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Evaluation of turmeric (*Curcuma longa* L.) genotypes under sub-tropical plains of Jammu region (J&K)

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Abstract
The present investigation was conducted in the Division of Vegetable Science & Floriculture, FoA, Chatha, SKUAST-Jammu (J&K) to evaluate the performance of ten turmeric genotypes under subtropical plains of Jammu region during the year 2019-20. The experiment was laid in Randomized Block Design with three replications. The genotypes used in the present investigation were SJT-09, Prabha, Sugandham, Suroma, Tanda Local, Rajendra Sonia, PH-1, Allepey Supreme, Suguna and Local Chowkichora. The results revealed maximum plant height (101.06cm) and Leaf Area Index (7.43) in genotype Suroma whereas maximum number of leaves per plant was recorded in Tanda Local (7.83). However, SJT-09 recorded the maximum number of fingers per rhizome (15.38) and length of fingers per rhizome (4.22 cm) whereas girth of fingers per rhizome (cm) was statistically non significant. In case of yield parameters, the maximum rhizome yield per plot and rhizome yield was recorded in SJT-09 (18.38 kg and 20.39 t/ha respectively). Among all the genotypes, minimum crop duration was recorded in Prabha (201 days). With respect to quality parameters, highest curcumin content was recorded in Rajendra Sonia (6.43%) which was statistically at par with SJT-09 (6.43) whereas maximum dry recovery was also recorded in SJT-09 (20.60%). Based on the results of our study, turmeric line SJT-09 was found to be most promising both in terms of yield as well as quality and can be promoted for cultivation under subtropical plains of Jammu region.

Keywords: Turmeric, genotype, yield, curcumin

Introduction
Turmeric (*Curcuma longa* L.) commonly known as *haldi* belongs to family Zingiberaceae and is a triploid with a somatic chromosome number of 63 (2n=3x=63). Its centre of origin is South-East Asia (Purseglove *et al.*, 1981) [24]. It consist of 40 genera and 70 species and only 5 species are grown globally i.e. *Curcuma amada*, *Curcuma aromatica*, *Curcuma longa* Linnand, *Curcuma angustifolia* and *Curcuma domestica* (Jain and Prakash, 1995) [13]. Out of these, *Curcuma longa* covers an area of ninety percent of production in India. It is grown most extensively in India, Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, Philippines, Australia, Africa, Peru and West Indies. India is the largest producer and consumer of turmeric contributing around 75-80 percent of world's production which stands around 8 lakh tons (Anonymous, 2014) [2]. Turmeric is cultivated all over India and stands in an area of 193.40 thousand hectares with annual production of 105.2 thousand tons and productivity of 5.44 metric tons per hectare. In erstwhile state of Jammu and Kashmir, it is cultivated in 0.1 thousand hectare area with 0.10 thousand tons of production (Anonymous, 2019) [3].

Turmeric is considered to have a long history with India and its people and is relegated as "Indian saffron" considering its orange yellow colour of dried rhizomes. The rise in demand of curcumin is largely due to growing awareness among the consumers regarding its anti-oxidant, anti-inflammatory, chemo preventive, antifertility, anti-depressant and HIV I & HIV II protease inhibitor properties (Jain *et al.*, 2007) [12].

The traditional method of cultivating turmeric is through mother rhizomes. The seed set is rare and hence turmeric is propagated vegetatively through rhizome.

Both mother and finger rhizomes are used for commercial cultivation. Planting of primary fingers is the common practice in major turmeric growing belts.

Performance of any crop depends upon its genetic makeup and climatic conditions of the region under which they are grown. Genotype which performs better in one region may or may not perform in other regions due to varying climatic conditions. Hence, it is essential to collect and evaluate genotypes in order to select best genotype for a particular agro-climatic condition. The present investigation has been carried out with an objective to evaluate the field performance of turmeric genotypes for yield and quality traits under Jammu region.

Materials and Methods

The investigation was carried out in the Experimental farm II (32-40º N 74-53º E and 300 mMSL) of Division of Vegetable Science and Floriculture, SKUAST- Jammu, Chatha during the year 2019-2020. Geographically the location represents agro-climate zone V with an average rainfall of 23.89 mm from South-west monsoon, maximum temperature rises up to 35 ºC and minimum temperature falls to 4.8 ºC (Fig. 1) during winter and is characterized by a Sub-tropical climate. The experiment was laid out in randomized block design (RBD) with three replications having plot size 9m2 and spacing of 60 cm x 20 cm on loamy soil having alkaline pH (7.4), low in organic carbon and available nitrogen while medium in phosphorus, potassium with EC in the normal range. At the time of sowing healthy and disease free rhizomes of different turmeric genotypes were treated with a combination of Mancozeb (0.25%) and Carbendazim (0.10%) for 30 minutes as recommended in Package of Practices, 2020 of the university.

