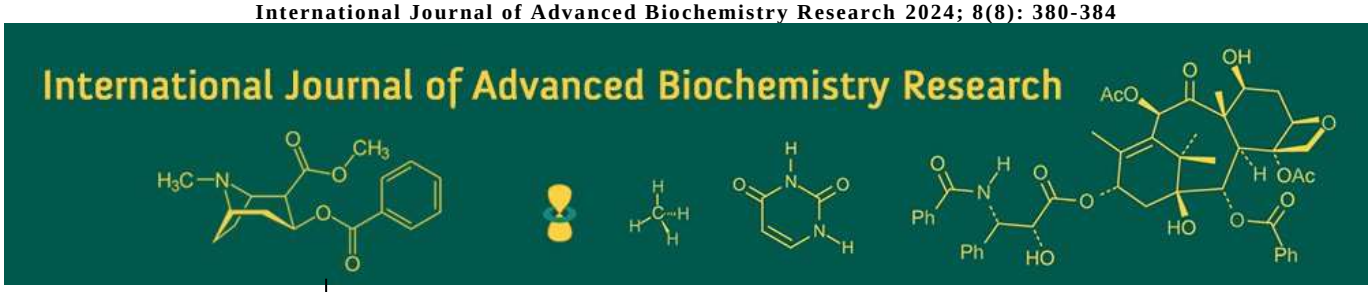

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Sandhya Mishra
M.Sc. Scholar, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, BTC CARS, Bilaspur, Chhattisgarh, India

Roshan Parihar
Assistant Professor, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, BTC CARS, Bilaspur, Chhattisgarh, India

DJ Sharma
Assistant Professor, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, BTC CARS, Bilaspur, Chhattisgarh, India

SK Verma
Professor & Head of Section, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, BTC CARS, Bilaspur, Chhattisgarh, India

NK Chaure
Professor & Head of Section, Department of Agri. Statistics, Indira Gandhi Krishi Vishwavidyalaya, BTC CARS, Bilaspur, Chhattisgarh, India

Corresponding Author:
Sandhya Mishra
M.Sc. Scholar, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, BTC CARS, Bilaspur, Chhattisgarh, India

Correlation and path coefficient studies for quantitative characters of turmeric varietal evaluation in Bilaspur region of Chhattisgarh

Sandhya Mishra, Roshan Parihar, DJ Sharma, SK Verma and NK Chaure

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Abstract
In present experiment, ten turmeric varieties were used (Narendra, Duggirala red, CG-01, CG-02, BSR-2, Suranjana, Roma, Local, NDH-98 and Rajendra sonia). The research was conducted in randomized block design (RBD) with three replications. The correlation analysis study revealed that total yield of rhizomes per ha (q) had strong positive association with yield of rhizomes per plot (kg), weight of primary rhizome (gm/clump), core diameter of primary rhizome (cm), girth of primary rhizome (cm), length of primary rhizome (cm), plant height (cm) at 90 DAP, length of leaves (cm) at 120 DAP and plant height (cm) at 120 DAP. The association studied indicated that rhizome yield of turmeric can be improved by varieties having higher performances for the above characters. Inter- correlation among yield attributing traits revealed that positive and significant association among most of the component traits under studied. The path coefficient analysis revealed that length of leaves (cm) at 90 DAP, plant height (cm) at 120 cm, number of leaves (no./plant) at 120 DAP, weight of primary rhizome (gm/clump), core diameter of primary rhizome (cm), girth of primary rhizome (cm) and length of primary rhizome (cm) were exerted negligible positive direct effect on rhizome yield. In conclusion, the current study has revealed useful information on v yield attributing traits *viz.* weight of primary rhizome (gm/clump), core diameter of primary rhizome (cm), girth of primary rhizome (cm), length of primary rhizome (cm), plant height (cm) at 90 DAP, length of leaves (cm) at 120 DAP, number of leaves (no./plant) at 120 DAP and plant height (cm) at 120 DAP for improving turmeric yield. Roma was significant superior over all the varieties for traits like weight of primary rhizome (gm/clump) and core diameter of primary rhizome (cm) but at par with local, BSR-2 and NDH-98 for core diameter of primary rhizome (cm). Varieties Roma, local landrace, BSR-2 and Duggirala red were found significant superior over all other tested varieties for yield and yield contributing traits.

