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NEW VARIETY RELEASE

Registration of high oil-yielding lemongrass *(Cymbopogon flexuosus* Steud.) Wats Variety: CIM–Krishnapriya

CHANNAYYA H*[1] • NAGEGOWDA DA[1] • BASKARAN K[1] • VERMA RS[2] • SUNDARESAN V[1], GUPTA P[1] • ASHWINI KV[1] • SINGH S[2] • SWAMY GOWDA MR[1] • JNANESHA AC[3] • TRIVEDI PK[2]

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ABSTRACT

Lemongrass, a highly aromatic herb rich in citral content within its essential oil, serves diverse industries like fragrance, culinary, pharmaceuticals, and cosmetics. Traditional Indonesian cuisine benefits from its use as a spice, while it also contributes to Vitamin A production. Forecasts indicate a projected Compound Annual Growth Rate (CAGR) of 9.93% from 2021 to 2028, propelling the global lemongrass oil market from $41.98 million to $81.43 million. CSIR-CIMAP has diligently focused on advancing lemongrass cultivation and oil extraction through novel cultivars and agrotechnologies. Their efforts aim to elevate farmer income and cater to escalating lemongrass oil demands. A breakthrough cultivar, "CIM-Krishnapriya," has been introduced, poised to amplify lemongrass oil yield and subsequently augment farmers' earnings. This new cultivar boasts an herb yield of 25-30 t/ha and an oil yield of 300-320 kg/ha.

INTRODUCTION

Lemongrass (*Cymbopogon flexuosus* Steud., Wats) is a fragrant tropical perennial grass belonging to the Poaceae family. Its distinct lemony aroma has garnered it widespread recognition across industries for its aromatic and therapeutic properties. The prominent molecule in lemongrass, citral, plays a pivotal role in its fragrance and holds diverse applications in the fragrance, culinary, pharmaceutical, and cosmetic sectors. Responsible for the zesty citrus scent associated with lemongrass, citral possesses potential therapeutic attributes (Pinder, 1960). In the realm of traditional Indonesian cooking, lemongrass is a cherished spice that enhances the flavor and aroma of dishes. Beyond its culinary role, lemongrass contributes to Vitamin A production. Enriched with compounds that serve as precursors to vitamin A synthesis, lemongrass becomes a valuable asset in promoting health and nutritional well-being. Extracting essential oil from lemongrass yields a highly fragrant substance that infuses various products with its captivating scent. Soaps, detergents, and insect-repellent formulations benefit from its potent and pleasant aroma, elevating their appeal (Bhatnagar, 2020; Alam *et al*., 1994; Ganjewala *et al*., 2012; Mukarram *et al*., 2022). A core application of lemongrass oil revolves around its citral content. This compound extracted from lemongrass finds utilization in perfumes, cosmetics, and beverages, introducing a revitalizing citrus note to these commodities (Ganjewala *et al*., 2013).

[1]CSIR - Central Institute of Medicinal and Aromatic Plants, Research Centre, Bangalore, India
[2]CSIR-Central Institute of Medicinal and Aromatic Plants, P.O CIMAP, Lucknow, India
[3]CSIR - Central Institute of Medicinal and Aromatic Plants, Research Centre, Hyderabad, India
Institutional Communication Number: CIMAP/PUB/ 2023/107.
Corresponding author, Email: channayyahiremath@cimap.res.in
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Lemongrass predominantly thrives in tropical and subtropical regions across Southeast Asia and Africa. While it once occurred naturally in India a hundred years ago, it is now commercially cultivated across various states in the country (Rangari, 2009). Notable Indian states engaged in the commercial growth of lemongrass encompass West Bengal, Assam, Uttar Pradesh, Maharashtra, Kerala, Karnataka, Andhra Pradesh, and Tamil Nadu. The global market for lemongrass oil is currently on an upward trajectory and is poised to sustain its expansion. As per an undisclosed source in 2022, the projected Compound Annual Growth Rate (CAGR) for the global lemongrass oil market hovers around 9.93% between 2021 and 2028. This progressive momentum is forecasted to drive the market value from $41.98 million in 2021 to an estimated $81.43 million by 2028 (Anonymous, 2022). In India, around 1,000 tonnes of lemongrass oil is produced annually to meet both domestic consumption and export demands. The CSIR-Central Institute of Medicinal and Aromatic Plants has been involved in research and development efforts related to lemongrass enhanced cultivation agrotechnology and introduced improved cultivars, including varieties such as Cauvery, Krishna, and CIM-Shikar.

