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Optimization of harvesting interval in curry leaf (*Murraya koenijii* Spreng.)

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Abstract
India is called the "Botanical Garden of the World" as it contains several medicinal plants and herbs that are traditionally used to cure ailments. Curry leaf is one such plant with a wide range of medicinal properties. Twenty genotypes of curry leaves were analysed to optimise the correct harvesting maturity with respect to yield, essential oil, oleoresin and beta-carotene. A field experiment on Optimization of harvesting interval in curry leaf was conducted at Spices research field, Department of spices and Plantation Crops, HC&RI, TNAU, Coimbatore during the year 2021-2022.The experiment was laid out in FRBD with three replication and three treatments. The experimental result revealed that G10 recorded maximum yield (0.53 kg/plant), essential oil (0.25%), oleoresin (12.51%) and beta-carotene (7.81 mg/100g) content and G1 was the lowest essential oil (0.01%) yielding genotype followed by G19 with respect to oleoresin (9.91%) content. There is a significant change in the quality and yield of curry leaf with respect to harvesting interval. Among the three different harvesting intervals (H1- 2 months after pruning, H2- 3 months after pruning, H3- 4 months after pruning) H2 was the best harvesting interval to get higher yield and quality of curry leaf for all genotypes.

Keywords: curry leaf, harvesting interval, genotype, essential oil, oleoresin

Introduction
Curry leaf (*Murraya koenigii* Spreng.) is a tropical to sub-tropical tree crop that belongs to the family Rutaceae. It is a native crop of India. In certain regions of South India, curry leaves are extensively grown. Around Tamil Nadu region, a variety known as Senkaampu is produced and is well-known for its peculiar aroma (Chittaragi *et al*., 2022) [3]. As curry leaves resemble neem, they are commonly called 'sweet neem'. Curry leaves not only add flavour to the dishes but also offer numerous health benefits without any side effects.
Curry leaf majorly consist of carbohydrates, energy, fibre, calcium, phosphorous, iron, magnesium, copper, and minerals. It also contains various vitamins such as nicotinic acid, vitamin C, vitamin A, vitamin B, vitamin E, antioxidants, plant sterols, amino acids, glycosides, and flavonoids (Manohar Lal and Navjot Kaur. 2019) [9]. Due to its vast medicinal properties and nice aroma, curry leaf is widely used in various cuisines across India. Alkaloid present in the curry leaf exhibits anti-diabetic, anti-cancerous, anti-microbial and antioxidant properties. Physicians utilise the roots and bark as stimulants (Kumar *et al.*, 2013) [8]. Likewise, they are applied externally to treat rashes and toxic animal bites (Ajay *et al.*, 2011) [1]. The green leaves can be consumed raw to treat diarrhoea, and the leaves can be infused to halt vomiting. Calcium deficit could also be treated using curry leaves (Suman singh *et al.*, 2014). The main constituent of the Indian curry leaf oil conist of α -pinene, sabinene, β -pinene, α -terpinene, β-phellandrene, and terpinen-4-01 (Gopal *et al*., 1999) [5].
The present study aims to standardize the harvesting interval of curry leaves based on its yield and quality traits to get better yield and superior quality and also to identify the best performing genotype with respect to yield and quality.

Materials and Methods
An experiment was conducted during the year 2021-22 at Department of spices and Plantation Crops, Horticultural College and Research Institute, TNAU, Coimbatore. Twenty curry leaf genotypes were tested for several yield and quality parameters at three different pruning intervals (2, 3 and 4 months after pruning) in order to standardise the ideal harvesting interval to improve yield and quality. As per the recommended schedule 150:25:50 kg / ha / year NPK was given in three split doses after each harvest. According to some standard procedures different biochemical parameters are estimated and subjected to statistical analysis (SPSS).

Leaf yield per plant (Kg/plant)
The crop was harvested at a height of 30 cm from the ground level at 3 different harvesting intervals (2, 3 and 4 months after pruning). The fresh leaf yield per plant was weighed and recorded using electronic balance and it is expressed in kilograms (kg) per plant.

Triple acid mixture preparation
A triple acid mixture was used to evaluate the mineral content present in the sample. 0.5 g of the sample was put into a 100 ml conical flask along with a 9:2:1 mixture of strong nitric, sulphuric, and perchloric acids. Following that, the flask was sealed with a funnel and left in a sand bath until the sample solutions turns translucent white. Then, No. 41 Whatman filter paper was used to filter the clear solution. The sample volume was made up to 100 ml with distilled water after filtering. The solution is further used for the estimation of nutrients.

