



## RESEARCH PAPER

# Character association studies in turmeric (*Curcuma longa* L.)

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**Abstract :** Turmeric (*Curcuma longa* L.) is an important spice crop being grown in India belongs to the family Zingiberaceae. Experiment was conducted in a farmer's field of Mysuru district in Karnataka for two growing seasons and 'IISR Prathibha' variety was used. Correlation co-efficients were worked out for the various growth, physiological, yield and quality parameters. Highly significant and positive association of plant height (0.91), number of leaves (0.89), number of tillers (0.86), secondary rhizome weight (0.81), mother rhizome weight (0.80), chlorophyll content (0.71), mother rhizome number (0.64), leaf area (0.62), leaf area index (0.62) and primary rhizome weight (0.52) with fresh rhizome yield was observed. A significant and negative correlation was observed for ar-turmerone content with PAL activity (-0.43) and curcumin content (-0.39). Between the SPAD values and the curcumin content, the association was highly significant and positive (0.55).

**Key Words :** Turmeric, Correlation, Quality traits

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## INTRODUCTION

Turmeric is known to Indians since time immemorial and is rightly identified with the epithet 'Golden spice of India' and many a times also regarded as 'spice of life'. Use of turmeric is associated with social, cultural and religious traditions of the Indian sub-continent. No wonder the ancients regarded turmeric as the *Oushadhi*, the healing herb, the most outstanding herb, the one herb above all others (Jager, 1997).

Turmeric (*Curcuma longa* L.), belonging to the

family Zingiberaceae, is one of the major spice crops grown in India, supporting the livelihoods of farmers involved in its production. It is a rhizomatous herbaceous perennial plant, native to tropical South-East Asia, but is now widely cultivated in the tropical and sub-tropical regions of the world. In India it is cultivated in an area of 2, 38,000 ha with a production of 11, 33,000 t and a productivity of 4.76 t ha<sup>-1</sup> during the year 2017-18 (NHB, 2017-18). In Karnataka, it is grown in an area of 20, 208 ha with a production and productivity of 1, 17, 558 t and 5.81 t ha<sup>-1</sup> during the year 2018-19, respectively

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(Anonymous, 2018). Further, India is the largest producer and consumer of turmeric and Indian turmeric is rated high in the world market (Sriram *et al.*, 2017) accounting for 65-70 per cent of world's production. During 2018-19, India exported 1, 33,600 t of turmeric (Anonymous, 2018).

## MATERIAL AND METHODS

The experimental material comprised of IISR 'Prathibha' turmeric variety, which was evaluated for two growing seasons during 2018-19 and 2019-20 and the field experiment was conducted on the land owned by the farmer Shri Rajbuddi at Tayur village, Nanjangud Taluk, Mysuru district, located in the southern dry zone of Karnataka, at a latitude of 12° 12' N and longitude of 76° 51' E.

Correlation co-efficients were worked out for the various growth, physiological, yield and quality parameters using WASP 2.0 software. For the same trait, correlation co-efficient was worked out taking into consideration of data measured during 2018-19, 2019-20 and also the data was averaged over those two growing seasons. Growth parameters consisted of leaf number, tiller number and plant height. Physiological parameters considered for working out the general correlation co-efficients included leaf area, leaf area index, specific leaf weight, SPAD values (chlorophyll) and net assimilation rate. Parameters contributing the yield included number of mother, primary and secondary rhizomes, weight of mother, primary and secondary rhizomes, harvest index, dry recovery and fresh rhizome yield. Since 'curcumin' is the major secondary metabolite, the association between curcumin and other quality parameters such as ar-turmerone content, total phenols, essential oil content, phenyl Alanine ammonia lyase activity and colour values in terms of  $L^*a^*b^*$  was also studied.

## RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

### Correlation among the growth, physiological and yield attributes:

The perusal of data presented in Table 1 reveals the association of growth, physiological and yield

attributes. Highly significant and positive association of plant height (0.91), number of leaves (0.89), number of tillers (0.86), secondary rhizome weight (0.81), mother rhizome weight (0.80), chlorophyll content (0.71), mother rhizome number (0.64), leaf area (0.62), leaf area index (0.62) and primary rhizome weight (0.52) with fresh rhizome yield was observed. However, significant but negative correlation of net assimilation rate (-0.53) with the fresh rhizome yield was noticed.

