eastern Uttar Pradesh. The soil type of Kumarganj is sandy loam with pH value of 8.2 and soil type of Gopalgram is also sandy loam, medium in organic carbon with 7.6 pH.

The observations were recorded on characters *viz.,* plant height (cm), number of tillers per clump, number of leaves per plant, plant girth (cm), weight of fresh rhizome per plant (g), weight of mother rhizome (g), length of mother rhizome (cm), width of mother rhizome (cm), number of primary rhizomes per plant, weight of primary rhizomes per plant (g), number of secondary rhizomes per plant, weight of secondary rhizomes per plant (g), number of tertiary rhizomes per plant, rhizome yield (q/ha), dry matter, curcumin and oleoresin per cent.

The correlation between different characters at genotypic (g), phenotypic (p) and environmental (e) levels were estimated according to Searle (1965). Path coefficient analysis carried out according to Wright (1921) and as elaborated by Dewey and Lu (1959) by partitioning the genotypic correlation coefficients into direct and indirect effects.

Results and Discussion

The modification of plant type has played an important role in developing more efficient genotypes possessing increased yield potential. Since yield is a complex trait and governed by many genes, its improvement is essentially linked with understanding of correlations among components affecting yield. In the present investigation, phenotypic and genotypic correlations were estimated. The genotypic correlation coefficients between different characters were generally similar in sign and nature to the corresponding phenotypic coefficient in the experiment. However, genotypic correlations were larger in magnitude than the corresponding phenotypic values.

The rhizome yield had significant positive correlations with weight of fresh rhizome, weight of primary rhizomes per plant, plant height, plant girth, weight of mother rhizome, weight of secondary rhizomes per plant, length of mother rhizome, number of secondary rhizomes per plant, number of leaves per plant and width of mother rhizome. The correlation coefficients analysis further revealed that the characters like weight of fresh rhizome, weight of primary rhizomes per plant, plant height, plant girth, weight of mother rhizome, weight of secondary rhizomes per plant, length of mother rhizome, number of secondary rhizomes per plant, number of leaves per plant and width of mother rhizome most important for the improvement of rhizome yield. The similar, results are previously reported by Panja *et al.* (2002), Pandey *et al.* (2002) and Tomar *et al.* (2005), Yadav *et al.* (2006), Singh *et al.* (2012) and Prajapati *et al.* (2014).

At phenotypic level among other traits, plant height was positively and significantly correlated with plant girth, number of secondary rhizomes per plant, weight of primary rhizomes per plant, weight of fresh rhizomes per plant, weight of secondary rhizomes per plant, dry matter, weight of mother rhizomes, number of leaves per plant, number of primary rhizomes per plant, number of tertiary rhizomes per plant, width of mother rhizome, length of mother rhizome and it was negative and significant correlated with curcumin %.

Number of tillers per clump was positively and significantly correlated with number of secondary rhizomes per plant, plant girth and negatively and significantly correlated with curcumin %.

Number of leaves per plant had significant and positive association with plant girth, number of secondary rhizomes per plant, length of mother rhizome, weight of mother rhizomes, weight of primary rhizomes per plant, weight of fresh rhizomes per plant, weight of secondary rhizomes per plant, dry matter, width of mother rhizome and weight primary rhizomes per plant.

Plant girth had significant and positive association with weight of fresh rhizomes per plant, number of secondary rhizomes per plant, weight of mother rhizomes, weight of primary rhizomes per plant, weight of secondary rhizomes per plant, width of mother rhizome, dry matter, length of mother rhizome, number of primary rhizomes per plant and it was negatively and significantly associated with curcumin %.

Weight of fresh rhizomes per plant had significant and positive association with weight of primary rhizomes per plant, weight of mother rhizomes, weight of secondary rhizomes per plant, length and width of mother rhizome, number of secondary rhizomes per plant, dry matter while, it was negatively and significantly associated with curcumin %.

