EVALUATION OF TURMERIC (C*URCUMA LONGA* L.) GENOTYPES FOR YIELD AND QUALITY ATTRIBUTING TRAITS UNDER AGRO-CLIMATIC CONDITIONS OF CHHATTISGARH PLAINS

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Abstract : The study was conducted in *Kharif* and *Rabi* season during the year 2009-10 at Horticulture Research Farm, Department of Horticulture, Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (C.G.). The experimental material consisted of twelve genotypes of turmeric, which were evaluated for yield and various growth and yield characters. The experiment was laid in Randomized Block Design (RBD) with three replications. The results revealed that all the genotypes different significantly for yield and various growth and yield characters under study. Based on the vegetative growth of the twelve genotypes under study, Shillong, Rajendra Sonia, Rashmi, BSR -2 and Roma were found to be vigorous types while RS -2 , TCP-1 and TCP-2 were poor performers. Maximum height of plants was recorded in variety Roma (94.80 cm) which was followed by Rashmi (81.93 cm), BSR-2 (76.63) and Shillong (75.40). The lowest plant height was observed in Narendra haldi-1 (37.50 cm). The maximum numbers of tillers were recorded on genotype Shillong (5.73) which was closely followed by Rashmi (5.54) and Narendra haldi-1 (5.40) which was statistically at par with each other. The average performance of genotypes for fresh tuber yield reveled that Roma, BSR-2, Duggirala red and Shillong were higher yielders whereas, TCP-1, Narendra haldi-1 and RS-2 were average yielders and RS -1 was the poorest performer. Highest yield per hactere was recorded in Roma (17.51 t), it was followed by BSR-2 (15.04 t), Shillong (10.86 t) and Duggirala red (10.69 t).

Keyword : Genotypes, Quality, Turmeric

INTRODUCTION

Turmeric (*Curcuma longa* L.) is an important spices cum medicinal plant belonging to the family *Zingiberaceae* and genus *Curcuma*. It is also known as Indian saffron or haldi. It has 42 *species* of which *Curcuma longa* is commercially cultivated (Kannan 1991). The genus curcuma consists of about 117 species, among which around 40 species are reported from India (Velayudhan *et al*., 1999). Turmeric occupies fifth place next to chillies, cumin, coriander, and black pepper, in terms of among spices and in production it rank second, next to chillies. It occupies 6.3% of the spice area and shares 18.8% of spices production. In India, Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra and Assam are some of the important states cultivating turmeric. However, Andhra Pradesh alone occupies 38.0% of area and 58.5% of production. The national productivity of the crop is 4446 kg $ha^{-1}$and wide variation is productivity is seen among the states. There are high yielders of fresh rhizomes and rich in curcumin and volatile oil content. Long duration types mature in nine months and are moderately good for both rhizome yield as well as quality.

It is used medicine to treat digestive disorders, purify blood, kill germs, protect liver and reduce cholesterol level. It possesses anti-inflammatory, anti-HIV, anti-cancer, anti-thrombosis and anti-Alzheimer (Khan, 1999) properties. Also it has unique bio-protective properties which help in neutralizing the free radicals on the surface of skin, thereby retarding aging and damage due to UV radiations (Khanna, 1999).

MATERIAL AND METHOD

An experiment was conducted in *Kharif* and *Rabi* season during the year 2009-10 at Horticulture Research cum instructional Farm, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The twelve genotypes were Roma, Rashmi, Shillong, Raipur selection-1, Raipur selection-2, Raipur selection-3, Rajendra Sonia, Narendra Haldi-1, Duggirala Red, TCP-1, TCP-2, and B.S.R.-2 . Plant character were Plant height (cm) Leaf width (cm) Leaf length (cm), Number of leaves per plant, Number of tillers per plant, Total yield, Yield of fresh rhizomes, Days to maturity, Leaf area index, Weight of mother rhizomes per plant, Weight of primary and secondary fingers, rhizomes per plant ,Number of primary and secondary fingers, rhizomes per plant, Dry matter percent of rhizomes and curcumin percentage. Raipur is situated in mid eastern part of Chhattisgarh at latitude $21^{o}16'$N, longitude $81^{o}36'$E and at an altitude of 298 meters above the mean sea level.
The general climate prevailing in the district Raipur of Chhattisgarh is dry sub-humid type with annual rainfall varying from 1200 to 1400 mm which is mostly received from the mid June to September end, with occasional light showers during winter and summer season. The temperature reaches up to maximum of 40.4^{o}C in month of March and minimum temperature during January may go down to 8.7^{o}C.