Essential oil (%)
The method recommended by ASTA was used to estimate the essential oil content (Anonymous, 1997). Forty grams of curry leaves were weighed and it is feed into the oil extraction unit (Clevenger's apparatus). The temperature was maintained at 90°C till boiling and afterward 70°C was sustainably maintained for 6 hours till the distillation ends. The volume of the oil was measured and the total oil content was calculated using the formula.

$$\text{Essential oil (\%) (v/w)} = \frac{Volume\ of\ oil\ (ml)}{Weight\ of\ sample(g)} \text{x100}$$

Oleoresin (%)
Sieved dry curry leaf powder (5g) were put into non-absorbent cotton-blocked glass columns. A glass column was filled with 30 ml of acetone, which was then allowed to percolate down into it and kept for overnight. Then, the soluble extract was drained off into a 100 ml beaker that had been previously weighed. The residue was again washed with 100 ml of acetone, and all of the extracts were combined before even being combined and evaporated to almost dryness. The final weight was then recorded.

$$\text{Oleoresin (\%)} = \frac{W2-W1}{Initial\ weight\ of\ the\ sample} \text{ x 100}$$

Where,
W1= Weight of the empty beaker
W2= Weight of the beaker with air dried oleoresin

β –carotene (mg/100g)
One gram of the sample was ground with a small quantity of acetone using a mortar and pestle. The acetone extract was then transferred to a separating funnel already having 20 ml of petroleum ether and gentle mixing was done. Then 5% of sodium sulphate (20 ml) solution was added to the mixture. After gentle shaking the upper layer was removed and the lower layer was reextracted. Then the extract was washed with distilled water. To that extract anhydrous sodium sulfate (10g) and kept undisturbed for the period of 20 minutes. Then the extract was observed under spectrophotometer at 453 nm for absorbance using petroleum ether as a blank (Goulden *et al.*, 1934) [6]. The calculated value was expressed as mg/100g of sample.

$$\text{B-carotene (mg/100g)} = \frac{1\ X\ \text{absorbance value x total volume of the extract (ml) x 100}}{0.2592 \text{ x weight of the sample x 100}}$$

Statistical analysis
The data were subjected to statistical computer package of SPSS and the treatment means are separated using L.S.D. and Duncan multiple range test at $P<0.05$ level.

Result and discussion
Leaf yield per plant
In the present study, the data on total fresh yield per plant was critically reviewed. It reveal that the individual effect of harvesting interval, genotype, two way interaction of genotype x harvesting interval showed a significant difference in the fresh leaf yield/plant.
In the first harvesting interval (H1) (2 months after pruning) G10 was recorded with highest leaf yield per plant (0.5 kg / plant) followed by (0.46 kg/ha) and G4, G6 AND G8 (0.39 kg/ha) was on par with each other while the lowest yield was observed on G13 (0.23 kg/plant) followed by G20 (0.24 kg/Plant).
In the second harvesting interval (H2) (3 months after pruning) G10 recorded the highest leaf yield per plant (0.52 kg/plant) followed by G12 (0.49 kg/ plant), G6 and G8 was on par with each other (0.42 kg/ plant) and the lowest yield was observed in G20 (0.27 kg/plant).
In the third harvesting interval (H3) (4 months after pruning) G10 was noted with highest leaf yield per plant (0.53 kg/plant) and it is followed by G12 (0.51 kg/ plant). The lowest leaf yield was recorded on G 20(0.30 kg/plant) (Nirpendra *et al.*, 2011) [10].
The interaction shows that the high leaf yield was recorded on G10 (0.53 kg/plant) during the third harvesting interval (4 months after pruning). In all three harvesting intervals, G10 was recorded with the highest fresh leaf production per plant out of the 20 genotypes.

Essential oil (%)
The difference in the essential oil recovery percent was critically analyzed at different harvesting intervals. High essential oil content was recorded with G10 (0.2%, 0.25% and 0.18% at 2, 3 and 4 months after pruning) respectively followed by G12 (0.19%.0.22% and 0.2% at 2, 3 and 4 months after pruning) respectively. G4 was on par with G19 (0.15% and 0.19%) in H1 and H2 respectively. The low quantity of essential oil was observed in G1 (0.01%, 0.05%, 0.04 % at 2, 3 and 4 months after pruning) respectively (Haileslassie *et al.*, 2014) [7].

Oleoresin
The high amount of oleoresin was observed with G10 **(**11.71 to 12.51%) at H1 (2 months after pruning) to H2 (3 months after pruning) followed by G12 (11.09%, 11.95%, 11.21%) at H1, H2 and H3 respectively. The lowest oleoresin content was recorded in G19 (9.91%, 10.03% and 9.93% at H1, H2

and H3) respectively (Oliveira.2012) [4].