Weight of mother rhizomes showed positive and significant association with width of mother rhizome, length of mother rhizome, weight of primary rhizomes per plant, weight of secondary rhizomes per plant, dry matter and number of secondary rhizomes per plant, while, it was negatively and significantly associated with number of tertiary rhizomes per plant.

Table 1 : Phenotypic correlation coefficients for different characters in turmeric MES 2013-14 (E_1).

S.no.	Characters	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Plant height (cm)	0.17	0.24**	0.30**	0.66**	0.55**	0.26**	0.35**	0.39**	0.66**	0.57**	0.57**	0.55**	0.38**	-0.21*	-0.13	0.59**
2.	Number of tillers per clump		0.18	0.24*	0.11	0.04	0.05	0.06	-0.11	0.11	0.39**	0.03	0.16	0.09	-0.22*	-0.00	-0.03
3.	Number of leaves per plant			0.51**	0.45**	0.46**	0.48**	0.35**	0.07	0.24*	0.39**	0.43**	0.05	0.41**	-0.15	-0.04	0.34*
4.	Plant girth (cm)				0.66**	0.56**	0.38**	0.49**	0.29*	0.56**	0.61**	0.49**	0.10	0.44**	-0.24*	-0.09	0.52**
5.	Weight of fresh rhizome per plant (g)					0.74**	0.57**	0.57**	0.18	0.87**	0.54**	0.66**	0.06	0.52**	-0.27*	0.10	0.71**
6.	Weight of mother rhizome (g)						0.65**	0.77**	0.13	0.47**	0.21*	0.19	-0.32*	0.36**	-0.17	0.20	0.51**
7.	Length of mother rhizome (cm)							0.62**	-0.06	0.38**	0.17	0.17	-0.31*	0.41**	-0.08	0.22*	0.40**
8.	Width of mother rhizome (cm)								0.13	0.36**	0.15	0.12	-0.24*	0.38**	-0.01	0.17	0.32**
9.	Number of primary rhizomes per plant									0.32*	0.31*	0.02	0.13	0.02	0.01	0.23*	0.08
10.	Weight of primary rhizomes / plant (g)										0.54**	0.56**	0.20	0.46**	-0.24*	0.19	0.65**
11.	Number of secondary rhizomes per plant											0.64**	0.46**	0.34*	-0.13	-0.13	0.36**
12.	Weight of secondary rhizome per plant (g)												0.43**	0.47**	-0.24*	-0.30*	0.51**
13.	Number of tertiary rhizomes per plant													0.18	-0.08	-0.33*	0.15
14.	Dry matter (%)														-0.27*	-0.24	0.38
15.	Curcumin (%)															0.32*	-0.25
16.	Oleoresin (%)																-0.01

*, ** Significant at 5% and 1% level against error.

Table 2 : Genotypic correlation coefficients for different characters in turmeric MES 2013-14 (E_1).

S.no.	Characters	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Plant height (cm)	0.19	0.56	0.93	0.66	0.45	0.29	0.34	0.58	0.66	0.78	0.58	0.33	0.07	-0.32	-0.14	0.59
2.	Number of tillers per clump		0.24	0.29	0.12	0.05	0.10	0.09	0.12	0.15	0.14	0.08	0.12	0.12	-0.24	-0.07	-0.02
3.	Number of leaves per plant			0.70	0.56	0.57	0.69	0.43	0.07	0.22	0.54	0.45	0.05	0.53	-0.19	-0.05	0.42
4.	Plant girth (cm)				0.78	0.65	0.56	0.61	0.30	0.66	0.78	0.57	0.18	0.61	-0.30	-0.10	0.62
5.	Weight of fresh rhizome per plant (g)					0.74	0.64	0.59	0.27	0.88	0.62	0.66	0.06	0.54	-0.28	0.11	0.71
6.	Weight of mother rhizome (g)						0.74	0.80	0.18	0.46	0.24	0.19	-0.34	0.38	-0.17	0.21	0.51
7.	Length of mother rhizome (cm)							0.70	-0.03	0.43	0.29	0.21	-0.37	0.42	-0.09	0.29	0.46
8.	Width of mother rhizome (cm)								0.21	0.38	0.18	0.12	-0.28	0.41	0.01	0.22	0.33
9.	Number of primary rhizomes per plant									0.44	0.37	0.02	0.23	0.13	0.05	0.36	0.12
10.	Weight of primary rhizomes / plant (g)										0.60	0.56	0.21	0.49	-0.24	0.20	0.65
11.	Number of secondary rhizomes per plant											0.70	0.57	0.42	-0.13	-0.19	0.41
12.	Weight of secondary rhizome per plant (g)												0.46	0.51	-0.24	-0.33	0.52
13.	Number of tertiary rhizomes per plant													0.18	-0.08	-0.36	0.16
14.	Dry matter (%)														-0.28	-0.30	0.40
15.	Curcumin (%)															0.36	-0.26
16.	Oleoresin (%)																-0.00