RESULT AND DISCUSSION

The purpose of the present investigation was to extract the basic information which can throw light on the strategies to be adopted for turmeric improvement with reference to Chhattisgarh Plains. The performance of twelve genotypes of turmeric under study with regard to vegetative characters is presented in Table 4.1. All the genotypes different significantly for growth characters such as plant height, number of leaves, number of tiller per plant, leaf length, leaf breadth and leaf area index. It is evident from the data presented in the Table 4.1 that plant height varied significantly for various turmeric genotypes under study. Maximum height of plants was recorded in variety Roma (94.80 cm) which was followed by Rashmi (81.93 cm), BSR-2 (76.63) and Shillong (75.40) were at par with each other. The lowest plant height was observed in Narendra haldi-1 (37.50 cm). Similar result had been earlier reported by Ramakrishna and Reddy (1992). In the present study plant height of BSR-2 was recorded lower than that reported by Velmurugan *et al.*, (2008) (95.12cm). The difference in plant height may probably be due to difference in agro-ecological conditions. Similar observations were made earlier in turmeric (Patil *et al*., 1995, Radhakrishanna *et al*., 1996, T Hrideek *et al*., 2006). The difference in plant height of different genotypes grown under similar conditions may attribute to difference in genetic makeup of the different varieties.

A large variation was observed in number of leaves per plant across the twelve genotypes of turmeric under study, which ranged from 5.40 to 30.13 (Table 4.1). The maximum number of leaves per plant was recorded in the genotype Shillong (30.13) followed by BSR-2 (26.73) and Rashmi (23.80), whereas Roma had the least number of leaves per plant (5.40). RS-2 also produced less number of leaves (7.80), while RS 1 and RS 3 produces significantly more leaves, 16.33 and 16.87 respectively, as compared to it. Leaf length and leaf width also displayed significant variation among the genotypes. Leaf length ranged from 19.30 cm to 33.27cm while, leaf width ranged from 6.43cm to 12.23cm (Table 4.1).

Maximum length of leaves was recorded in Roma (33.27 cm) and it was statistically at par with Shillong (33.20 cm) and Rashmi (33.07cm). The minimum leaf length was recorded on Narendra haldi-1 (19.30cm). The broadest leaves were observed in Shillong (12.23cm) and it was statistically at par with Duggirala red (11.93cm) followed by Rashmi (11.30 cm) and Roma (11.13cm) which was statically at par with each other. Narendra haldi-1 recorded narrowest (6.43cm) leaves and it was statistically at par with RS-3 (6.63cm). Thus we observe that, genotype Roma, Rashmi, Shillong, RS-1, RS-2, Duggirala Red and BSR-2 have bigger leaves, as compared other genotypes. Duggirala Red had smallest leaves. Significant difference in LAI was recorded in different genotypes under study, which varied from 0.61 to 4.45 (Table 4.1). Maximum LAI (4.45) was observed in Shillong which was followed by Rashmi (3.05) and BSR-2 (2.88) whereas lowest LAI (0.61) was observed on Rajendra Sonia.

The difference among varieties attributed to their genetic makeup. Such variation among the LAI may be attribute to difference in number and size of leaves and number of tillers per clump. Earlier, Kandiannan and Chandaragiri (2008) reported LAI 6.11 in BSR-2 Bhavanisagar (T.N.) this difference may be due to difference in spacing adopted apart from effect of varied agro climatic conditions. At closer spacing, more plants per unit area can be achieved compared to medium and wider spacing as a result of more leaf area per unit area of land (Kandiannan and Chandaragiri, 2008). Similar growth differences among turmeric varieties were also recorded by Rumi *et a*l. (1999), Dixit and Srivastava (2000). Significant difference was observed in mean number of tillers per plant across the genotypes and it ranged from 2.07 to 5.73 (Table 4.1) The maximum number of tillers were recorded on genotype Shillong (5.73) which was closely followed by Rashmi (5.54) and Narendra haldi-1 (5.40) which were statistically at par with each other. Whereas RS-2 was found to be a poor tiller producer, which recorded only a mean 2.07 tiller per plant. TCP-2 and Duggirala Red were also poor at tiller production producing less than 3 tillers per plant and produced 2.60 tillers per clump each. Earlier Satish *et al.* (1997) studied the 12 *C. domestica* [*C. longa*] cultivars at the southern dry region of Karnataka and reported that BSR-1 produced highest number of tillers (7/clump), whereas here in Chhattisgarh plains the same genotype produced fewer tillers (4.33).

