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Assessment of the yield, curcumin, and essential oil content of the turmeric (*Curcuma longa* L) genotypes in the Tamil Nadu region of Bhavanisagar

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Abstract
The experiment was conducted at the Turmeric Research Centre, Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar, Erode district, Tamil Nadu. In terms of the turmeric accessions evaluated at Thoppampalayam in Tamil Nadu, the results indicated the following; The tallest plants were CL-125, CL-197, and BSR-2, with heights of 169.51 cm, 162.98 cm, and 162.46 cm, respectively. The highest number of tillers were observed in CL-197 (7.78), followed by CL-223, BSR-1, and CO-2 (6.99 each), with CL-123 having 5.99 tillers.BSR-1 had the highest number of leaves (9.58), followed by CL-121 (9.13).The longest leaves were found in CL-27 (149.13 cm), CL-225 (148.97 cm), and CL-100 (147.82 cm).The widest leaves were observed in CL-27 (19.22 cm), CL-98 (18.92 cm), and CL-118 (18.13 cm).CL-225 had the most mother rhizomes per plant (5.99), followed by CL-100 (4.99) and CL-95 (4.92).CL-100 had the longest mother rhizomes (11.86 cm), followed by CL-95 (11.62 cm) and CO-2 (10.93 cm).The largest girth of mother rhizomes was in CL-100 (21.09 cm), CL-125 (19.05 cm), and CL-98 (18.98 cm).The heaviest mother rhizomes per plant were in CL-100 (398.38 gm), CL-98 (343.08 gm), and CL-225 (332.63 gm).CL-98 had the highest number of primary rhizomes per plant (46.23), followed by Salem local (33.18) and CL-121 (29.71).Salem local had the longest primary rhizomes (9.98 cm), followed by Erode local (9.95 cm) and CL-225 (9.74 cm).The largest girth of primary rhizomes was in CL-125 (11.31 cm), CL-121 (10.98 cm), and CO-2 (10.91 cm).The heaviest primary rhizomes per plant were found in CL-95 (683.21 gm), CL-225 (657.19 gm), and CL-118 (641.27 gm).The highest number of secondary rhizomes per plant were in CO-2 (27.43), Salem local (24.89), and CL-125 (24.46).CL-125 and CL-197 both had the highest weight of secondary rhizomes per plant (183.45 gm), followed by CL-118 (163.21 gm) and CL-123 (149.23 gm).The total number of fresh rhizomes per plant was highest in CL-98 (65.15), followed by Salem local (60.06) and CL-27 (55.29). The highest total weight of fresh rhizomes per plant was observed in CL-225 (1151.0 gm), CL-118 (1063.4 gm), and CL-95 (1003.7 gm).CO-2 had the highest curcumin content (4.23%), followed by BSR-3 (4.08%) and BSR-2 (3.92%).The highest essential oil content was in CO-2 (4.38%), followed by BSR-2 (3.68%) and CL-258 (3.19%).BSR-3 had the highest oleoresin content (10.02%), followed by CO-2 (9.81%) and CL-121 (9.23%).

Keywords: Yield, curcumin, essential oil, *Curcuma longa* L, genotypes

Introduction
Turmeric is a tropical perennial herb (*Curcuma longa* L.) in the Zingiberaceae family. It is cultivated widely in India and other Asian countries. It is used as a condiment, dye, drug, and cosmetic after processing and value addition. It is a certified natural food colour and has several uses in traditional Indian medicine as well as modern medicines for various human ailments. (Purseglove *et al*., 1981) [25]. The chromosome number of cultivated turmeric was reported frequently as 2n=63 (Ramachandran *et al.*, 1961) [29]. Basic chromosome number of the genus Curcuma is suggested as x=21 which in turn originated by dibasic amphidiploidy from x=9 and x=12 or by secondary polyploidy (Ramachandran *et al.*, 1961) [29]. India is the world's greatest producer, user, and exporter of spices, with 63 different varieties of them being cultivated there. South-East Asian native herb turmeric is used in China, Bangladesh, and other Asian nations as a culinary ingredient (spice), food preservative, and colouring agent.(Rathaur *et al.* 2012) [30]. Whereas turmeric initially served as a colour for textiles and yarns, its present use for health reasons much exceeds that of any other use, including spices (Liu *et al.* 2022) [20]. Turmeric powder derived from the rhizomes of *Curcuma longa* is widely used in the culinary industry as a spice, food preservative, natural colour, and in cosmetics and