Keywords: Path coefficient studies, quantitative characters, turmeric varietal evaluation

Introduction
Turmeric (*Curcuma longa* L.) is one of the important rhizomatous perennial spice crop much valued for its curcumin'. It is also known as "Indian saffron" of the Zingiberaceae family belonging to order Sacitaminae. India is also known as the "Home of Spices" or "Spice Bowl." It has chromosome number of 2n = 3x = 63 (diabasic amphidiploid) and sets seed rarely. Since, turmeric is a vegetatively propagated crop with no regular seed production. The area grown to turmeric in India is 3.05 lakh hectares with a total production of 10.54 lakh metric tons. In Chhattisgarh, turmeric occupies an area about 10650 hectares with a production of 100780 metric tons (Anonymous, 2023-24). In Bilaspur, turmeric covers 275 hectares area with a total production of 1399 metric tons. (DACG, 2022) [4]. The less area of Bilaspur needs an urgent evaluation study to screen out the best varieties out of available varieties. Therefore varietal evaluation in RBD design along with correlation and path studies has been carried out to organize the evaluation trail.

Materials and Methods
The present experiment was conducted during *kharif* 2023-24, at the Horticultural instructional cum research farm, B.T.C. College of Agriculture and Research Station (IGKV), Bilaspur, Chhattisgarh, using ten different turmeric varieties in a randomized block

design (RBD) with three replications. Five randomly selected plants were tagged and used from each replication of the varieties for recording observation on plant height (cm), number of leaves (no./plant), length of leaves (cm), number of primary rhizome (no./clump), weight of primary rhizome (gm/clump), length of primary rhizome (cm), girth of primary rhizome (cm), core diameter of primary rhizome (cm), yield of rhizomes per plot (kg) and total yield of rhizomes per ha (q). The correlation coefficient analysis and path coefficient analysis were estimated by formula given by Miller *et al.* (1958) [8] and Dewey and Lu (1959) [3] respectively. Correlation and path analysis were done using OPSTAT, GRAPES and R software.

Results and Discussion

The study reveals genotypic correlation coefficient were higher than respective phenotypic levels, indicating less influence of environment and presence of inherent association between various characters. Similar results were reported by Rajyalakshmi (2013) [12]. The correlation study revealed that total yield of rhizomes per ha (q) had strong positive association with yield of rhizomes per plot (kg) (r_g=0.998**, r_p=0.996**), weight of primary rhizome (gm/clump) (r_g=0.788**, r_p=0..697**), core diameter of primary rhizome (cm) (r_g=0.810**, r_p=0640**), girth of primary rhizome (cm) (r_g=0.724**,r_p=0.594**), length of primary rhizome (cm) (r_g=0.893**, r_p=0.0.498**), plant height (cm) at 90 DAP (r_g=0.586**, r_p=0.498**), length of leaves (cm) at 120 DAP (r_g= 0.468**, r_p= 0.461*) and plant height (cm) at 120 DAP (r_g=0.481**, r_p=0.427*). The association studied indicated that rhizome yield of turmeric can be improved by varieties having higher performances for the above characters. Inter- correlation among yield attributing traits revealed that positive and significant association among most of the component traits under studied. Correlation matrix presented in table 1. Similar result were reported Mamatha *et al.* (2020) [7], Poonam and Jakhar (2022) [10], Sadanand *et al.* (2019) [13], Yadav *et al.* (2006) [17], Verma *et al.* (2014) [16] and Prajapati *et al.* (2014) [11].