β –carotene

In this study, the data on Beta-carotene content was analyzed critically which shows that there is a significant difference among the genotypes and harvesting interval but the interaction between the genotype and harvesting interval was not significant. The highest range of beta carotene was recorded in G10 (7.31, 7.81 AND 7.51mg) at H1, H2 and H3 respectively while the lowest range of beta carotene was recorded in G1 (6.81mg/100g) in H1 followed by G13 (7.03 mg/100g) and G18 (7.04 mg/100g) which is on par with each other in H2 (Sivanna *et al*., 2013).

Effect of Harvesting Interval on yield and quality of curry leaf

Genotypes (G)	Harvesting interval (H)											
	Yield /plant (kg)			Essential oil (%)			Oleoresin (%)			β-Carotene		
	H1	H2	H3	H1	H2	H3	H1	H2	H3	H1	H2	H3
G1	0.32	0.35	0.4	0.01	0.05	0.04	10.6	11.71	11.5	7.01	7.32	7.21
G2	0.29	0.31	0.37	0.1	0.12	0.1	10.75	11.82	11.23	6.89	7.08	6.98
G3	0.37	0.39	0.41	0.17	0.20	0.18	11.10	11.29	11.01	6.92	7.12	7.02
G4	0.39	0.41	0.43	0.15	0.19	0.17	10.31	10.75	10.51	7.01	7.33	7.22
G5	0.37	0.40	0.42	0.04	0.09	0.07	10.51	10.7	10.31	7.21	7.43	7.21
G6	0.39	0.42	0.45	0.13	0.17	0.15	10.6	10.85	10.58	6.97	7.21	7.02
G7	0.37	0.39	0.4	0.05	0.08	0.06	10.13	10.5	10.09	7.15	7.52	7.24
G8	0.39	0.42	0.44	0.09	0.12	0.1	10.03	10.15	10.01	7.2	7.61	7.31
G9	0.37	0.38	0.39	0.03	0.07	0.05	10.15	10.39	10.21	6.97	7.22	6.97
G10	0.50	0.52	0.53	0.2	0.25	0.18	11.71	12.51	11.98	7.31	7.81	7.51
G11	0.30	0.32	0.36	0.11	0.14	0.12	10.07	10.85	10.71	6.93	7.29	6.92
G12	0.46	0.49	0.51	0.19	0.22	0.2	11.09	11.95	11.21	7.05	7.56	7.23
G13	0.23	0.27	0.29	0.08	0.12	0.11	11.31	11.65	11.05	6.84	7.03	6.81
G14	0.38	0.41	0.43	0.12	0.14	0.12	10.41	10.81	10.32	7.09	7.46	7.09
G15	0.30	0.32	0.35	0.07	0.11	0.09	10.65	10.71	10.22	6.83	7.14	6.94
G16	0.27	0.29	0.31	0.1	0.13	0.12	10.05	11.51	10.95	6.97	7.31	7.07
G17	0.28	0.3	0.32	0.06	0.1	0.09	11.09	11.23	10.77	6.81	7.07	6.96
G18	0.41	0.43	0.45	0.13	0.17	0.14	10.25	11.92	11.06	6.82	7.04	6.92
G19	0.25	0.28	0.31	0.08	0.12	0.09	9.91	10.03	9.93	7.05	7.28	7.04
G20	0.24	0.27	0.3	0.15	0.19	0.16	11.01	11.9	11.52	7.03	7.26	7.03
Mean	0.34	0.37	0.39	0.10	0.14	0.12	10.59	11.16	10.76	7.00	7.30	
SE(d) G	0.15			0.002			0.13			0.09		
SE(d) H	0.06			0.001			0.05			0.03		
SE(d) G*H	0.25			0.004			0.23			0.15		
CD G	*0.29			*0.004			*0.26			*0.17		
CD H	*0.11			*0.002			*0.10			*0.07		
CD G*H	*0.50			*0.008			*0.46			NS		
NS - Non significant, * - Significant												

Conclusion

The experimental result revealed that the interaction between the genotype and harvesting interval shows a significant difference in all the parameters except Beta-carotene. There is a significant difference in the yield with respect to the harvesting interval. With the mean data G10 was concluded as the high leaf yielding genotype per plant and G20 was the low yielding genotype. There was a significant increase in oleoresin content from 11.71 to 12.51% at H1 TO H2 (2 to 3 months after pruning) was recorded in G10**.** Among the genotypes G10 was the best genotypes with respect to yield and quality of the essential oil and G1 was the lowest essential oil yielding genotype. Thus it was concluded that G1 was the best performing genotype with respect to all traits and H2 (3 months after pruning) was the significant pruning interval to get higher yield and quality. With prolonged harvesting interval the quality of the curry leaf get decreased accordingly.

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Conflict of interest: None

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