pharmaceuticals (Cooksey *et al.* 2017) [6]. Similar to curry dishes, which is one of the most widely used spices in many southern Asian countries, turmeric powder has a nice bitterness and earthy flavour similar to pepper and mustard. It may be used either on its own as turmeric or combined with other spices. In many countries, curry recipes have traditionally included turmeric as a colour and food flavouring component. Dried turmeric powder is the main component of curry powder. Although pure turmeric powder has a higher curcumin level than other goods made from turmeric, including curry powder, with an average of 3% by dry weight (Li *et al.,* 2011) [40], turmeric is a medicinal plant that has been extensively investigated. The *Curcuma longa* plant's dried rhizome powder, or turmeric, contains a variety of compounds. According to its estimated composition, turmeric is mostly made up of water (80–90%), followed by carbohydrates (about 13%), proteins (2%), minerals (2%), and lipids (1%). Throughout the years, turmeric's therapeutic characteristics have been linked to a wide range of benefits that have the potential to treat hepatic, cardiac, and liver problems, as well as allergies, asthma, sinusitis, and wounds. (Bange *et al.,* 2018) [4]. According to the manner in which all other spices are made, quality parameters, which include physical characteristics, colour, and extraction content (oleoresin and essential oil), are crucial consideration. Several criteria are used to evaluate the quality of curried turmeric. These include the rhizome's general appearance, size, and physical shape; the colour (curcumin); and the organoleptic (aesthetic, gustatory) characteristics (Hailmichael *et al.,* 2016) [15]. Curcumin and other resinous substances found in turmeric oleoresins (Krishnamurthy *et al.*, 1976) [19] are widely used as functional additives in the food and pharmaceutical sectors. They are abundant sources of curcuminoids and essential oils, with extracts from several turmeric cultivars often containing 0.2–2% and 2-2.5% of each at the same time (Chattopadhyay *et al.,* 2004) [7]. The colouring and flavouring qualities of a spice are connected to its oleoresins, which are made up of both volatile and non-volatile substances. Oleoresins are employed in several pharmacological and cosmetic formulations in addition to being used in the food industry. They also have many positive health effects (Rajashri *et al.,* 2020) [31]. Oleoresins are seen as a prospective functional component in the food and pharmaceutical industries based on handling and application. Oleoresins have beneficial effects on live cells and tissues because they include a number of bioactive substances. Oleoresins are the ideal functional element for industrial usage because of their anti-microbial, anti-fungal, and immunity-boosting qualities (Pal *et al*., 2020) [27]. Turmeric oleoresin is used in brine pickles and, to some extent, in nonalcoholic beverages, gelatins, butter, cheese, etc. Curcumin also protects the liver from toxic compounds. It acts as an anticoagulant by inhibiting collagen and adrenaline-induced platelet aggregation (Srivastava *et al.,* 1985) [35]. The active yellow pigment in turmeric, called curcumin (diferuloylmethane), has a wide range of biological and cellular activities, including antioxidant, anti-inflammatory, anticarcinogenic, anti-oxidant, anti-hepatotoxic, anti-microbial, anti-depressant, etc., as well as the more recently discovered chemopreventive, anti-fertility, neuroprotective, HIV1 and HIV2 protease inhibitors. (Jain *et al.,* 2007) [17]. Few studies have looked at the whole turmeric root as a possible tool for reducing inflammation or other health issues. When used in moderation, turmeric is safe and healthful to consume. The most important curcuminoid, curcumin, was originally isolated from turmeric in 1815 and is responsible for most of the therapeutic benefits of turmeric (Dumomangi *et al.,* 2021) [8]. Turmeric contains about 3–8% curcumin (depending on the growing season). A dessert spoon of turmeric powder (an average of 3 g) will contain an average of 30–90 mg of curcumin, although other plant species also contain some curcumin (Fabianowska *et al.,* 2021) [12]. In various research and studies, turmeric's antiseptic, anti-inflammatory, and antioxidant properties have been proven and proposed as a complementary treatment for Alzheimer's, diabetes, asthma, stomach ulcers, etc. (Esmaeii *et al.,* 2021) [11]. Curcumin has anticancerous effects and has potential in the treatment of various forms of cancer, including prostate, skin, and colon (Rao *et al*., 1995) [32]. It is being used more often to add colour and flavour in the processed food sectors in the West. In order to disperse the extracted substance and make it 'soluble' and free-flowing for commercial usage, it is typically combined with a non-volatile edible solvent such as vegetable oil, propylene glycol, or polyoxyethylene sorbitan fatty acid esters. (Purseglove *et al.,* 1981) [25]. Essential oil is an important active constituent of turmeric. It is collected from turmeric leaves and rhizomes by hydro-distillation in Clevenger's apparatus. GC-MS analysis reveals that the oil from turmeric contains many important constituents having varied properties like anti-microbial, anti-inflammatory, anti-wounds, anti-dermatosis, insect repellant, antiseptic, antacid, and carminative, and is also used in various digestion ailments (Purseglove *et al.,* 1981) [25]. These essential oils are valuable for the pharmaceutical as well as cosmetic industries. (Krishnamurthy *et al.,* 1976) [19]. India, one of the main producers of turmeric, produces 80% of the world's output. Turmeric was produced in the amount of 389 thousand metric tonnes in the year 2018–19, with an area and productivity of 246 thousand hectares and 5646.34 kg per hectare, respectively. Turmeric was grown on 231 ha and produced 863 MT in the years 2017–2018. In the years 2018–2019, there were 253 ha of turmeric production land and 961 MT (Anonymous 2022 National Horticultural Board). India exported turmeric to 162 nations worldwide in the years 2020–21. The average amount of fresh turmeric exported between 2015–16 and 2017–18 is 7013 metric tonnes, and for the period from 2018–19 to 2020–21, it averages 6747 tonnes. Dried turmeric was exported on average in 52165 tonnes between 2015–16 to 2017–18 & 88275 tonnes between 2018–19 to 2020–21, the average amount of turmeric powder exported during 2015–16 to 2017–18 reached 39469 tonnes, and between 2018–19 to 2020–21, it reached 43971 tonnes. The average quantity of turmeric oleoresin exported via 2015–16 to 2017–18 had been 979 tonnes, as well as from 2018–19 to 2020–21, it amounted to 2071 tonnes. (Anonymous 2022. Ministry of Commerce and Industry, Government of India) Raw and dried rhizomes, turmeric powder, curcumin, and oleoresin are the main exports. Leading producers of turmeric in our nation include the states of Andhra Pradesh, Orissa, Tamil Nadu, West Bengal, Assam, Bihar, and Uttar Pradesh. Along with Bangladesh, Jamaica, Sri Lanka, Taiwan, China, Burma, Indonesia, Fiji, and Thailand, it is also widely grown in India. (Reeta *et al*., 2022) [33]. Turmeric occupies up roughly 6% of the throughout 3858 thousand hectares of land in India that is cultivated for spice