Table 3 : Direct and indirect effects of different characters on rhizome yield at phenotypic level in turmeric MES 2013-14 (E_1).

S.no.	Characters	Plant height (cm)	Number of tillers/clump	Number of leaves/plant	Plant girth (cm)	Weight of fresh rhizome per plant (g)	Weight of mother rhizome (g)	Length of mother rhizome (cm)	Width of mother rhizome (cm)	Number of primary rhizomes per plant	Weight of primary rhizomes per plant (g)	Number of secondary rhizomes per plant	Weight of secondary rhizome per plant (g)	Number of tertiary rhizomes per plant	Dry matter (%)	Curcumin (%)	Oleoresin (%)	Rhizome yield per plot (kg)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.	Plant height (cm)	**0.761**	-0.027	0.020	0.062	0.297	0.059	0.037	-0.072	-0.034	0.112	-0.117	0.053	0.050	-0.053	0.002	0.006	0.52**
2.	Number of tillers/clump	0.046	**-0.153**	0.008	0.019	0.070	0.006	0.008	-0.013	-0.010	0.025	-0.014	0.009	0.015	-0.009	0.001	0.000	0.08
3.	Number of leaves/plant	0.117	-0.028	**0.045**	0.040	0.204	0.061	0.070	-0.077	-0.006	0.042	-0.093	0.002	0.005	-0.041	0.001	0.002	0.34**
4.	Plant girth (cm)	0.210	-0.037	0.023	**0.077**	0.300	0.072	0.054	-0.108	-0.025	0.095	-0.116	-0.003	0.015	-0.043	0.001	0.004	0.57**
5.	Weight of fresh rhizome per plant (g)	0.172	-0.024	0.021	0.051	**0.452**	0.096	0.082	-0.124	-0.016	0.149	-0.102	-0.004	0.009	-0.051	0.002	-0.005	0.71**
6.	Weight of mother rhizome (g)	0.119	-0.007	0.021	0.043	0.336	**0.129**	0.095	-0.167	-0.012	0.079	-0.040	-0.001	-0.045	-0.036	0.001	-0.009	0.51**
7.	Length of mother rhizome (cm)	0.068	-0.008	0.022	0.029	0.257	0.085	**0.145**	-0.133	0.005	0.064	-0.032	-0.001	-0.043	-0.041	0.000	-0.010	0.40**
8.	Width of mother rhizome (cm)	0.086	0.009	0.016	0.038	0.258	0.099	0.089	**-0.217**	-0.012	0.061	-0.028	-0.001	-0.034	-0.038	0.000	-0.008	0.32**
9.	Number of primary rhizomes per plant	0.101	-0.018	0.003	0.022	0.084	0.017	-0.009	-0.030	**-0.087**	0.055	-0.059	0.000	0.018	-0.002	0.000	-0.011	0.08
10.	Weight of primary rhizomes per plant (g)	0.173	-0.023	0.011	0.043	0.398	0.060	0.055	-0.079	-0.028	**0.169**	-0.101	-0.003	0.029	-0.045	0.001	-0.009	0.65**
11.	Number of secondary rhizomes per plant	0.176	-0.060	0.022	0.047	0.245	0.027	0.025	-0.032	-0.027	0.091	**-0.188**	-0.004	0.064	-0.033	0.001	0.006	0.36**
12.	Weight of secondary rhizome per plant (g)	0.149	-0.012	0.020	0.038	0.300	0.025	0.025	-0.026	-0.002	0.094	-0.121	**-0.006**	0.061	-0.046	0.001	0.014	0.51**
13.	Number of tertiary rhizomes per plant	0.093	-0.017	0.002	0.008	0.028	-0.042	-0.045	0.053	-0.012	0.035	-0.087	-0.002	**0.139**	-0.018	0.000	0.015	0.15
14.	Dry matter (%)	0.140	-0.014	0.019	0.034	0.235	0.047	0.060	-0.083	-0.002	0.078	-0.064	-0.003	0.025	**-0.098**	0.002	0.011	0.38
15.	Curcumin (%)	-0.082	0.035	-0.007	-0.018	-0.125	-0.022	-0.012	0.000	-0.002	-0.040	0.025	0.001	-0.012	0.027	**-0.006**	-0.015	-0.25
16.	Oleoresin (%)	-0.034	0.001	-0.002	-0.007	0.047	0.026	0.033	-0.037	-0.020	0.033	0.025	0.002	-0.046	0.024	-0.002	**-0.046**	-0.01

