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Character Association of Different Varieties of Turmeric (*Curcuma longa* L.) under Ranchi Condition

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Authors' contributions

This work was carried out in collaboration between both authors. Current experiment work was carried out by author Sadanand in guidance of author SM. Author Sadanand planned the study, performed the statistical analysis, wrote the protocol, drafted the manuscript and managed the analyses of the study. Author SM also managed the analysis of the study and managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The present experimental work entitled "Character Association of Different Varieties of Turmeric (*Curcuma longa* L.) under Ranchi condition." has been worked out in the research field of Department of Horticulture, Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi (Jharkhand) during Kharif season,2017. In this experiment 10 genotypes of turmeric have been evaluated with check Rajendra Sonia for different traits. Different observations were recorded at different interval on emergence, number of tillers and leaves per plant, plant girth and height, leaf length and breadth, length, girth and weight of mother, primary and secondary rhizomes, number of primary and secondary rhizomes per plant, yield per plot and yield ha, dry matter recovery. Significant differences have been observed among the different genotypes for all the traits by observing the Analysis of variance. Three genotypes among the 10 genotypes namely Pratibha (23.88 t/ha), BSR-I(21.03 t/ha) and Punjab Haldi (17.96 t/ha) have excelled over the check; Rajendra Sonia (12.81 t/ha) for most of the characters including rhizome yield per hectare.

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Performance for other horticultural traits viz. number of tillers per plant, number of primary and secondary rhizomes per plant, length and girth of mother rhizome and weight of mother were superior among these three genotypes. The correlation coefficients among the different characters at phenotypic and genotypic levels revealed that yield per plot was having significantly positive association with number of tillers per plant, leaf length, leaf width, plant height, number of leaves per plant, length of mother rhizome, girth and weight of mother rhizome. High heritability coupled with high genetic gain were estimated for weight of mother and secondary rhizomes and yield per plot. This indicates that these characters are under additive gene effects and are more reliable for effective clonal selection for yield improvement.

Keywords: Primary rhizome; mother rhizome; secondary rhizome; productivity; phenotypic correlation; genotypic correlation; heritability; genetic gain.

1. INTRODUCTION

Being native to Tropical South Asia, Turmeric (*Curcuma longa* L.) its cultivation is mostly confined to South East Asian countries such as India, Sri Lanka, China, Myanmar, Australia, Africa, Peru and West Indies. Among different spices, turmeric is one of the most important spice and medicinal crop which have been playing a vital role in Indian economy. In India turmeric is cultivated in area of 2.31 lakh ha with 8.63 lakh ton production in 2017-18 and it accounts for 78% of total world production and has 60% share in world export share (Statistics of spices, Spice board India, Ministry of Commerce & Industry, Govt. of India). The major turmeric cultivating states in India are Telangana, Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, Maharashtra and Kerala. Among these states Telangana ranked first in production (255000 tonnes) as well as in area (50000 ha). Among eastern states, Jharkhand has not attained significant status in production of Turmeric among other spice crops, this may be probably due to their poor yield and crop duration is quite long due to which farmers hesitate to cultivate turmeric. Currently there are some growers especially in Ranchi, Hazaribagh and Ramgarh belt who have shown interest in the crop and the area under cultivation has been gradually increasing as it can be successfully planted under rainfed conditions with minimal care and attention. The scope of improvement of germplasm mainly depends upon the magnitude of genetic variability present in the available germplasm. So, in order to bring out desired improvement in trait, this requires proper screening of turmeric germplasm for the best genotypes with higher yield and improved quality parameter for the selection purpose. Therefore, keeping in view of the aforesaid considerations, the present investigation entitled "Correlation of different varieties of Turmeric (*Curcuma longa* L.) under Ranchi condition." with respect to vegetative parameters, growth parameters, yield and yield attributing parameters in different turmeric cultivars has been carried out.