crops, and its output accounts for 9% of all spice production. The acreage and output of turmeric in India in 2019–20 were 245 thousand hectares and 939 thousand MT, respectively. Telangana, Karnataka, Maharashtra, Assam, and other states in India that cultivate a significant amount of turmeric Telangana has the largest share of these, at 37%, followed by Maharashtra, at 5%. (Nilima Darekar *et al*., 2021) [9]. Turmeric is a crucial crop in India, providing economic returns to farmers and foreign exchange to the country. A study examining turmeric export performance found that it grew significantly in quantity and value from 1990-91 to 2005-06. The powdered form accounted for 42% of global trade, followed by dry turmeric (33%), fresh turmeric (23%), and oleoresin oils (2%). The UAE was the major importer of fresh turmeric, accounting for 22% of total exports. The UK was the major destination for powdered turmeric, accounting for 17%, while the US was the largest importer of dried turmeric. The USA was the major destination for oleoresins, accounting for 17% of exports. Given an average yield of 3.73 tonnes per hectare and a production of 11, 02,000 tonnes, turmeric is cultivated on an area of roughly 2, 95,000 hectares in India. Telangana (55,443 ha), Odisha (27,864 ha), Tamil Nadu (18,296 ha), West Bengal (17,711 ha), Karnataka (17,598 ha), Assam (16,550 ha), Maharashtra (14,511 ha), and Andhra Pradesh (13,223 ha) are the major states in India that produce turmeric. About 80% of the world's output of turmeric and 60% of its exports come from India. India, Thailand, Taiwan, and numerous other South-East Asian, Central American, and Latin American nations are the main exporters of turmeric. (Nandhini *et al.*, 2023) [21]. Despite the fact that the crop exhibits significant genetic variation under the Bhavanisagar condition, research has been done to characterise and evaluate these cultivars with regard to growth, yield, and quality in terms of curcumin, essential oil, and oleoresin content among the turmeric genotypes of western Tamil Nadu in order to satisfy domestic and international market demand and to properly advise farmers.