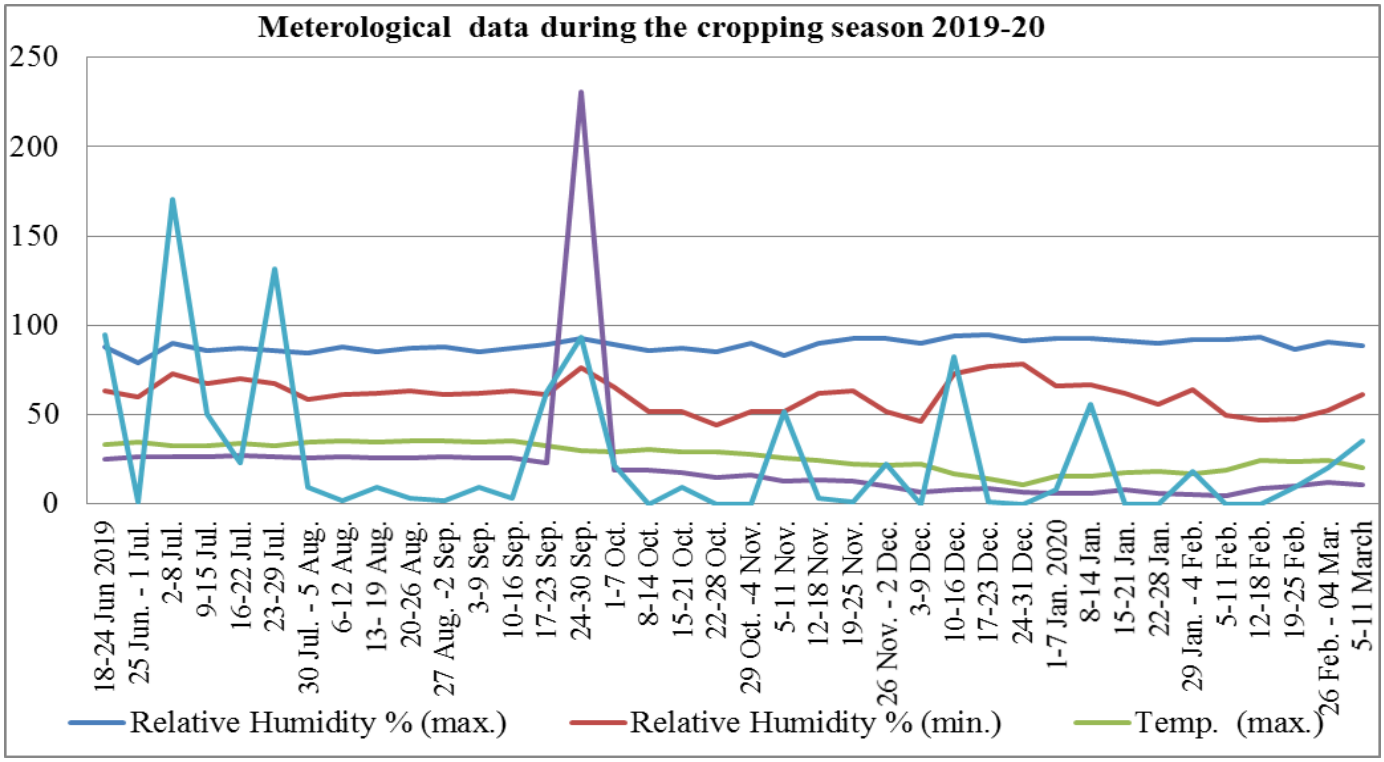

Fig 1: Meteorological data during the cropping season 2019-2020 (Source: The Meteorological observatory, located at the Experimental farm, Chatha)