2. MATERIALS AND METHODS

The investigation has been carried out in the Experimental farm of Department of Horticulture, Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi. The experimental trials were laid out with three replications in Randomized Block Design (RBD) using ten varieties of turmeric namely Megha Haldi, BSR-I, Punjab Haldi, Ranga, BSR-II, Prabha, Sobha, Pratibha, Rajendra Sonia and Narendra Haldi. The size of plot was 3 m x 2 m (100 plants/plot) and planting of rhizomes were done during third week of June on ridge and furrow method with a spacing of 30 cm x 20 cm. The observations were recorded on vegetative growth, yield and yield attributes. Agronomic practices viz., irrigation, fertilizer application, manuring was done according to the recommendation of Department of Horticulture, Birsa Agricultural University for turmeric production. The vegetative parameter has been recorded using thread, measuring tapes and measuring scale. The yield parameter like weight of rhizome has been measured using digital balance. Harvesting was done on the basis of maturity indices like drying of leaf and falling of plants from January to March. Growth Parameters like Emergence (%) number of tillers, number of leaves, plant height, Leaf length (cm), Leaf width (cm), yield parameters like weight of primary and secondary rhizome, number of primary and secondary rhizomes, length, girth and weight of mother rhizome, Dry matter recovery (%), Yield per plot (Kg) were recorded from five randomly selected and tagged plants in each replication [1]. The statistical analysis of data has been carried out for every observed character under the study

using different software tools like MS-Excel and Indostat.

3. RESULTS AND DISCUSSION

3.1 Vegetative Growth

The growth characters varied significantly in different varieties and all these characters has significant positive correlation with yield. Observations shows significant differences among the varieties with respect to plant height, number of tillers and number of leaves at different stages of crop growth (Table 1). Maximum and minimum number of leaves per plant was observed in Pratibha (8.83) and Ranga (6.27) respectively. Maximum and minimum number of tillers was found in genotype Pratibha (3.5) and Megha Haldi (2.12) respectively. BSR-I has recorded maximum plant height i.e. 51.30 cm followed by Pratibha (49.13). Minimum plant height was recorded in Sobha (32.27 cm). The present study is in line with those reported by Chattopadhyay et al. [2], Mukhopadhyay et al. [3], Singh et al. [4], Singh et al. [5], Chaturvedi et al. [6] and Jan et al. [7]. Vegetative characters i.e. number of leaves, numbers of tillers and plant height were mainly affecting the yield parameter and yield.

3.2 Yield Parameters of Turmeric

Maximum and minimum length of mother rhizome was recorded in Pratibha (10.54 cm) and BSR –II (6.00) respectively. Maximum and minimum girth of mother rhizome was recorded in Pratibha (14.10 cm) and Narendra Haldi (9.8 cm). Maximum and minimum weight of mother rhizome was recorded in Pratibha (68.85 g) and Narendra Haldi (19.38 g) respectively.

Maximum and minimum number of primary fingers was observed in BSR-1 (6.4) and Narendra Haldi (3.6) respectively. Maximum and minimum weight of Primary rhizome was recorded in BSR-I (82.72 g) and Rajendra Sonia (30.30 g) respectively.

Maximum and minimum number of secondary fingers was recorded in genotype BSR-II (11.63) and Rajendra Sonia (4.30) respectively. Maximum weight of secondary fingers was recorded in genotype BSR-I (38.5 g) and minimum weight was recorded in Sobha (5.53 g).

Maximum yield per plot was recorded in Pratibha (14.39 kg). BSR-1 (12.66 kg) was at par with it and followed by Punjab Haldi (10.82 kg). Minimum yield per plot was recorded in Narendra Haldi (4.58 kg).

The maximum yield per hectare was recorded in Pratibha (23.88 t) which was significantly superior over other varieties and BSR-I (21.03 t) was at par with it and followed by Punjab Haldi (17.96 t). Minimum yield per hectare was recorded in Narendra Haldi (7.60 t). The present study of yield attributes is in agreement with earlier reports by Philip and Nair [8], Muthuswamy and Shah [9].