Methods and Materials

The Turmeric Research Centre, Thoppampalayam Block of Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar, Erode district, Tamil Nadu, is where the current study was carried out. The research farm is located in the western region of Tamil Nadu, 11°29'N latitude, 77°80'E longitude, and 256m above mean sea level. June - September 2022: The monsoon season begins in June and lasts till September. Rainfall is heavy during this period, with an average of 1000 mm of rain received during the four months. Temperatures are moderate, with average highs ranging from 28 °C to 32 °C and average lows ranging from 22 °C to 25°C.Humidity levels are high, averaging around 80%. October - December 2022: The monsoon season ends in September and the post-monsoon season begins. Rainfall is less frequent and less intense during this period. Temperatures start to drop, with average highs ranging from 25 °C to 28 °C and average lows ranging from 20 °C to 22 °C. Humidity levels also start to drop, averaging around 70%. January - February 2023: The winter season begins in January and lasts till February. Rainfall is rare during this period. Temperatures are cool, with average highs ranging from 22 °C to 25 °C and average lows ranging from 18 °C to 20 °C. Humidity levels are low, averaging around 60%. The treatments comprised of 20 genotypes which were replicated thrice under Randomized Block Design (RBD). Spacing 30 x 45 cm accomadating 30 Plants. Plot size is about 3 x 2 m size.

Extraction of Curcumin

Curcumin has been extracted from turmeric using various kinds of techniques. But because its primary advantages are simple and ongoing, the Soxhlet extraction technique which combines the extraction and filtration operations into a single phase—is widely used to extract curcumin. According to the method outlined (Manjunath *et al.* in 1991) [41], the required amount of dried turmeric is added to the soxhlet extraction chamber, and 95% ethanol is then added to the flask at a ratio of 1:50. The extraction procedure involves 3 hours of reflux at 50–60 °C. Up until the mixture starts to turn a light yellow tint, extraction is kept up. The extract was filtered and dried by evaporation. The dried curcumin was collected and purified by recrystallization (Hafeena *et al*. 2017) [16].

Extraction of Oleoresin

The oleoresin content in a known quantity of sample was extracted with acetone solvent using a Soxhlet equipment. The extracted sample was then placed in an oven for two hours at 110 °C to evaporate the solvent, and the sample's weight was noted. By dividing the difference among the samples initially and final weights by the samples initial weight, expressed as a percentage, the oleoresin content was estimated (Panse *et al.*, 1967) [26].

Extraction of Essential oil

The essential oil was separated by steam distillation using Clevenger equipment. During the distillation procedure, the water and oil from the powdered turmeric were condensed. The oil and water were separated into different layers based on their differences in densities. (Nithya *et al.* 2020) [22].