Path coefficient analysis revealed that length of leaves (cm) at 90 DAP (0.002), plant height (cm) at 120 DAP (0.002), number of leaves (no./plant) at 120 DAP (0.004), weight of primary rhizome (gm/clump) (0.006), and length of primary rhizome (cm) (0.000) were exerted negligible positive direct effect and plant height (cm) at 90 DAP (-0.000), number of leaves (no./plant) at 90 DAP (-0.003) and length of leaves (cm) at 120 DAP (-0.004), number of primary rhizome (no./clump) (-0.003), girth of primary rhizome (cm) (-0.000) and core diameter of primary rhizome (cm) (-0.006), were exerted negligible negative direct effect on rhizome yield at genotypic level.

At phenotypic level length of leaves (cm) at 90 DAP (0.003), plant height (cm) at 120 DAP (0.003), number of leaves (no./plant) at 120 DAP (0.001), number of primary rhizome (no./clump) (0.002), girth of primary rhizome (cm) (0.001) and length of primary rhizome (cm) (0.000) were exerted negligible positive direct effect and plant height (cm) at 90 DAP (-0.004), number of leaves (no./plant) at 90 DAP (-0.002), length of leaves (cm) at 120 DAP (-0.002) weight of primary rhizome (gm/clump) (-0.004) and core diameter of primary rhizome (cm) (-0.001) were exerted negligible negative direct effect on rhizome yield. Path coefficients presented in table 2 and table 3. Similar results were reported by Sivakumar *et al.* (2022) [15], Patel *et al.* (2021) [9], Gowthami (2019) [5], Singh *et al.* (2018) [14], Jagadeeshkanth *et al.* (2017) [6].

Study of performance of varieties revealed that the variety NDH-98 was at par with Roma, Narendra, BSR-2 and Suranjana but superior and highly significant over all the varieties for number of primary rhizome (no./clump). Highest number of primary rhizome (no./clump) were found for variety NDH-98 (6.80) and lowest for variety C.G.- 02 (4.53) The variety Roma was superior and highly significant over all the varieties for weight of primary rhizome (gm/clump) highest weight of primary rhizome (gm/clump) were recorded for Roma (151.76 gm) while lowest for variety C.G.- 02 (42.36 gm). The variety Duggirala red was superior and highly significant over all the genotypes but at pat with Rajendra Sonia, Roma, NDH-98, Suranjana, Narendra, Local landrace and CG-01 for length of primary rhizome (cm). The variety Roma was at par with Local landrace, BSR-2 and NDH-98 but superior and highly significant over all the varieties for girth of primary rhizome (cm). Highest girth of primary rhizome (cm) was recorded for variety Roma (7.10 cm) while lowest for variety C.G.- 02 (4.18 cm). The variety Roma was found superior and highly significant over all the varieties, while at par with Local landrace, BSR-2 and NDH-98 for core diameter of primary rhizome (cm) highest core diameter of primary rhizome (cm) was recorded for variety Roma (2.12 cm) and lowest for variety C.G.- 02 (1.42 cm). The variety Roma was at par with Local landrace but superior and highly significant over all the varieties for yield of rhizomes per plot (kg) and total yield of rhizomes per ha (q). highest yield of rhizomes per plot (kg) and total yield of rhizomes per ha (q) were recorded for variety Roma (8.13 kg) and lowest for variety C.G.- 02 (2.60 kg). Mean performance data presented in table 4.

Table 1: Phenotypic (above diagonal) and Genotypic (below diagonal) correlation matrix