Estimates of variability have been worked out for the selection of various characters among different varieties, i.e. coefficient of variability (Genotypic and Phenotypic), heritability and genetic gain.

The phenotypic coefficients of variation (PCV)was recorded high (>30%) for weight of secondary rhizome (71.32%), weight of mother rhizome (41.18%), Yield per plot (38.22%), weight of Primary rhizome (31.44%) and number of secondary rhizome (33.62%). Whereas, moderate (15-30%) phenotypic coefficients of variation (PCV) were recorded for Number of primary rhizomes per plant (19.07%), Length of mother rhizome (18.30%), Number of tillers per plant (15.82%), Plant girth (17.93%), Plant height (15.61%) and number of leaves per plant (10.92%). Phenotypic coefficients of variation (PCV) were low (<15%) for Dry matter recovery (12.94%), Girth of mother rhizome (9.13%), leaf length (8.18%), emergence (7.63%) and leaf width (5.05%).

The genotypic coefficients of variation (GCV) were high (>30%) for Weight of secondary rhizome (70.48%), Weight of mother rhizome (39.77%), Yield per plot (37.58%) and Number of secondary rhizomes per plant (32.83%). Moderate (15-30%) genotypic coefficients of variation (GCV) were recorded for Weight of primary rhizome (29.58%), Number of primary rhizomes per plant (17.14%) Length of mother rhizome (17.10%) and Plant girth (16.58%). Genotypic coefficients of variation (GCV) were low (<15%) for Emergence percent (2.43%), Leaf width (4.62%), Girth of mother rhizome (6.40%), Leaf length (5.73%), Number of leaves per plant (9.24%) and Number of tillers per plant (12.83%). Results were similar with the results reported by Babu et al. [10] and Singh et al. [5]. Also, Babu et al. [10] found high GCV for number and weight of secondary rhizomes per plant.

Since similar trend was observed in both Phenotypic coefficient of variation and genotypic coefficient of variation, this shows that these characters were least influenced the environment.

The highest phenotypic and genotypic coefficients of variation was recorded high (>30%) for weight of secondary rhizome weight of mother rhizome, yield per plot and number of secondary rhizomes per plant. This indicates that selection can be applied to the traits to isolate more promising line.

The estimates of heritability (broad sense) varied from 10.16 – 97.67% for different characters which were studied. It was found high (>80%) for the characters viz. Weight of secondary rhizome (97.67%), Yield per plot (96.70%), Number of secondary rhizomes per plant (95.37%), Weight of mother rhizome (93.24%), Length of mother rhizome (87.37%), Weight of primary rhizome (88.54%), Plant girth (85.48%) and Number of primary rhizomes per plant (80.86%). Various studies reported similar results; Indiresh et al. [11], who showed high heritability for rhizome yield; Lynrah et al. [12], reported that mother and finger rhizome yield components reported high broad-sense heritability, Chattopadhyay et al. [2] who also observed that weight of secondary rhizome have high heritability; Rao et al. [13] also revealed that weight of the mother rhizome and number of secondary rhizomes had moderate to high heritability.

Genetic Gain was recorded high (>50%) for the characters viz. weight of secondary rhizome (143.50%), weight of mother rhizome (79.11%), yield per plot (76.13%), number of secondary rhizomes per plant (66.05) and weight of primary rhizome (57.35%). These current findings were in line with Babu et al. [10], who also revealed high genetic gain for number and weight of secondary rhizomes and moderate genetic gain for plant girth and number of primary rhizomes; Singh et al. [5] also reported high genetic gain for weight of mother and primary rhizomes and moderate genetic gain for length of mother rhizome and yield per hectare. Rao et al. [13] also reported high genetic advance for weight of mother rhizome. Singh et al. [14] also revealed high genetic advance for weight of mother and primary rhizomes and moderate for length and width of mother rhizome.

High heritability was estimated; coupled with high genetic gain was observed for weight of mother and primary rhizomes and girth of primary rhizome, which indicated that these characters are under additive gene effects and are more reliable for effective clonal selection [15]. Singh et al. [5] and Singh et al. [14] have reported similar results for weight of mother and primary rhizomes.