These differences may be attributed to the difference in agro climatic conditions at two places. The various genotypes under study showed significant difference in days to maturity. Based on maturity group, its cultivars are classified as short-duration (7 months), medium-duration (8 months) and long-duration (9months) (Table 4.2) Duggirala red, BSR-2, Shillong and Roma were found to be long duration (250-260 days) genotypes, while, TCP-1, TCP-2, RS-2, RS-3, Rashmi and Narendra haldi-1 were medium duration genotypes. Among all the genotypes under study, RS-1 was earliest to mature (203) and it was the only short duration genotype, while Duggirala Red took maximum number of days to maturity (260). Earlier, Chaudhary *et al*., (2006), had reported that Rajendra Sonia matured in 230.06 days under Bareilly (U.P.) conditions, which is earlier to maturity duration recorded at Chhattisgarh plains. It is interesting to note that under Chhattisgarh plains there in a delay in attaining maturity for harvest this may be due to prevailing agro climatic conditions here, which are

characterized by high temperature and humidity, which promotes vegetative growth.

Similar variations in different growth parameters among different genotypes have been earlier reported by various researchers (Naidu *et al.* 2000; Srivastava and Singh, 2003). Based on the vegetative growth of the twelve genotypes under study, Shillong, Rajendra Sonia, Rashmi, BSR -2 and Roma were found to be vigorous types with more number of tillers per plant, while RS -2 , TCP-1 and TCP-2 were poor performers with lower tillering and vegetative growth. RS 1 and RS 3, Narendra Haldi and Duggirala Red were average performers. Although Roma had lesser number of leaves but it was good tiller and had biggest leaves. All the genotypes different significantly for yield and for various yield characters viz. weight of mother rhizome, number of primary and secondary fingers and weight of primary and secondary fingers and quality parameters. The data recorded are presented in table 4.3. The weight of mother rhizomes per plant varied from 10 g. to 37.87 g. with the mean value of 17.18 g. (Table 4.3) (Fig) The maximum weight of mother rhizomes was recorded in (Duggirala red) 37.87 g. it was followed by (Roma) 33.67 g and minimum weight of maximum rhizomes per plant was recorded in Shillong, TCP-2 and Rajendra Sonia with 10 g each and Narendra haldi-1 (10.67 g) which were statistically at par with each other. The most important yield contributing characters in turmeric is the number the rhizomes and their size (Chadha, 2001).

Significant difference in number of primary as well as secondary fingers per plant was observed among the different genotypes (Table 4.2) (Fig.) The number of primary finger per plant varied from 4.13 in TCP-2 to 8.27 in Shillong. Whereas number of secondary fingers per plant varied from 5 in TCP-2 to 16.67 in BSR-2. Maximum number of primary fingers was produced by Shillong (8.27) which was statistically at par with Rashmi (8.10), which were followed by Duggira red (7.57), Roma (7.33) and BSR-2 (7.27) which was statistically at par with each other. Minimum number of primary finger per plant were recorded TCP-2 (4.13) which was the statistically at par with TCP-1(4.43). BSR-2 recorded maximum number of secondary fingers per plant which was statistically at par with Roma (15.90). Whereas TCP-2 recorded minimum secondary finger per plant i.e. (5.00) and it was statistically at par with TCP-1. At Raipur we recorded a mean of 5.23 primary fingers and 5.13 secondary fingers. For Rajendra Sonia whereas more number of rhizomes per plant was (10.22) were reported in the same genotype at Bareilly by Chaudhary *et al*., (2006).

There variation may be attributed to difference in agro-climatic condition and fertility status of the soil at two places. A perusal of data in Table 4.3 revealed significant difference in weight of primary as well as secondary fingers per plant. The weight of primary finger per plant varied from 32g in Raipur Sel.-I to 135.40g in Duggirala red (Fig.). Similarly, weight secondary finger per plant varied from 20.67g in TCP-1 to 177.87g in Roma. Highest weight of primary finger per plant was recorded in Duggirala red 135.40g which was followed by BSR-2 (121.67g) and Roma (119.67g). On the other hand, minimum weight of primary finger per plant was recorded in Raipur sel.-1 (32g). Highest weight of secondary fingers per plant was recorded for Roma (177.87g) which was followed by BSR-2 (128.50g) and Shillong (111.33). Minimum weight of secondary finger per plant was recorded on TCP-2 (20.67g), Raipur sel.-2(23.93g) which were spastically at par with each other. Similar variations have been reported by Sinkar *et al*., 2005; Jadhao *et al*., and Raveendra *et al*., 2005. Yield per plant varied significantly among the various genotypes under study (Table 4.4) and Fig. It varied from 95.42g to 289.02g with a mean 168.28g. Highest yield per plant was recorded in Roma (331.20 g), it was followed by BSR-2 (272.67g), Duggirala red (209.27 g) and Shillong (200.97 g). TCP-1 (86.83 g), Narendra haldi-1 (84.43 g) and RS-2 (83.00 g) were statistically at par with the each other. Low yield per plant was recorded in RS -1 (71.33g).