	PH90	NL90	LL90	PH120	NL120	LL120	NPR	WPR	LPR	GPR	CDPR	YPP	TY
PH90	1	0.561**	0.735**	0.920**	0.627**	0.679**	0.482**	0.725**	0.289	0.730**	0.747**	0.516**	0.516**
NL90	0.660**	1	0.609**	0.668**	0.791**	0.323	0.612**	0.629**	-0.107	0.624**	0.629**	0.234	0.234
LL90	0.788**	0.684**	1	0.803**	0.430*	0.603**	0.383*	0.634**	0.051	0.609**	0.559**	0.251	0.252
PH120	0.955**	0.738**	0.830**	1	0.649**	0.751**	0.652**	0.799**	0.224	0.682**	0.705**	0.428*	0.427*
NL120	0.678**	0.965**	0.489**	0.708**	1	0.248	0.543**	0.499**	-0.04	0.610**	0.541**	0.204	0.204
LL120	0.759**	0.402*	0.650**	0.831**	0.294	1	0.411*	0.539**	0.331	0.361	0.348	0.461*	0.461*
NPR	0.643**	0.714**	0.523**	0.842**	0.774**	0.556**	1	0.635**	0.039	0.453*	0.535**	0.196	0.196
WPR	0.802**	0.646**	0.686**	0.847**	0.616**	0.618**	0.787**	1	0.398*	0.756**	0.811**	0.698**	0.697**
LPR	0.375*	-0.091	0.208	0.374*	0.012	0.575**	0.192	0.575**	1	0.296	0.229	0.498**	0.498**
GPR	0.851**	0.727**	0.641**	0.761**	0.820**	0.408*	0.570**	0.842**	0.560**	1	0.872**	0.594**	0.594**
CDPR	0.856**	0.715**	0.659**	0.783**	0.755**	0.429*	0.623**	0.938**	0.425*	0.979**	1	0.641**	0.640**
YPP	0.586**	0.22	0.295	0.481**	0.202	0.468**	0.255	0.788**	0.892**	0.723**	0.809**	1	0.996**
Ty	0.586**	0.22	0.295	0.481**	0.201	0.468**	0.255	0.788**	0.893**	0.724**	0.810**	0.998**	1

Note- PH90- plant height at 90 DAP, NL 90 -number of leaves at 90 DAP, LL90- length of leaves at 90 DAP, PH120- plant height at 120 DAP, NL 120 -number of leaves at 120 DAP, LL120- length of leaves, NPR – number of primary rhizome, WPR- weight of primary rhizome, LPR- length of primary rhizome, GPR- Girth of primary rhizome, CDPR- Core diameter of primary rhizome, YRP- yield of rhizomes per plot, TY- total yield of rhizomes per hectare (**)- Significant at 1% Probability level, (*)- Significant at 5% Probability level

Table 2: Genotypic path coefficient analysis showing of direct (diagonal) and indirect effects (off diagonal)

	PH90	NL90	LL90	PH120	NL120	LL120	NPR	WPR	LPR	GPR	CDPR	YRP	Genotypic correlation with TY
PH90	-0.000	-0.002	0.002	0.002	0.003	-0.003	-0.002	0.005	0.000	-0.000	-0.005	0.587	0.586**
NL90	-0.000	-0.003	0.002	0.001	0.004	-0.001	-0.002	0.004	-0.000	-0.000	-0.005	0.22	0.22
LL90	-0.000	-0.002	0.002	0.002	0.002	-0.002	-0.001	0.004	0.000	-0.000	-0.004	0.296	0.295
PH120	-0.000	-0.002	0.002	0.002	0.003	-0.003	-0.002	0.005	0.000	-0.000	-0.005	0.482	0.481**
NL120	-0.000	-0.003	0.001	0.001	0.004	-0.001	-0.002	0.004	0.000	-0.000	-0.005	0.202	0.201
LL120	-0.000	-0.001	0.002	0.002	0.001	-0.004	-0.001	0.004	0.000	-0.000	-0.003	0.469	0.468**
NPR	-0.000	-0.002	0.001	0.002	0.003	-0.002	-0.003	0.005	0.000	-0.000	-0.004	0.255	0.255
WPR	-0.000	-0.002	0.002	0.002	0.003	-0.002	-0.002	0.006	0.000	-0.000	-0.006	0.788	0.788**
LPR	-0.000	0.000	0.000	0.001	0.000	-0.002	-0.001	0.004	0.000	-0.000	-0.003	0.893	0.893**
GPR	-0.000	-0.002	0.001	0.002	0.004	-0.002	-0.002	0.005	0.000	-0.000	-0.006	0.723	0.724**
CDPR	-0.000	-0.002	0.002	0.002	0.003	-0.002	-0.002	0.006	0.000	-0.000	-0.006	0.81	0.810**
YRP	-0.000	-0.001	0.001	0.001	0.001	-0.003	-0.002	0.005	0.000	-0.000	-0.005	1.001	0.998**