3.3 Correlation Studies

The correlation coefficients among the different characters were worked out at phenotypic and genotypic levels. The correlation coefficients among the different characters at phenotypic and genotypic levels revealed that yield per plot was having significantly positive association with number of tillers per plants, number of leaves per plant, leaf length, leaf width, plant height, length of mother rhizome, girth of mother rhizome and weight of mother rhizome, while significant negative correlations were observed with dry matter recovery; indicating that the clonal selection should be made on the basis of these traits to bring desired improvement in yield of turmeric.

3.4 Phenotypic Correlations

The phenotypic correlation coefficients among different characters showed that yield per plot had positive and significant association with number of tillers per plant (0.809), number of leaves per plant (0.741), leaf length (0.752), leaf width (0.678), plant height (0.794), length of mother rhizome (0.855), girth of mother rhizome (0.788), and weight of mother rhizome (0.947).

Weight of mother rhizome had significant and positive correlation with number of tillers per plant (0.664), number of leaves per plant (0.744), leaf length (0.714), plant height (0.666), length of mother rhizome (0.924), girth of mother rhizome (0.848) and yield per plot (0.947). While, significant and negative correlation was observed with dry matter recovery (-0.664).

3.5 Genotypic Correlations

The genotypic correlation coefficients among different characters revealed that yield per plot had significant positive association with emergence (0.977), number of tillers per plant (0.969), number of leaves per plant (0.822), leaf length (0.968), leaf width (0.983), plant height (0.911), length of mother rhizome (0.946), girth of mother rhizome (0.947), weight of mother rhizome (0.995) and number of primary rhizome (0.711). While, significant and negative correlation was observed with dry matter recovery (-0.634).

Table 1. Mean performance of vegetative parameters

Varieties	Emergence (%)	Leaf Length(cm)	Number of leaves per plant	Number of tillers per plant	Plant height(cm)
Megha haldi	70.33	40.47	6.33	2.12	34.20
BSR-1	94.00	45.73	7.27	3.13	51.30
Punjab Haldi	93.17	46.23	6.73	3.30	44.90
Ranga	87.17	37.17	6.27	2.63	38.13
BSR-2	91.83	45.50	6.97	2.87	45.67
Prabha	88.67	42.28	7.10	2.60	42.53
Sobha	89.33	37.27	6.83	2.23	32.27
Pratibha	91.50	49.42	8.83	3.50	49.13
Narendra Haldi	88.00	41.15	6.37	2.67	35.67
Rajendra Sonia(Check)	86.67	45.23	7.63	3.03	46.10
S.E (m)	6.37	3.56	0.41	0.26	3.33
CD (0.05)	18.92	10.56	1.22	0.77	9.91
CV (%)	12.53	14.20	10.09	16.03	13.75

Source: (Sadanand, Dr, et al. [1])

Table 2. Mean performances of primary and secondary rhizomes

Varieties	Number of pri. rhizome	Weight (g) of pri. rhizome	Number of sec. rhizome	Weight (g) of sec. rhizome
Megha haldi	4.73	53.49	5.67	4.95
BSR-1	6.4	82.72	9.73	38.5
Punjab Haldi	6.3	57.62	6.03	10.19
Ranga	4.63	33.97	5.6	10.2
BSR-2	5	52.85	11.63	26.05
Prabha	4.47	51.85	8.2	25.41
Sobha	4	39.36	4.83	5.53
Pratibha	4.43	46.78	6.13	10.27
Narendra Haldi	3.6	36.05	6.47	25.17
Rajendra Sonia (Check)	4.27	30.3	4.3	6.16
S.E(m)±	0.40	5.16	0.50	1.77
CD(0.05)	1.19	15.34	1.47	5.25
CV(%)	14.45	18.44	12.52	18.84

Source: (Sadanand, Dr, et al. [1])