Table 4 : Direct and indirect effects of different characters on rhizome yield at genotypic level in turmeric MES 2013-14 (E_1).

S.no.	Characters	Plant height (cm)	Number of tillers/clump	Number of leaves/plant	Plant girth (cm)	Weight of fresh rhizome per plant (g)	Weight of mother rhizome (g)	Length of mother rhizome (cm)	Width of mother rhizome (cm)	Number of primary rhizomes per plant	Weight of primary rhizomes per plant (g)	Number of secondary rhizomes per plant	Weight of secondary rhizome per plant (g)	Number of tertiary rhizomes per plant	Dry matter (%)	Curcumin (%)	Oleoresin (%)	Rhizome yield per plant (g)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Plant height (cm)	**1.365**	0.071	-0.046	-0.185	0.127	-0.174	0.435	-0.130	-0.009	-0.547	-1.291	0.108	0.302	-0.248	-0.129	0.047	**0.598**
2.	Number of tillers/clump	0.366	**0.360**	-0.148	-0.152	0.301	-0.018	0.154	0.035	-0.002	-0.134	-0.786	0.020	0.106	-0.054	-0.096	0.024	**-0.029**
3.	Number of leaves/plant	1.039	0.086	**-0.320**	-0.365	0.954	-0.220	0.013	-0.162	-0.001	-0.242	-1.905	0.093	0.041	-0.231	-0.076	0.017	**0.424**
4.	Plant girth (cm)	1.749	0.106	-0.438	**-0.517**	1.331	-0.249	0.829	-0.227	-0.005	-0.544	-1.318	0.108	0.142	-0.264	-0.121	0.036	**0.618**
5.	Weight of fresh rhizome per plant (g)	1.231	0.064	-0.347	-0.403	**1.707**	-0.284	0.940	-0.220	-0.005	-0.724	-1.044	0.126	0.051	-0.234	-0.112	-0.037	**0.709**
6.	Weight of mother rhizome (g)	0.851	0.017	-0.358	-0.339	1.271	**-0.381**	1.080	-0.297	-0.003	-0.385	-0.405	0.037	-0.274	-0.165	-0.070	-0.071	**0.510**
7.	Length of mother rhizome (cm)	0.555	0.038	-0.429	-0.293	1.097	-0.281	**1.463**	-0.262	0.000	-0.357	-0.486	0.040	-0.299	-0.183	-0.038	-0.098	**0.466**
8.	Width of mother rhizome (cm)	0.651	-0.034	-0.270	-0.316	1.013	-0.305	1.033	**-0.371**	-0.004	-0.313	-0.306	0.024	-0.223	-0.178	0.004	-0.072	**0.333**
9.	Number of primary rhizomes per plant	0.986	0.043	-0.046	-0.157	0.463	-0.071	-0.042	-0.079	**-0.017**	-0.363	-0.623	0.004	0.185	-0.057	0.020	-0.120	**0.128**
10.	Weight of primary rhizomes per plant (g)	1.241	0.059	-0.183	-0.342	1.504	-0.178	0.636	-0.141	-0.007	**-0.822**	-1.014	0.106	0.174	-0.212	-0.097	-0.068	**0.654**
11.	Number of secondary rhizomes per plant	1.429	0.168	-0.333	-0.404	1.057	-0.092	0.422	-0.067	-0.006	-0.495	**-1.685**	0.133	0.461	-0.182	-0.054	0.063	**0.415**
12.	Weight of secondary rhizome per plant (g)	1.075	0.028	-0.317	-0.297	1.139	-0.075	0.308	-0.046	0.000	-0.461	-1.186	**0.189**	0.373	-0.221	-0.098	0.109	**0.519**
13.	Number of tertiary rhizomes per plant	0.704	0.048	-0.032	-0.092	0.109	0.131	-0.548	0.104	-0.004	-0.178	-0.970	0.088	**0.800**	-0.082	-0.035	0.119	**0.162**
14.	Dry matter (%)	1.074	0.045	-0.332	-0.317	0.927	-0.146	0.622	-0.154	-0.002	-0.404	-0.710	0.097	0.151	**-0.431**	-0.113	0.099	**0.406**
15.	Curcumin (%)	-0.602	-0.087	0.118	0.157	-0.480	0.066	-0.140	-0.004	-0.001	0.199	0.226	-0.046	-0.070	0.123	**0.399**	-0.118	**-0.258**
16.	Oleoresin (%)	-0.265	-0.026	0.033	0.056	0.193	-0.082	0.437	-0.082	-0.006	-0.171	0.321	-0.062	-0.290	0.131	0.143	**-0.329**	**0.000**