Results

Significant variations for the traits, Plant height, Number of Tillers, Number of Leaves, Leaf length, Leaf width, Number of Mother rhizomes/Plant, Length of Mother rhizomes/rhizome, girth of Mother rhizome/rhizome, weight of mother rhizome/plant, Number of primary rhizome/plant, Length of primary rhizome/rhizome, girth of primary rhizome/rhizome, weight of primary rhizome/plant, Number of Secondary rhizome/plant, weight of secondary rhizome/plant, total number of fresh rhizome/plant, total weight of fresh rhizome/plant, Curcumin, essential oil, Oleoresin content were observed among the 20 genotypes (Table 1, 2, 3, 4, 5 & 6)

Table 1: Growth Parameters

Germplasm	Plant height (cm)	Number of tillers	Number of leaves	Leaf length (cm)	Leaf width (cm)
CL-27	158.39	5.68	7.33	140.13	19.22
CL-95	140.56	1.54	8.98	123.21	13.27
CL-98	158.72	1.92	8.72	149.13	18.92
CL-100	157.98	1.97	8.58	147.82	15.67
CL_118	124.43	1.65	8.71	111.28	18.13
CL-121	137.34	3.57	9.13	128.99	13.98
CL-123	134.92	5.99	8.39	123.98	14.78
CL-125	169.51	2.45	7.87	115.98	17.31
CL-197	162.98	7.78	8.57	139.45	16.23
CL-223	115.92	6.99	7.59	98.98	15.29
CL-225	162.23	4.47	8.99	148.97	15.78
CL-258	145.23	4.68	6.27	130.21	17.13
CL-272	122.13	4.99	7.59	109.12	15.23
CL-273	138.65	3.55	7.55	130.03	17.83
BSR-1	159.43	6.99	9.58	89.95	12.39
BSR-2	162.46	4.75	8.53	92.38	13.45
BSR-3	107.38	2.91	4.58	107.23	13.48
CO-2	128.72	6.99	8.98	101.98	16.78
Salem local	119.76	3.79	7.67	105.23	16.23
Erode local	119.23	3.57	6.97	107.92	16.98
SE(d)	3.2825	0.0914	0.1744	2.5498	0.3294
CD (0.05%)	6.6452	0.1851	0.3531	5.1618	0.6668
CD (0.01%)	8.9011	0.2479	0.4729	6.9141	0.8931
CV	2.85	2.60	2.66	2.60	2.54

Table 2: Characters of Mother Rhizome

Germplasm	Number of mother rhizomes/plant	Length of mother rhizomes/ Rhizome (cm)	Girth of mother rhizome/ Rhizome (cm)	Weight of mother rhizome/plant (gm)
CL-27	3.98	8.88	14.08	223.88
CL-95	4.92	11.62	17.03	211.23
CL-98	3.54	9.66	18.98	343.08
CL-100	4.99	11.86	21.09	398.38
CL_118	3.92	9.66	13.98	258.88
CL-121	3.67	9.13	10.03	190.98
CL-123	3.67	9.54	14.22	223.23
CL-125	3.78	10.23	19.05	161.21
CL-197	2.57	8.93	12.59	78.08
CL-223	3.99	8.97	15.33	133.27
CL-225	5.99	8.77	14.32	332.63
CL-258	1.64	7.63	15.23	53.18
CL-272	3.59	8.87	13.17	156.33
CL-273	4.55	8.92	13.93	225.48
BSR-1	1.76	8.98	11.23	60.87
BSR-2	3.67	8.78	13.26	88.68
BSR-3	2.94	9.67	10.29	98.88
CO-2	3.92	10.93	13.87	193.55
Salem local	1.99	9.66	13.74	65.38
Erode local	1.95	8.93	14.23	48.13
SE	0.0817	0.1746	0.3345	3.8803
CD (0.05%)	0.1655	0.3535	0.6772	7.8553
CD (0.01%)	0.2216	0.4735	0.9070	10.5221
CV	2.82	2.26	2.83	2.68