Table 3. Mean performance of mother rhizome and yield

Varieties	Length of mother rhizome (cm)	Girth of mother rhizome (cm)	Weight of mother rhizome (g)	Estimated fresh rhizome yield per plot (kg)	Estimated rhizome yield per ha (t)	Dry matter recovery (%)
Megha haldi	6.53	12.47	35.02	6.56	10.88	23.22
BSR-1	7.90	13.27	54.78	12.67	21.03	23.33
Punjab Haldi	7.43	12.60	39.50	10.82	17.96	26.76
Ranga	6.76	12.53	31.73	6.47	10.74	25.39
BSR-2	6.00	11.8	25.77	7.41	12.30	26.83
Prabha	7.16	12.60	30.24	6.54	10.84	22.68
Sobha	6.13	12.00	25.86	6.20	10.29	31.67
Pratibha	10.54	14.10	68.85	14.39	23.88	23.35
Narendra Haldi	6.91	9.80	19.38	4.58	7.60	27.59
Rajendra Sonia (Check)	6.46	11.73	31.08	7.72	12.81	29.79
S.E(m)±	0.46	0.80	3.88	0.58	0.96	1.88
CD(0.05)	1.38	2.38	11.52	1.72	2.85	5.64
CV(%)	11.26	11.29	18.54	12.02	12.02	12.52

Table 4. Estimates of phenotypic and genotypic coefficients of variability, heritability, genetic advance and genetic gain for different traits in turmeric

Characters	Range	Mean ±SE(m)	Coefficients of variability (%)		Heritability (%)	Genetic Advance	Genetic gain (%)
			Phenotypic	Genotypic			
1. Emergence (%)	70.33-34.00	88.06±6.36	7.63	2.43	10.16	1.40	1.59
2. Number of tillers per plant	2.12-3.50	2.80 ±0.26	15.82	12.83	65.79	0.60	21.44
3. Number of leaves per plant	6.26-7.63	7.03 ±0.40	10.92	9.24	71.57	1.13	16.10
4. Leaf length (cm)	40.11 – 52.90	46.31±2.70	8.18	5.73	49.03	3.83	8.27
5. Leaf width (cm)	13.06-15.03	13.95 ±0.95	5.05	4.62	- 83.76	-1.21	-8.71
6. Plant height (cm)	32.26 -51.30	41.99± 3.33	15.61	13.44	74.15	10.01	23.85
7. i) Length of mother rhizome (cm)	6.00- 10.54	7.18± 0.46	18.30	17.10	87.37	2.36	32.94
ii) Girth of mother rhizome (cm)	9.80-14.10	12.29± 0.80	9.13	6.40	49.10	1.13	9.24
iii) Weight of mother rhizome (g)	19.38-68.85	36.22± 3.87	41.18	39.77	93.24	28.66	79.11
8. i) Number of primary rhizomes per plant	3.60-6.40	4.78 ± 0.39	19.07	17.14	80.86	1.51	31.76
ii) Weight of primary rhizome (g)	30.30-82.72	48.49± 5.16	31.44	29.58	88.54	27.81	57.35
9. i) Number of secondary rhizomes per plant	4.30-11.63	6.86± 0.49	33.62	32.83	95.37	4.53	66.05
ii) Weight of secondary rhizome (g)	4.95-38.5	16.24 ± 1.76	71.32	70.48	97.67	23.30	143.50
10. Dry matter recovery (%)	21.68 – 31.67	26.04± 1.95	12.94	10.54	66.31	4.60	17.66
11. Yield i) Yield per plot (kg)	4.58 – 14.39	8.33 ± 0.57	38.22	37.58	96.70	6.34	76.13

Table 5. Phenotypic and genotypic correlation coefficients for different traits in turmeric (pooled basis)