**Note- ***Significant at 5% probability level, ** Significant at 1% probability level, Residual effect genotypic= 0.003, PH90- plant height (cm) at 90 DAP, NL 90 -number of leaves (no./plant)at 90 DAP, LL90- length of leaves (cm) at 90 DAP, PH120- plant height (cm)at 120 DAP, NL 120 -number of leaves (no./plant)at 120 DAP, LL120- length of leaves (cm) at 120 DAP, NPR – number of primary rhizome (no./clump), WPR- weight of primary rhizome, LPR- length of primary rhizome (cm), GPR- Girth of primary rhizome (cm), CDPR- Core diameter of primary rhizome (cm), YRP- yield of rhizomes per plot (kg), TY- total yield of rhizomes per ha (q)

Table 3: phenotypic path coefficient analysis showing of direct (diagonal) and indirect effects (off diagonal)

	PH90	NL90	LL90	PH120	NL120	LL120	NPR	WPR	LPR	GPR	CDPR	YRP	Phenotypic correlation with TY
PH90	-0.004	-0.001	0.002	0.002	0.000	-0.001	0.001	-0.003	0.000	0.001	-0.001	0.518	0.516**
NL90	-0.002	-0.002	0.002	0.002	0.001	-0.000	0.001	-0.003	-0.000	0.001	-0.001	0.235	0.234
LL90	-0.003	-0.001	0.003	0.002	0.000	-0.001	0.001	-0.003	0.000	0.001	-0.001	0.252	0.252
PH120	-0.003	-0.001	0.003	0.003	0.000	-0.001	0.001	-0.003	0.000	0.001	-0.001	0.429	0.427*
NL120	-0.002	-0.001	0.001	0.002	0.001	-0.000	0.001	-0.002	-0.000	0.001	-0.001	0.204	0.204
LL120	-0.002	-0.001	0.002	0.002	0.000	-0.002	0.001	-0.002	0.000	0.000	-0.000	0.463	0.461*
NPR	-0.002	-0.001	0.001	0.002	0.000	-0.001	0.002	-0.003	0.000	0.001	-0.001	0.197	0.196
WPR	-0.003	-0.001	0.002	0.002	0.000	-0.001	0.001	-0.004	0.000	0.001	-0.001	0.700	0.697**
LPR	-0.001	0.000	0.000	0.001	-0.000	-0.001	0.000	-0.002	0.000	0.000	0.000	0.500	0.498**
GPR	-0.003	-0.001	0.002	0.002	0.000	-0.001	0.001	-0.003	0.000	0.001	-0.001	0.596	0.594**
CDPR	-0.003	-0.001	0.002	0.002	0.000	-0.001	0.001	-0.003	0.000	0.001	-0.001	0.643	0.640**
YRP	-0.002	-0.001	0.001	0.001	0.001	-0.002	0.000	-0.003	0.000	0.001	-0.001	1.003	0.996**

Note- *Significant at 5% probability level, ** Significant at 1% probability level, Residual effect phenotypic= 0.007, PH90- plant height (cm) at 90 DAP, NL 90 -number of leaves (no./plant) at 90 DAP, LL90- length of leaves (cm) at 90 DAP, PH120- plant height (cm) at 120 DAP, NL 120 -number of leaves (no./plant) at 120 DAP, LL120- length of leaves (cm) at 120 DAP, NPR – number of primary rhizome (no./clump), WPR- weight of primary rhizome, LPR- length of primary rhizome (cm), GPR- Girth of primary rhizome (cm), CDPR- Core diameter of primary rhizome (cm), YRP- yield of rhizomes per plot (kg), TY- total yield of rhizomes per ha (q)

Table 4: Mean performance of 10 turmeric varieties for thirteen quantitative traits