Length of mother rhizomes showed positive and significant association with width of mother rhizome, dry matter and oleoresin while, it was negatively and significantly associated with number of tertiary rhizomes per plant. Width of mother rhizome had significant and positive association with dry matter, weight of primary rhizomes per plant and negatively and significantly associated with number of tertiary rhizomes per plant.

Number of primary rhizomes per plant was positively and significantly correlated with weight of primary rhizomes per plant, number of secondary rhizomes per plant and oleoresin. Weight of primary rhizomes per plant had significant and positive association with weight of secondary rhizomes per plant, number of secondary rhizomes per plant, dry matter and negatively and significantly associated with curcumin %.

Number of secondary rhizomes per plant was positively and significantly correlated with weight of secondary rhizomes per plant and number of tertiary rhizomes per plant at phenotypic level. Weight of secondary rhizomes per plant showed positive and significant association with dry matter, number of tertiary rhizomes per plant and negatively and significantly associated with curcumin and oleoresin. Number of tertiary rhizomes per plant negatively and significantly associated with oleoresin and dry matter content showed negative and significant correlation with curcumin. Curcumin content had positive and significant association with oleoresin.

Path coefficient is simply a standardized partial regression coefficient and as such measures the direct influence of one variable upon another, which permits the separation of correlation coefficient into components of direct and indirect effects.

In present study, at phenotypic level weight of fresh rhizome per plant exerted highest positive direct effect on rhizome yield followed by plant height, weight of primary rhizomes per plant, length of mother rhizome, number of tertiary rhizomes per plant and weight of mother rhizome. However, width of mother rhizome exerted highest negative direct effect on rhizome yield followed by number of secondary rhizome per plant and number of tillers per clump. The present findings are supported by Panja *et al*. (2002), Pandey *et al*. (2003), Tomar *et al*. (2005), Verma *et al*. (2014), Mishra *et al*. (2015) and Gupta *et al*. (2016)

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