Similar variation in yield had been reported by various earlier researchers. (Yudhvir *et al*., 2003; Rao *et al*., 2004). More yields per plant in Roma may be attributed to more number and weight of primary and secondary finger per plant. Which are directly related to the yield per plant similarly result have been reported by Chaudhary *et al*., 2006; Harinkhede, 2005. Yield per plot varied significantly among the various genotypes under study (Table 4.4) and Fig. . It varied from 3.36 kg to 15.76 kg/ plot. Highest yield per plot was recorded in Roma (15.76 kg), it was followed by BSR-2 (13.55 kg) and by Shillong (9.78 kg) and Duggirala red (9.63 kg) which were statistically at par with each other. RS-2 (4.10 kg), Narendra Haldi-1 (4.00) and TCP-1 (4.13 kg) were statistically at par with the each other. Low yield per plot was recorded in RS -1 (3.36 kg). Similar variation in yield had been reported by various earlier researchers. (Yudhvir *et al*., 2003; Rao *et al*., 2004). Here we see that although the per plant yield for genotypes like RS-2, Narendra haldi-1, TCP-1, TCP-2 and Duggirala Red was fairly good but their performance in yield per plot was not so good, this may be attributed to the fact that these genotypes suffered from more insect, pest and diseases incidence and thus some of the plants were destroyed completely or partially, lowering the yield per plot. Yield per hectare varied significantly among the various genotypes under study (Table 4.4) and Fig. 4.3. It varied from 3.73 t/ ha to 17.51 ton/ha. Highest yield per ha was recorded in Roma (17.51 t), it was followed by BSR-2 (15.05 t/ha) a Shillong (10.86 t/ha) and Duggirala red (10.69 t/ha) which were statistically at par with each other. RS-2 (4.55

t/ha), Narendra Haldi-1 (4.44 t/ha) and TCP-1 (4.50 t/ha) were statistically at par with the each other.

Low yield per hectare was recorded in RS -1 (3.73 t).Similar variation in yield had been reported by various earlier researchers. (Yudhvir *et al*., 2003; Rao *et al*., 2004). The mean value of dry matter in percentage was 21.54% among all the collected genotypes, which ranged from 13.20% to 26.74 %.(Table 4.5) (fig 4.5). The maximum dry matter percentage was recorded in RS-1 (26.74%) followed by RS-2 (24.27%), RS-3 (23.33%) and Roma (22.75%). The percentage was comparatively low in genotype Duggirala red (13.20%). Variety Roma, Rajendra Sonia, Narendra haldi-1, TCP-1, TCP-@, and BSR -2 also recorded fairly good dry matter percentage, ranging from 20.68 % to 22.70%. Similar results for TCP-1 and TCP-2 have been reported by Aditi ((2005). Similar variation in dry matter percentage among various turmeric genotypes has been earlier reported by Jadhao *et al*., 2005 and Raveendra *et a*l., 2004. Considerable variation was observed in curcumin percentage among the different turmeric genotypes under study. (Table 4.5) (Fig.) The variation recorded for curcumin content all the genotypes ranged from 4.3% to 8.5%. The highest curcumin percentage was recorded in the genotype Roma (8.5%) followed by Rajendra sonia (8.2%), RS-2 (7.9%). These observations are in line with those reported earlier by Kumar *et al.*(2001). The curcumin content found comparatively low in TCP-1 (4.3%).

CONCLUSION

On the basis of mean performance with respect to yield and other parameters, it is observed that the genotypes Roma, BSR-2, Duggirala red and Shillong are more suitable to C.G. plain of Raipur district and can be suggested that the same can be multiplied for extensive cultivation to augment the production and productivity of turmeric at Chhatishgarh plains. Roma and Rajendra Red recorded highest curcumin percentage and can be recommended for quality turmeric production. RS-1, RS-2 and RS-3 recorded high dry matter percentage in rhizomes; these may be included in breeding programmes for increasing dry matter content in hybrids. Duggirala red, BSR-2, Shillong and Roma were found to be long duration (250-260 days) genotypes, while, TCP-1, TCP-2, Raipur selection-2, Raipur selection-3, Rashmi and Narendra haldi-1 were medium duration genotypes. Raipur selection-1 was earliest to mature (203) and it was the only short duration genotype, while Duggirala Red took maximum number of days to maturity (260).