TRAITS		EMG	NTP	NLP	LL	LW	PH	LMR	GMR	WMR	NPR	WPR	NSR	WSR	DMR	YPP
EMG	P	1	0.696*	0.421	0.333	0.203	0.622	0.304	0.172	0.257	0.338	0.21	0.355	0.432	0.131	0.469
	G	1	0.97**	0.98**	0.98**	0.987**	0.983**	0.799**	-0.351	0.62	0.896**	0.667*	0.912**	0.932**	0.913**	0.977**
NTP	P		1	0.688*	0.662*	0.512	0.874**	0.718*	0.413	0.664*	0.457	0.262	0.185	0.22	-0.264	0.809**
	G		1	0.96**	0.92**	0.11	0.967**	0.914**	0.753*	0.853**	0.771*	0.281	0.214	0.262	-0.453	0.969**
NLP	P			1	0.648*	0.45	0.683*	0.827**	0.582	0.744*	0.006	0.084	0.019	-0.013	-0.317	0.741*
	G			1	0.901**	0.403	0.938**	0.983**	0.921**	0.958**	0.056	0.143	-0.015	-0.031	-0.508	0.822**
LL	P				1	0.655*	0.749*	0.68*	0.376	0.714*	0.403	0.635*	0.38	0.534	-0.488	0.752*
	G				1	0.698**	0.963**	0.963**	0.812**	0.972**	0.675*	0.949**	0.607	0.773**	-0.76	0.968**
LW	P					1	0.538	0.526	0.766**	0.611	0.476	0.616	0.564	0.292	-0.54	0.678*
	G					1	0.72*	0.221	0.023	0.996**	0.202	0.987**	0.962**	0.984**	-0.824**	0.983**
PH	P						1	0.61	0.532	0.666*	0.585	0.511	0.464	0.446	-0.439	0.794**
	G						1	0.682*	0.622	0.719*	0.717*	0.486	0.594	0.495	-0.492	0.911**
LMR	P							1	0.711*	0.924**	0.186	0.232	-0.068	0.001	-0.608	0.855**
	G							1	0.862**	0.97**	0.134	0.222	-0.074	-0.015	-0.654*	0.946**
GMR	P								1	0.848**	0.501	0.474	0.076	-0.084	-0.696*	0.788**
	G								1	0.912**	0.588	0.556	0.118	-0.177	-0.814**	0.971**
WMR	P									1	0.445	0.488	0.054	0.06	-0.664*	0.947**
	G									1	0.461	0.503	0.071	0.047	-0.72*	0.995**
NPR	P										1	0.821**	0.416	0.342	-0.37	0.604
	G										1	0.951**	0.466	0.357	-0.386	0.711*
WPR	P											1	0.63*	0.623	-0.538	0.562
	G											1	0.694**	0.646*	-0.68	0.605
NSR	P												1	0.821**	-0.343	0.166
	G												1	0.838**	-0.429	0.178
WSR	P													1	-0.275	0.139
	G													1	-0.313	0.138
DMR	P														1	-0.523
	G														1	-0.634*
YPP	P															1
	G															1

**Significant at 5% level of significance; **Significant at 1% level of significance*

Where, EMG= Emergence, NTP= Number of tillers per plant, NLP= Number of leaves per plant, LL= Leaf length, PH= Plant height, LMR= Length of mother rhizome, GMR= Girth of mother rhizome, WMR= Weight of mother rhizome, NPR= Number of primary rhizome, WPR= Weight of primary rhizome, NSR= Number of secondary rhizome, WSR= Weight of secondary rhizome, DMR= Dry matter recovery and YPP= Yield per plot