Table 3: Characters of Primary Rhizome

Germplasm	Number of primary Rhizomes/ plant	Length of primary Rhizomes/ rhizome (cm)	Girth of primary Rhizome/ rhizome (cm)	Weight of primary Rhizome/ plant (gm)
CL-27	26.89	8.31	9.68	343.17
CL-95	18.73	8.98	9.76	683.21
CL-98	46.23	9.65	9.18	433.18
CL-100	22.73	9.32	10.23	353.17
CL_118	23.73	9.13	10.33	641.27
CL-121	29.71	9.31	10.98	321.18
CL-123	23.16	8.16	9.33	362.19
CL-125	22.16	9.22	11.31	190.13
CL-197	26.73	7.14	9.52	283.19
CL-223	19.97	8.98	8.21	193.75
CL-225	27.89	9.74	10.78	657.19
CL-258	28.92	7.32	10.43	289.28
CL-272	24.16	9.17	7.54	445.29
CL-273	18.98	9.31	9.31	243.73
BSR-1	25.18	9.38	10.52	236.19
BSR-2	17.34	9.12	9.98	273.27
BSR-3	17.23	9.33	10.76	333.21
CO-2	13.12	9.04	10.91	328.19
Salem local	33.18	9.98	10.73	219.19
Erode local	22.18	9.95	10.33	215.28
SE	0.4576	0.2115	0.2158	9.1485
CD (0.05%)	0.9264	0.4283	0.4368	18.5203
CD (0.01%)	1.2410	0.5736	0.5851	24.8077
CV	2.30	2.87	2.65	3.18

Table 4: Characters of secondary rhizome

Germplasm	Number of secondary Rhizomes/ Plant	Weight of secondary Rhizome/plant (gm)
CL-27	24.42	141.28
CL-95	19.26	109.23
CL-98	15.38	105.68
CL-100	22.38	135.67
CL_118	18.11	163.21
CL-121	15.22	107.32
CL-123	23.36	149.23
CL-125	24.46	183.45
CL-197	13.26	183.45
CL-223	20.61	108.98
CL-225	19.21	161.23
CL-258	17.13	103.48
CL-272	18.41	99.47
CL-273	18.91	107.78
BSR-1	15.23	111.23
BSR-2	17.23	116.78
BSR-3	17.34	123.43
CO-2	27.43	128.54
Salem local	24.89	134.34
Erode local	23.78	120.98
SE	0.3302	3.1520
CD (0.05%)	0.6684	6.3809
CD (0.01%)	0.8953	8.5471
CV	2.04	2.98

Table 5: Characters of genotypes rhizomes

Germplasm	Total number fresh rhizomes/plant	Total weight of fresh rhizomes/plant (gm)
CL-27	55.29	708.3
CL-95	42.91	1003.7
CL-98	65.15	881.9
CL-100	50.10	887.2
CL_118	45.76	1063.4
CL-121	48.60	619.5
CL-123	50.19	734.7
CL-125	50.40	534.8
CL-197	42.56	544.7
CL-223	44.57	436.0
CL-225	53.10	1151.0
CL-258	47.69	445.9
CL-272	46.16	701.1
CL-273	42.44	577.0
BSR-1	42.17	408.3
BSR-2	38.24	478.7
BSR-3	37.51	555.5
CO-2	44.47	650.3
Salem local	60.06	418.9
Erode local	47.91	384.4
SE	0.9465	13.7906
CD (0.05%)	1.9161	27.9179
CD (0.01%)	2.5666	37.3956
CV	2.43	2.56

Table 6: Quality parameters

Germplasm	Curcumin (%)	Essential oil (%)	Oleoresin (%)
CL-27	2.98	2.56	8.32
CL-95	2.73	2.43	8.01
CL-98	3.11	3.19	9.02
CL-100	3.09	3.13	8.07
CL_118	2.78	3.16	9.01
CL-121	2.75	3.06	9.23
CL-123	2.63	2.96	9.08
CL-125	2.68	1.56	8.02
CL-197	2.48	1.98	8.13
CL-223	1.36	1.63	8.67
CL-225	1.88	1.76	8.87
CL-258	1.46	3.19	8.88
CL-272	2.16	1.87	8.83
CL-273	2.18	2.45	8.79
BSR-1	2.56	2.53	8.67
BSR-2	3.92	3.68	8.13
BSR-3	4.08	2.98	10.02
CO-2	4.23	4.38	9.81
Salem local	2.88	1.93	8.12
Erode local	2.36	1.36	8.04
SE	0.0607	0.0478	0.1925
CD (0.05%)	0.1229	0.0968	0.3898
CD (0.01%)	0.1646	0.1297	0.5221
CV	2.74	2.26	2.71