Uniform cultivation practices were adopted and randomly five plants of turmeric were taken from each plot for recording observations on growth, yield and quality. The plant height was recorded from the base of the main stem to the tip of longest leaf and fully opened leaves from main stem were counted and expressed as the total number of leaves per plant. In case of leaf area index (LAI), leaf area (LA) was calculated using formulae LA= 5.71 + 0.72 x Length x Breadth of leaf (Panja *et al.*, 2005) [22] and calculated leaf area was multiplied with total number of leaves per plant. However, leaf area index (LAI) was calculated by dividing total leaf area per plant with land area occupied per plant. Numbers of fingers were calculated, length of fingers per rhizome was measured in centimetre whereas girth was measured using digital Vernier calliper. Crop was harvested during second week of March and the number of days were calculated from planting to the stage of drying out one- third (1/3) of the plant from the top portion. The net plot cumulative rhizome yield was represented in kilograms as yield per plot. Fresh rhizome yield data from the net plot was used to measure fresh rhizome yield per hectare. The curcumin content (%) was calculated using solvent extraction and spectrophotometric calculation method (Geethanjali *et al.*, 2016) [10] and for dry recovery calculation rhizomes of various treatments fresh weight was recorded and was dried in the shade for 2 to 3 days followed by heat air oven at 80 ^{0}C for 48h (Singh *et al.*, 2010) [30]. Dry recovery was calculated by using formulae-Dry recovery (%) = (Dry weight/Fresh weight) × 100. The data of various observations recorded during the course of investigation were analyzed by Randomized Block Design (Sheoran *et al.*, 1998) [28].

Results and Discussion

The performance of different genotypes varied significantly with regard to growth, yield and quality parameters and the observations recorded on various parameters and detailed results has been given in the Table 1 and Figure 2.

Among growth parameters plant height is an important growth parameter depicting the general health and vigour of the plant. Plant height of genotype Suroma (101.06 cm) was significantly higher and was statistically at par with six other genotypes *viz*., Rajendra Sonia (98.56cm), Sugandham (98.40cm), PH-1 (97.63cm), Tanda local (97.41cm), SJT-09 (95.96cm) and Prabha (95.40cm) whereas minimum plant height was recorded in Suguna (88.80cm). Genotypic variation for plant height have been also reported by various workers *viz*., Maurya *et al.* (2018) [19]; Mishra and Singh (2017) [20] and Deb and Chakraborty (2017) [9].

Leaves are the active site of photosynthesis in plants and the leaf number is an important factor determining the overall growth and vigour of the plant. Tanda Local (7.83) recorded maximum number of leaves per plant along with four genotypes *viz*., SJT-09 (7.51), Prabha (7.16), Local Chowkichora (7.08) and Sugandham (7.00). However, minimum number of leaves was found in Allepey Supreme (5.91). Various workers have reported variation in number of leaves per plant among different genotypes like Kallur *et al.* (2017) [14] reported maximum number of leaves in Pratibha (19.70) and minimum in Allepey Supreme (13.06).

Table 1: Mean performance of turmeric genotypes for various parameters

S. No.	Genotypes	Plant height (cm)	Number of leaves per plant	Leaf Area Index	Numbers of fingers/rhizome	Length of fingers/rhizome (cm)	Girth of fingers/rhizome (cm)	Crop duration (days)	Rhizome yield per plot (kg)	Rhizome yield per hectare (q)	Curcumin content (%)	Dry recovery (%)
1.	SJT-09	95.96	7.51	6.80	15.38	4.22	2.61	205.00	18.37	20.39	6.43	20.60
2.	Prabha	95.40	7.16	6.63	13.94	3.90	2.58	201.00	15.67	17.38	5.70	18.83
3.	Sugandham	98.40	7.00	7.26	10.80	3.63	2.71	231.00	13.18	14.63	3.43	17.43
4.	Suroma	101.06	6.50	7.43	7.97	3.09	2.66	254.00	12.26	13.61	5.43	14.23
5.	Tanda local	97.41	7.83	7.00	14.63	3.80	2.72	247.66	15.50	18.32	4.66	19.37
6.	Rajendra Sonia	98.56	6.08	7.29	7.60	3.43	2.60	237.66	11.62	12.89	6.63	17.14
7.	PH-1	97.63	6.33	4.64	13.71	3.66	2.62	231.66	15.30	16.97	5.33	16.37
8.	Allepey Supreme	93.86	5.91	7.39	12.54	3.55	2.73	218.00	13.87	15.39	5.40	16.04
9.	Suguna	88.80	6.66	6.39	6.67	3.07	2.55	202.00	11.88	13.18	6.26	14.07
10.	Local Chowkichora	94.73	7.08	7.31	13.30	3.45	2.57	221.00	15.04	16.69	6.30	17.54
$CD_{(0.05)}$		6.10	1.06	1.23	1.91	0.53	N.S.	8.26	2.60	2.88	0.50	0.62
C.V. (%)		3.67	9.01	10.48	9.50	8.62	5.58	2.12	10.51	10.51	5.20	2.08