Table 1. Mean performance of twelve genotypes of turmeric for various vegetative parameters

Genotypes	Plant height (cm)	No. of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Leaf area index	No. of tillers plant^{-1}
Roma	94.80	5.40	33.27	11.13	0.73	4.43
Rashmi	81.93	23.80	33.07	11.30	3.05	5.53
Shillong	75.40	30.13	33.20	12.23	4.45	5.73
Raipur Sel.-1	65.30	16.33	29.33	8.91	1.55	3.80
Raipur Sel.-2	60.47	7.80	30.27	8.46	0.73	2.07
Raipur Sel.-3	64.40	16.87	23.33	6.63	0.95	4.40
Rajendra Sonia	62.33	20.07	25.23	8.33	0.61	5.40
Narendra Haldi-1	37.50	13.67	19.30	6.43	1.53	3.33
Duggirala Red	71.37	15.27	31.53	11.93	2.09	2.60
TCP-1	51.13	13.67	21.73	8.03	0.86	3.80
TCP-2	53.93	12.60	25.27	8.23	0.95	2.60
BSR-2	76.63	26.73	28.10	10.57	2.88	4.33
SEm+	0.84	0.30	0.39	0.19	0.06	0.07
CD at 5% level	2.45	0.86	1.13	0.55	0.18	0.19
CV (%)	6.37	8.78	7.04	10.12	18.54	8.27

Genotypes	No. of primary fingers rhizomes^{-1}	No. of Secondary fingers rhizomes^{-1}	weight of mother rhizomes	weight of primary fingers rhizomes^{-1}	weight of secondary fingers rhizomes^{-1}
Roma	7.33	15.90	33.67	119.67	177.87
Rashmi	8.10	7.67	18.67	53.77	104.17
Shillong	8.27	13.37	11.10	79.63	111.33

Raipur Sel.-1	4.87	8.73	10.00	32.00	27.33
Raipur Sel.-2	5.00	6.77	12.00	40.40	23.93
Raipur Sel.-3	5.53	11.43	18.33	56.17	53.37
Rajendra sonia	6.17	8.20	10.00	62.67	40.43
Narendra Haldi-1	5.23	5.13	10.67	46.17	27.60
Duggirala Red	7.57	7.00	37.87	135.40	36.00
TCP-1	4.43	5.63	11.33	54.83	20.67
TCP-2	4.13	5.00	10.00	37.00	24.80
BSR-2	7.27	16.77	22.50	121.67	128.50
SEm+	0.11	0.27	0.27	0.85	1.26
CD at 5% level	0.31	0.77	0.78	2.47	3.64
CV (%)	8.82	14.31	7.86	6.10	9.71

Table 2. Mean performance of twelve genotypes of turmeric for various yield parameters

Genotypes	Yield (g) plant^{-1}	Yield (kg) plot^{-1}	Yield t ha^{-1}	Dry matter % of rhizomes	Curcumin % in rhizomes
Roma	**331.20**	**15.76**	**17.51**	22.75	**8.5**
Rashmi	169.03	8.12	9.02	19.16	6.2
Shillong	200.97	9.78	10.87	14.94	4.6
Raipur Sel.-1	**71.33**	**3.36**	**3.73**	**26.74**	7.9
Raipur Sel.-2	83.00	4.10	4.55	24.27	6.5
Raipur Sel.-3	127.87	6.19	6.87	23.33	5.3
Rajendra Sonia	113.10	5.51	6.12	22.13	8.2
Narendra Haldi-1	84.43	4.00	4.44	21.14	4.8
Duggirala Red	209.27	9.63	10.70	**13.20**	5.3
TCP-1	86.83	4.13	4.59	21.57	**4.3**
TCP-2	71.80	3.44	3.83	21.64	6.1
BSR-2	**272.67**	**13.55**	**15.05**	20.68	5.7
SEm+	1.16	0.09	0.01	2.5	2.0
CD at 5% level	4.79	0.26	0.29	2.47	3.64
CV (%)	5.44	6.20	6.20	6.10	9.71

Table 3. Mean variation in days to maturity in twelve turmeric genotypes

Duration	Genotype	Maturity (Days)
Long maturing **(9 months)**	Duggirala Red	260
	Roma	251
	BSR-2	249
	Shillong	245
Medium duration **(8 months)**	Raipur Sel.-2	240
	TCP-2	239
	Raipur Sel.-3	236
	Narendra Haldi-1	233
	Rajendra Sonia	232
	TCP-1	226
	Rashmi	226
Short duration **(7 months)**	Raipur Sel.-1	203
SEm+		1.25
CD at 5% level		3.62
CV (%)		2.64

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