1. Performance of growth characters

The height of the plant varied from 77.11 cm (BS.73) to 38.63 cm (BS.116). The character average length was 65.10 cm. (Abbasi *et al.*, 1995) [1]. According to Jilani *et al.*, (2012) [18], the highest plant height was observed in CL-125 and CL-197, followed by BSR-2, which is 169.51 cm, 162.98 cm, and 162.46 cm, and the lowest height was recorded for BSR-3 (107.38 cm). (Tomar *et al.*, 2005) [38]. The genotype BS.9 produced 2.63 tillers per plant, which was the highest amount ever (Xiao *et al.*, 2004) [39]. The genotype SLP-389/1 had the greatest mean value and a substantially larger number of tillers per plant (3.27) than other genotypes, while PTS-12 recorded the lowest (2.08). And observed variance for the number of tillers per plant across the genotypes studied (Padmadevi *et al.*, 2012) [24]. Table 1 shows that the highest number of tillers was observed in CL197 (7.78 no's), CL-223 and BSR-1, CO-2 (6.99 no's), followed by CL-123 (5.99 no's), and the lowest tillers in CL-95 (1.54 no's), according to B.C. Deb (2016) [5], there were between 11.3 and 9.3 leaves per plant, with a mean value of 10.6 found across nine genotypes. In Table.1 shows that the highest Number of Leaves was observed in BSR-1 (9.58), CL-121 (9.13)

followed by CL225 (8.99), and the lowest number of leaves BSR-3 (4.58). (Meenakshi *et al.*, 2020) [42] observed that length of leaves between maximum length of leaf LC-T-11-18 (67.87 cm) and minimum length of leaf in LC-T-17-18 (50.20 cm). In Table.1 shows that the highest length of leaf was observed in CL 27 (149.13 cm), CL 225 (148.97 cm) followed by CL-100(147.82 cm) and the lowest length of leaf BSR-1 (89.95 cm). (Meenakshi *et al.*, 2020) [42] observed that width of leaves between maximum width of leaf LC-T-11-18 (15.07 cm) and minimum width of leaf in LC-T-17-18 (20.73 cm). Table 1 shows that the highest width of leaf was observed in CL-27 (19.22 cm), CL-98 (18.92 cm), followed by CL-118 (18.13 cm), and the lowest width of leaf BSR-1 (12.39 cm).