Leaf area index (LAI) is the measure of rate of photosynthesis and the results revealed maximum LAI value in genotype Suroma (7.43) along with seven other genotypes *viz*., Allepey supreme (7.39), Local Chowkichora (7.31), Rajendra Sonia (7.29), Sugandham (7.26), Tanda Local (7.00), SJT-09 (6.80), Prabha (6.63) and minimum LAI value was recorded in PH-1(4.64). Similar results were recorded by Kallur *et al.* (2017) [14] who reported maximum LAI in variety Suroma (9.45) and variety Pratibha (8.73); which was in consistency with Kandiannan *et al.* (2015) [15]; Shashidhar (2015) [27]; Veena (2012) [32] and Anusuya (2004) [4].

The most important yield contributing character in turmeric is the number of fingers per rhizomes and their size (Chadha, 2001). The results show **s**ignificantly highest number of fingers per rhizome in genotype SJT-09 (15.38) followed by three genotypes *viz*., Tanda Local (14.63), Prabha (13.94) and PH-1 (13.71) and minimum number of fingers per rhizome recorded in Suguna (6.67). Considerable variation with respect to number of fingers per rhizome was reported by Krishna *et al.* (2019) [16] who evaluated nineteen turmeric genotypes under high altitude of Andhra Pradesh.

It is obvious that the genotypes with more length and girth have tendency to increase yield. The maximum length of fingers per rhizome (4.22 cm) was recorded in SJT-09 along with two genotypes *viz*., Prabha (3.90 cm) and Tanda Local (3.80 cm) whereas minimum length of fingers per rhizome was recorded in Suguna (3.07 cm) and with respect to girth of fingers per rhizome, non-significant results were obtained among all selected genotypes in our studies. However, maximum value for girth of finger per rhizome was recorded in Allepey Supreme (2.73 cm). Researchers like Sadanand *et al.* (2019) [25] have reported maximum number of fingers per rhizome in BSR-1 (6.4cm). Venugopal and Pariari (2017) [33] reported girth of fingers per rhizome of different genotypes ranging between 2.57 cm to 1.93 cm.

Crop duration is an important factor to determine the cropping sequence of the specific region (Luiram, 2017) [17]. Our results revealed that, minimum crop duration of 201 days in genotype Prabha along with two other genotypes *viz*., Suguna (202 days) and SJT-09 (205 days) which was significantly less than rest of the genotypes. However, maximum crop duration was reported in genotype Suroma (254 days). The variation in crop duration was also reported by Kallur *et al.* (2017) [14] who observed minimum crop duration (210 days each) in Kanti, Suvarna and Varna.

Yield is the most economic parameter. The performance of genotypes varies under different agro-climatic conditions (Krishna *et al.*, 2019) [16]. However, genotypes grown under the similar agro-climatic conditions, variations in rhizome yield can be attributed to genetic factor (Anandraj *et al*., 2014) [1]. On evaluation of ten turmeric genotypes revealed significantly superior response for rhizome yield per plot and per hectare in genotype SJT-09 (18.38 kg and 20.39 tonnes) followed by Prabha (15.67 kg and 17.38 tonnes) whereas minimum yield was recorded in Rajendra Sonia (11.62 kg and 12.89 tonnes). The variation in rhizome yield of different genotypes grown under different agro-ecological situations has been reported by Deb and Chakraborty (2017) [9] who evaluated 27 genotypes of turmeric under Terai region. Other workers such as Prasath *et al.* (2016) [23]; Salimath *et al.* (2016) [26]; Kandiannan *et al.* (2015) [15] and Singh *et al.* (2015) [31].