	PH90	NL90	LL90	PH120	NL120	LL120	NPR	WPR	LPR	GPR	CDPR	YRP	TY
Narendra	121.87	6.42	66.77	137.4	7.1	70.5	6.2	108.8	8	5.78	1.73	4.53	113.33
Duggirala red	84.27	5.51	31.87	95.5	6.77	62.37	5.47	70.87	8.46	5.23	1.52	5.67	141.67
CG-01	58.17	5.3	31.71	69.83	6.67	32.37	5.07	57.37	7.38	5.01	1.48	2.87	71.83
CG-02	68.37	6.47	47.1	80.77	6.3	48.67	4.53	42.37	6.54	4.59	1.42	2.6	65
BSR-2	95	6.67	55.64	105.93	7.2	53.57	5.8	99.8	8.24	6.64	1.89	5.8	145.33
Suranjana	96.33	7.43	57.13	110.17	8.2	58.43	5.8	87.03	7.4	6.01	1.68	3.83	95.67
Roma	118.59	8.6	61.7	132.97	9.1	62.6	6.4	151.77	8.36	7.11	2.12	8.13	203.33
Local	118.73	6.33	52.2	108.1	7.77	53.57	4.57	85.53	7.96	6.71	1.91	6.51	162.75
NDH-98	118.8	8.77	54.73	131.33	10.43	55.8	6.8	95.1	7	6.65	1.9	3.4	85
Rajendra Sonia	94.37	7.03	56.23	106.77	8.1	57.27	5.03	74	8.43	6.11	1.57	3.87	96.67
Mean	97.45	6.85	51.51	107.88	7.76	55.51	5.57	87.26	7.78	5.98	1.72	4.72	118.06
CV%	6.89	5.82	6.68	5.4	8.14	6.78	9.07	8.51	7.05	5.41	5.91	16.11	16.18
SEM	3.88	0.23	1.99	3.36	0.36	2.17	0.29	4.29	0.32	0.19	0.06	0.44	11.03
SED	5.48	0.33	2.81	4.76	0.52	3.07	0.41	6.06	0.45	0.26	0.08	0.62	15.6
CD 5%	11.52	0.68	5.9	10	1.08	6.46	0.87	12.74	0.94	0.55	0.17	1.3	32.78
CD 1%	15.79	0.94	8.08	13.7	1.48	8.85	1.19	17.45	1.29	0.76	0.24	1.79	44.91
Maximum	121.87	8.77	66.77	137.4	10.43	70.5	6.8	151.77	8.46	7.11	2.12	8.13	203.33
Minimum	58.17	5.3	31.71	69.83	6.3	32.37	4.53	42.37	6.54	4.59	1.42	2.6	65

Note- PH90- plant height (cm) at 90 DAP, NL 90 -number of leaves (no./plant) at 90 DAP, LL90- length of leaves (cm) at 90 DAP, PH120- plant height (cm) at 120 DAP, NL 120 - number of leaves (no./plant) at 120 DAP, LL120 - length of leaves (cm) at 120 DAP, NPR – number of primary rhizome (no./clump), WPR - weight of primary rhizome, LPR- length of primary rhizome (cm), GPR- Girth of primary rhizome (cm), CDPR- Core diameter of primary rhizome (cm), YRP- yield of rhizomes per plot (kg), TY- total yield of rhizome per hectare (q).

Conclusion

The current study has revealed useful information on yield attributing traits for improving turmeric yield. The correlation analysis investigated that total yield of rhizomes per ha (qt) had positive and significant correlation with yield of rhizomes per plot (kg), weight of primary rhizome (gm/clump), core diameter of primary rhizome (cm), girth of primary rhizome (cm), length of primary rhizome (cm), length of leaves at 120 DAP (cm), plant height (cm) at 90 DAP and plant height (cm) at 120 DAP. The intercorrelation was found positive and significant between most of the yield component traits under studied. From path coefficient analysis it is investigated that length of leaves (cm) at 90 DAP, plant height (cm) at 120 cm, number of leaves (no./plant) at 120 DAP, weight of primary rhizome (gm/clump), core diameter of primary rhizome (cm), girth of primary rhizome (cm) and length of primary rhizome (cm) were exerted negligible positive direct effect on rhizome yield. Varieties Roma, local landrace, BSR-2 and Duggirala red were found significant superior over all other tested varieties for yield and yield contributing traits.

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