Rhizome yield is a complex trait affected by various component characters either in combination or individually. Many times it is a product and function of many factors including genetic factors as well as environmental conditions that prevail during the course of growth and development of any crop. It is quite obvious that all changes in yield must be accompanied by changes in one or more of these components; while the changes in the components used need not be reflected on the yield.

In the present investigation (Table 1), among the characters studied, the positive and significant association with the yield was noticed for all the traits except for the net assimilation rate. These findings are in corroboration with the earlier works of Hazra and Bandopadhyay (2000) for height of the plant, number of leaves and number of secondary rhizomes. Rajyalakshmi *et al.* (2013) and Singh *et al.* (2018), as in the present study, obtained positive and significant correlation of rhizome yield with plant height, number of tillers plant<sup>-1</sup> and number of leaves plant<sup>-1</sup>.

Positive and highly significant association was also observed between plant height (0.96), number of tillers (0.90), dry recovery (0.77), secondary rhizome weight (0.73), mother rhizome weight (0.71), leaf area (0.61), and leaf area index (0.61) with the number of leaves. The correlation between net assimilation rate and number leaves was found be significant and negative (-0.57).

Height of the plant was found to be positively correlated with the yield and in line with the findings of Pillai (1978) in turmeric. The increased height of the plant, number of leaves, leaf length and leaf breadth may be helpful for the better exposure of leaves to the sun and thereby increasing the photosynthetic area of the plant which might have accounted for higher yield. Positive association of rhizomes characters had direct influence on the yield which can be attributed to the better absorption and translocation of nutrients from the soil. This is in accordance with the findings of Shashidhar *et*

al. (1997), who opined that, fresh rhizome yield was positively correlated with dry matter accumulation and nutrient uptake.

Number of tillers per plant exhibited positive and highly significantly association with plant height (0.93), SPAD values (0.86), secondary rhizome weight (0.83), dry recovery (0.79), mother rhizome weight (0.63), leaf area (0.50), leaf area index (0.50) and mother rhizome number (0.42).

Dry recovery was found be significantly and positively correlated with most of the traits except

specific leaf weight with highest positive value of 0.88 and 0.99 for secondary rhizome weight and plant height.

Correlation of leaf area and leaf area index with tiller number, plant height, leaf number, mother rhizome weight and mother rhizome number was highly significant and positive.

Highly significant and positive correlation was observed for secondary rhizome weight with most of the traits with highest values recorded for dry recovery (0.88) and tiller number (0.83). Leaf number, tiller number, plant height and mother rhizome number were

**Table 1: Correlation co-efficients among the growth, physiological and yield attributes of turmeric (*Curcuma longa* L.)**

	LN	TN	PH	MRN	PRN	SRN	MRW	PRW	SRW	LA	LAI	SPAD	SLW	DR	NAR	HI	FRY
LN	1.00	0.90**	0.96**	0.51**	0.07	0.20	0.71**	0.28	0.73**	0.61**	0.61**	0.70**	-0.30	0.77**	-0.57**	-0.01	0.89**
TN		1.00	0.93**	0.42*	0.24	0.38*	0.63**	0.36	0.83**	0.50**	0.50**	0.90**	-0.11	0.79**	-0.34	-0.09	0.86**
PH			1.00	0.59**	0.11	0.20	0.76**	0.31	0.78**	0.59**	0.59**	0.82**	-0.27	0.79**	-0.50**	-0.05	0.91**
MRN				1.00	0.01	-0.30	0.85**	0.35	0.48**	0.57**	0.58**	0.20	-0.13	0.38*	-0.30	0.09	0.64**
PRN					1.00	0.68**	0.25	0.77**	0.52**	0.23	0.23	0.26	-0.01	0.51**	0.00	0.39*	0.37
SRN						1.00	0.04	0.48**	0.60**	0.01	0.01	0.45*	0.03	0.57**	0.07	0.33	0.29
MRW							1.00	0.59**	0.73**	0.75**	0.75**	0.44*	-0.02	0.73**	-0.27	0.20	0.80**
PRW								1.00	0.65**	0.43*	0.43*	0.27	0.01	0.62**	-0.05	0.37*	0.52**
SRW									1.00	0.57**	0.57**	0.75**	-0.03	0.88**	-0.23	0.19	0.81**
LA										1.00	1.00**	0.39*	0.06	0.62**	-0.39*	0.09	0.62**
LAI											1.00	0.39*	0.06	0.62**	-0.39*	0.10	0.62**
SPAD												1.00	-0.07	0.72**	-0.26	-0.22	0.71**
SLW													1.00	-0.06	0.86**	0.21	-0.34
DR														1.00	-0.27	0.18	0.83**
NAR															1.00	0.17	-0.53**
HI																1.00	-0.01
FRY																	1.00