2. Performance of rhizome characters

Table 2 shows that the highest number of mother rhizomes per plant was observed in CL-225 (5.99), CL-100 (4.99), followed by CL-95 (4.92), and the lowest number of mother rhizomes per plant in CL-258 (1.64). (Meenakshi *et al.*, 2020) [42] observed that the length of mother rhizomes or rhizomes was observed in genotype LC-T-1-18 (12.93), while the minimum was observed in genotypes LC-T-18-18 and LC-T-20-18 (5.21); Table 2 shows that the highest length of mother rhizomes or rhizomes was observed in CL-100 (11.86 cm), CL-95 (11.62 cm), followed by CO-2 (10.93 cm), and the lowest length of mother rhizomes or rhizome was CL-258 (7.63 cm). Table 2 shows that the highest girth of the mother rhizome or rhizome was observed in CL-100 (21.09 cm), CL-125 (19.05 cm), followed by CL-98 (18.98 cm), and the lowest girth of the mother rhizome or rhizome was observed in CL-121 (10.03 cm). In Table.2 shows that Highest Weight of mother rhizome/plant was observed in CL-100 (398.38 gm), CL-98, (343.08 gm) followed by CL-225(332.63 gm), and the lowest Weight of mother rhizome/plant erode local (48.13 gm). (Meenakshi *et al.*, 2020) [42] observed that maximum number of primary rhizome were observed from genotype LC-T-19-18(9.80) while minimum in genotype LC-T-18-8 (2.27). In Table.3 shows that Highest Number of primary rhizome/plant was observed in CL-98 (46.23), Salem local (33.18), followed by CL-121 (29.71) the lowest Number of primary rhizome/plant CO-2(13.12). In Table.3 shows that Highest Length of primary rhizome/rhizome was observed in Salem local (9.98 cm), Erode local, (9.95 cm) followed by CL-225 (9.74 cm), and the lowest Length of primary rhizome/rhizome CL-197 (7.14 cm). Highest girth of primary rhizome/rhizome was observed in CL-125 (11.31 cm), CL-121(10.98 cm) followed by CO-2(10.91 cm), the lowest girth of primary rhizome/rhizome CL-272(7.54 cm). In Table.3 shows that highest Weight of primary rhizome/plant was observed incl-95 (683.21 gm), CL-225 (657.19 gm) followed by CL-118 (641.27 gm),the lowest Weight of primary rhizome/plant CL-125 (190.13 gm).In Table.4 shows that Highest Number of Secondary rhizome/plant was observed in CO-2(27.43), Salem local (24.89), followed by CL-125 (24.46),the lowest Number of Secondary rhizome/plant CL-197(13.26). In Table.4 shows that highest Weight of secondary rhizome/plant was observed in CL 125 & CL-197 are same (183.45 gm), CL-118 (163.21 gm) followed CL-123(149.23 gm), the lowest weight of secondary rhizome/plant CL-272 (99.47 gm). In Table.5 shows that highest Total number of fresh rhizome/plant was observed in CL-98 (65.15), Salem local (60.06), followed CL--27 (55.29), the lowest Total number of fresh rhizome/plant BSR-3 (37.51).Throughout all of the yield and quality features under study, a very broad range of genotype-level variation in mean performance was seen. The genotypes exhibiting strong performance in the desired direction for a variety of traits may be employed as donors to enhance the characters for which they have high mean values. (Rohit Maurya *et al.*, 2022) [34]. Table 5 shows that the highest total weight of fresh rhizome/plant was observed in CL-225 (1151.0 gm), CL-118 (1063.4 gm), followed by CL-95 (1003.7 gm), and the lowest total weight of fresh rhizome/plant in Erode Local (384.4 gm).

3. Performance of Quality Parameters

3.1 Curcumin Content: Various studies on curcumin content revealed contradictory findings and differences in curcumin levels under various agro-climatic situations (Singh *et al.*, 2013, and Geethanjali *et al*., 2016) [36, 14]. Table 6 shows that the highest curcumin content was observed in CO-2 (4.23%), BSR-3 (4.08%), followed by BSR-2 (3.92%), and CL-223 (1.36%).

3.2 Essential oil content

The percentage of essential oils ranged from 2.03 to 6.50. The highest concentration of essential oil was found in the Prabha variety (6.50%), which was comparable to the Pratibha variety (6.20%), while the lowest concentration was found in the Krishna variety (2.03%) (Shashidhar *et al.*, 2018) [37]. Table 6 shows that the highest essential oil content was observed in CO-2 (4.38%), BSR-2 (3.68%), followed by CL-258 (3.19%), and the lowest essential oil content was in Erode local (1.36%).

3.3 Oleoresin content

Oleoresin was found in the highest concentration in accession B 9 (11.35%), followed by BS 122 (10.87%) and B 29 (10.78%), while the lowest concentration was found in BS 50 (8.16%). BSR 2 has the greatest essential oil concentration (4.62%), followed by CL 101 (4.52%), and BS 9 (4.47%). Turmeric's qualitative characteristics are quite susceptible to little and large environmental changes as well as differences in agroclimatic conditions (Praneetha *et al.* 2020) [28]. In Table.6 shows that highest Oleoresin content was observed in BSR-3 (10.020%), CO-2 (9.81%) followed by CL-121 (9.23%), and the lowest Oleoresin content CL-95 (8.01%).

Conclusion

Based on the results of our study, it is clear that there was significant variation among 20 genotypes of turmeric for different yield and quality traits, but overall performance of yield in CL-225 genotype was found to be best in comparison to other genotype and quality parameters of Curcumin and essential oil is high in the variety of CO-2, and Oleoresin is highest in the variety of BSR-3, so can be promoted for further evaluation cultivation over larger area under Thoppampalayam condition.

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