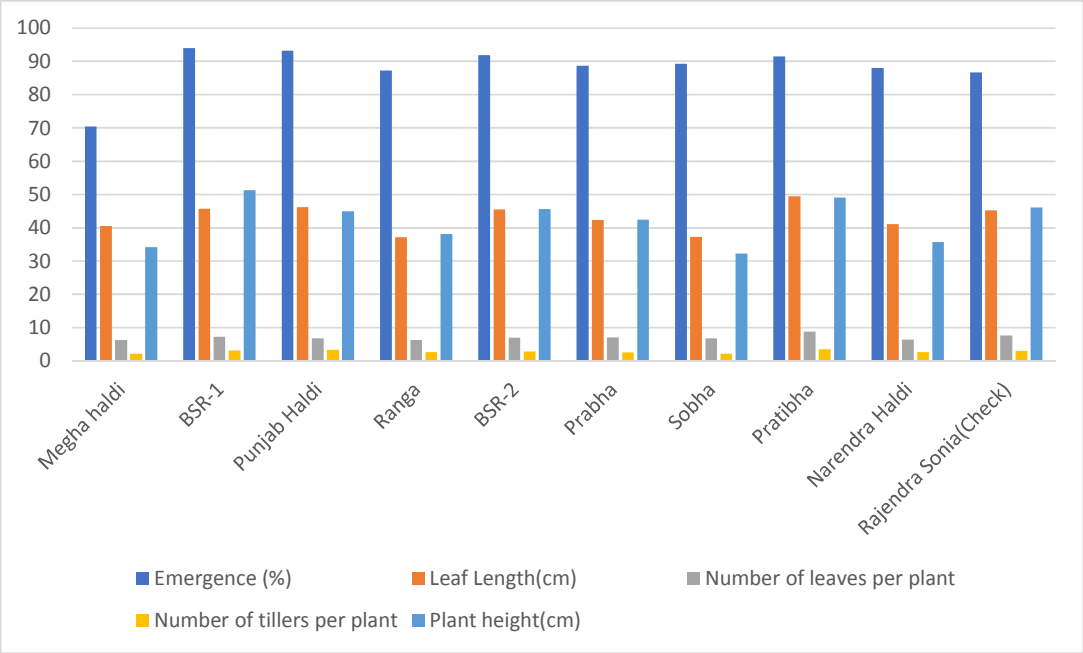

Fig. 1. Graphical representation of mean performance of vegetative parameters

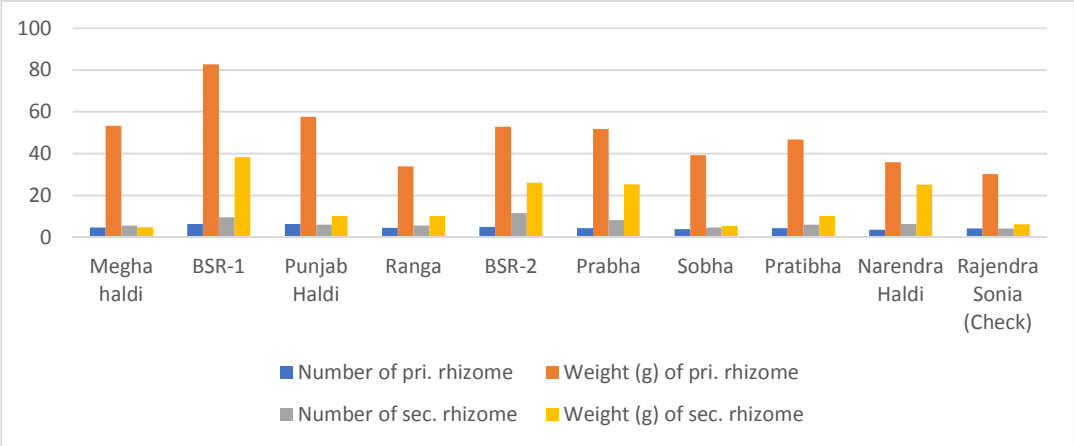

Fig. 2. Graphical representation of mean performance of primary and secondary rhizomes

Weight of secondary rhizome has positive and significant association with number of tiller per plant (0.853), number of leaves per plant (0.958), leaf length (0.972), leaf width (0.996), plant height (0.719), length of mother rhizome (0.97) girth of mother rhizome (0.912) and yield per plot (0.995). While, significant and negative correlation was observed with dry matter recovery (-0.72).