\* and \*\* indicate significance of values at P=0.05 and 0.01, respectively

LN	- Leaf number	MRW	- Mother rhizome weight	SLW	- Specific leaf weight
TN	- Tiller number	PRW	- Primary rhizome weight	DR	- Dry recovery
PH	- Plant height	SRW	- Secondary rhizome weight	NAR	- Net assimilation rate
LA	- Leaf area	HI	- Harvest index	PRN	- Primary rhizome number
FRY	- Fresh rhizome yield	SRN	- Secondary rhizome number	SPAD	- SPAD Values
MRN	- Mother rhizome number	LAI	- Leaf area index		

**Table 2: Correlation co-efficients among the quality attributes of turmeric**

	ar-tur	b* value	EO	PAL	TP	SPAD	Cur
ar-tur	1.00	0.24	-0.23	-0.43*	-0.15	0.09	-0.39*
b* value		1.00	0.37	-0.15	0.01	-0.23	-0.60**
EO			1.00	0.07	0.25	-0.32	-0.07
PAL				1.00	-0.09	0.06	0.19
TP					1.00	-0.27	0.01
SPAD						1.00	0.55**
Cur							1.00

\* and \*\* indicate significance of values at P=0.05 and 0.01, respectively

ar-tur	- ar-turmerone	b* value	- Colour value
EO	- Rhizome oil	TP	- Total phenol
SPAD	- Chlorophyll	Cur	- Curcumin
PAL	- Phenylalanine ammonia liase		

also showed highly significant and positive correlation with mother rhizome weight. In the present study, highly significant and positive correlation was observed for secondary rhizome weight with most of the traits with highest values recorded for dry recovery (0.88) and tiller number (0.83). Leaf number, tiller number, plant height and mother rhizome number were also showed highly significant and positive correlation with mother rhizome weight. The present results are in concurrence with the earlier findings of Singh *et al.* (2018).

Leaf number had positive and highly significantly association with plant height (0.96), tiller number (0.90), dry recovery (0.77), secondary rhizome weight (0.73), mother rhizome weight (0.71), leaf area (0.61) and leaf area index (0.61). However, the association was significantly negative with net assimilation rate (-0.57).

Highly significant and positive correlation of number of tillers per plant was observed with plant height (0.93), SPAD values (0.90), secondary rhizome weight (0.83), dry recovery (0.79), mother rhizome weight (0.63), leaf area (0.50) and leaf area index (0.50).

Though not significant, the association between specific leaf weight and most other traits was negative except for net assimilation rate with which it had positive and highly significant (0.86) relation. Similarly, the net assimilation rate had highly significant but negative association with leaf number (-0.57) and plant height (-0.50).

Harvest index was found to be significantly and positively correlated with primary rhizome number (0.39) and weight (0.37) only.

### Correlation among the quality traits:

A significant and negative correlation was observed for ar-turmerone content with PAL activity (-0.43) and curcumin content (-0.39). Highly significant, but negative correlation was seen between  $b^*$  value and curcumin content (-0.60), which implies that, the colour composition in terms of  $b^*$  value does not solely depend only on the curcumin content in the ground turmeric powder. However, though not significant, a positive association was noticed between  $b^*$  value and rhizome essential oil content (0.37).

Correlation between rhizome essential oil and total phenols (0.25) was positive but, between essential oil and SPAD value, the association was negative (-0.32) though not significant. Between PAL activity and

curcumin content, the association though not significant, was positive (0.19). A negative correlation was observed for total phenols with that of SPAD values (-0.27).

Between the SPAD values and the curcumin content, the association was highly significant and positive (0.55), which is one of the major reasons which supports the finding of the present study that, highest curcumin was obtained in case of blue net among the different photo-selective nets. Efforts to maximize the leaf chlorophyll content may further become an approach towards achieving the higher curcumin content of the final product.

The traits contributing for higher productivity in terms of yield per unit area and quality in terms of curcumin are to be given at most important either during the selection of any genotype or while evaluating various accessions. Even in case of experiments related to evolving production technology, the traits which significantly influences the yield and quality to be considered.

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