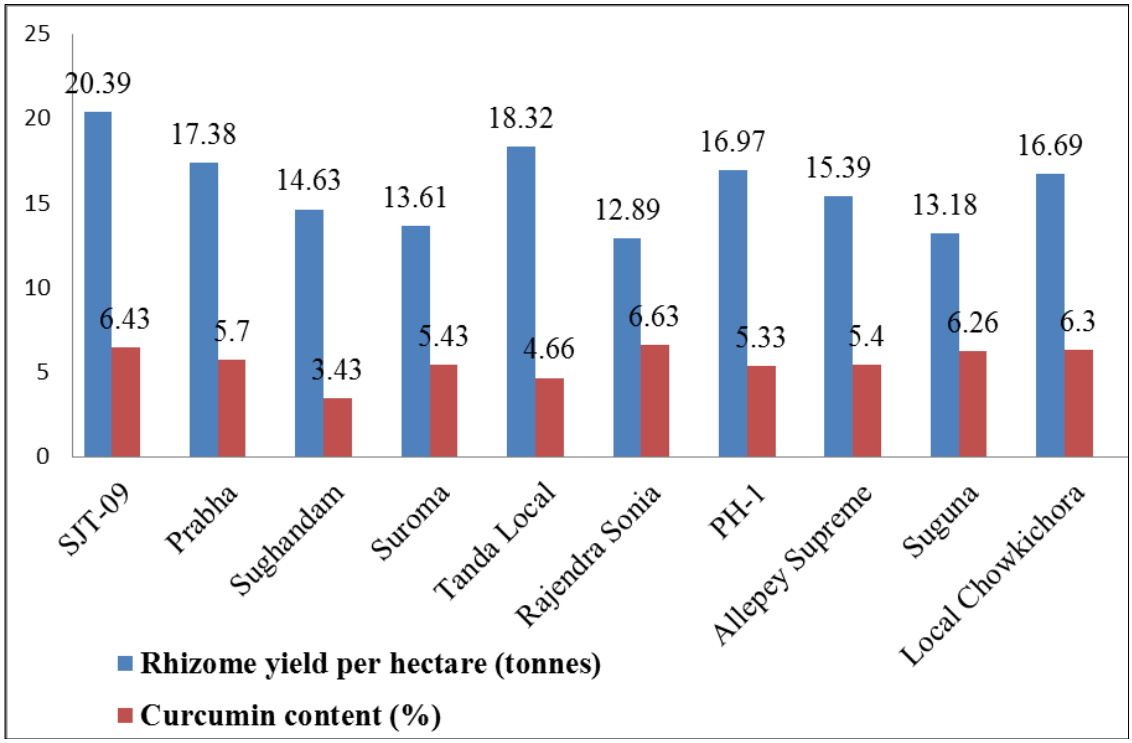

Fig 2: Evaluation of turmeric genotypes for rhizome yield per hectare (tonnes) and curcumin content (%)

Curcumin content of turmeric varies from place to place due to genotypic character, influence of environment and agro-climatic condition (Singh *et al.*, 2013) [29]. Among all genotypes highest curcumin content was recorded in genotype Rajendra Sonia (6.63%) along with three other genotypes *viz*., SJT-09 (6.43%), Local Chowkichora (6.30%) and Suguna (6.26%) whereas minimum curcumin content was recorded in Sugandham (3.43%). Significant variation with respect of curcumin percentage was also reported by Das *et al.* (2020) [8] who reported maximum curcumin content in genotype Allepey Supreme (5.2%). Variation among different genotypes with respect to curcumin content (%) has also been reported by Mishra (2019) [21]; Hrideek *et al.* (2006) [11]; Rao *et al.* (2006) [18] and Anusuya (2004) [4].

Dry recovery is considered as an important character which decides the yield of cured produce (Luiram, 2017) [17]. Significantly highest dry recovery percent was reported in SJT-09 (20.60%) which was at par with seven genotypes *viz*., Tanda local (19.37%), Prabha (18.83%), Local Chowkichora (17.54%), Sugandham (17.43%), Rajendra Sonia (17.14%), PH-1 (16.37%) and Allepey Supreme (16.04%) whereas minimum dry recovery was recorded in Allepey Supreme (16.04%). The results were in agreement with the findings of Das *et al.*, (2020) [8] who reported maximum dry recovery in Rajendra Sonia (26.6%) and Das (2015) [7].

Conclusion

Based on the findings of our study, it is evident that there was wide variation among ten turmeric genotypes for various yield and quality traits but the overall performance of SJT-09 genotype was found to be best as compared to other genotypes and thus, can be promoted for further evaluation / cultivation over larger area under subtropical plains of Jammu region.

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