In the present investigation, phenotypic and genotypic correlations were estimated. Correlation study of yield with its component traits has been executed, to find out the yield contributing traits. In general, the genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients. The phenotypic and genotypic correlation coefficients among different characters showed that yield per plant had significantly positive association with number of tillers per plants, number of leaves per plant, leaf length, leaf width, plant height, length of mother rhizome, girth of mother rhizome and weight of mother rhizome, while significantly negative correlations were observed with dry matter recovery. Similar correlations of yield with

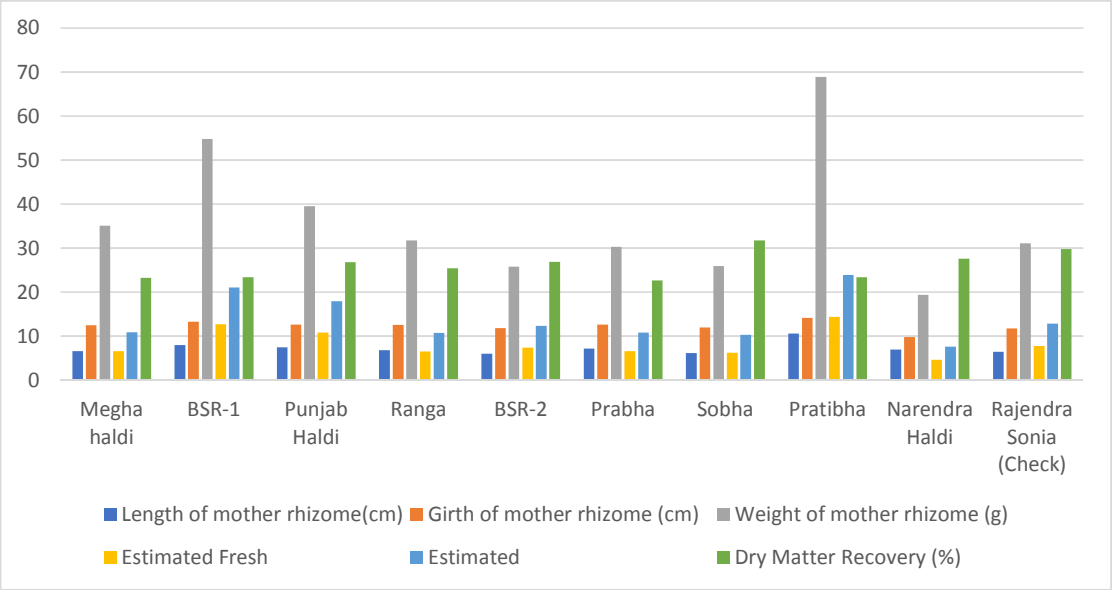

Fig. 3. Graphical representation of mean performances of mother rhizome and yield

various other horticultural traits to different extents in turmeric have been reported by Pathania et al. [16], Jalgaonkar et al. [17], Nandi et al. [18], Shashidhar and Sulikeri [19], Shashidhar et al. [20], Lynrah et al. [12], Venkatesha et al. [21], Chandra et al. [22], Jana et al. [23], Raveendra et al. [24], Panja et al. [25], Rao et al. [26], Tomar et al. [27], Kumar et al. [28], Yadav et al. [29], Kumar et al. (2007), Velmurugan et al. [30], Sharon et al. [31] and Singh et al. [14].

4. CONCLUSION

The scope of improvement of any crop depends upon the magnitude of genetic variability present in the available germplasm. Greater the variability in the available germplasm better would be the chances of selecting superior genotypes [32]. By screening turmeric germplasm to select elite genotypes with higher yield and improved quality for direct clonal selection, it can be genetically improved.

This study revealed that Pratibha, BSR-I and Punjab haldi has more yield per plot than the check Rajendra Sonia. In addition, these genotypes performed better for other horticultural traits *viz*. emergence, number of tillers per plant, number of primary and secondary rhizomes per plant, length, girth, and weight of rhizome. Therefore, it is suggested that, these genotypes Pratibha, BSR-I and Punjab Haldi can be utilized for the further commercial cultivation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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