We are delighted to introduce our ground-breaking lemongrass variety, CIM-Krishnapriya, which boasts a remarkable enhancement in oil yields compared to previously cultivated variants. This new lemongrass variety presents a noteworthy breakthrough, demonstrating oil yields ranging from 1.10% to 1.30% on a commercial scale. This achievement stands in stark contrast to the conventional varieties that typically yield between 0.4% and 0.8% oil. This advancement holds immense promise for both farmers and the industry at large. The augmented oil yields signify a significant stride in production efficiency, potentially translating to heightened revenues for farmers. Moreover, the industries reliant on lemongrass oil as a fundamental raw material are likely to view this novel variety with great enthusiasm. The elevated yield potential not only contributes to potential cost savings but also offers the prospect of improved product quality. This innovation thus heralds a positive transformation within the agricultural and industrial landscape.

The successful development of this new lemongrass variety demonstrates the value of agricultural research and innovation in enhancing crop productivity and addressing industry needs. It also underscores the importance of ongoing efforts to improve agricultural practices and develop new varieties to meet the evolving demands of various sectors. As this new variety becomes more widely adopted and integrated into commercial cultivation, it has the potential to make a significant impact on the lemongrass industry and contribute to its growth and sustainability.

Origin of Variety CIM-Krishnapriya

The development of the CIM-C4-C-6 (CIM - Krishnapriya) lemongrass clone is the result of a systematic breeding program aimed at enhancing oil content through recurrent selection. The process involved several steps over the years, and the final clone demonstrated impressive performance. The breeding process and the characteristics of the CIM-C4-C-6 clone: The breeding program began with open-pollinated SD-68 seeds, which served as the starting population. Dr R N Kulkarni initiated the process by generating diverse populations from Cycle 1 to Cycle 4 using SD-68 as a parent over the period from 1982 to 2012.

Cycle 4 Population Selection

In 2017, open-pollinated seeds were collected from the Cycle 4 population. From this population, 1450 individual plants were tested for oil content in the year 2017-18. 11 plants were selected based on their high oil content, ranging from 2.00% to 2.80% (measured using the Clevenger apparatus). Initial Evaluation Trial (IVT): The 11 selected plants were planted in rows for the initial evaluation trial (IVT) in the year 2018-19.

Advanced Varietal Trials (AVT)

From the 11 plants, six clones were chosen for further testing in advanced varietal trials (AVT) from 2019 to 2021.

Performance of CIM-C4-C-6 (CIM-Krishnapriya)

Among the six clones tested, the CIM-C4-C-6 clone (CIM-Krishnapriya) demonstrated superior performance in both IVT and AVT experiments. Pilot Scale Trial (PST) and Comparative Analysis: In 2022, the CIM-C4-C-6 clone was evaluated in a

pilot scale trial (PST) alongside the control varieties Krishna and CIM-Shikar. The CIM-C4-C-6 clone consistently outperformed both Krishna and CIM-Shikar by a significant margin of at least 30-40% across all experiments.

Citral Content and Oil Yield

The average citral concentration in CIM-C4-C-6 ranged from 78% to 82% across all trials, surpassing the minimal 70% citral content required by ISI guidelines. The successful development of the CIM-C4-C-6 (CIM - Krishnapriya) clone showcases the effectiveness of the breeding program in achieving higher oil content and superior performance compared to existing varieties. The significant improvement in oil yield and citral content holds promise for enhancing both the productivity of lemongrass cultivation and the quality of derived products in various industries.

Initial Evaluation Trial

The initial evaluation study of lemongrass clones involved the examination of eleven different clones along with two control varieties over the period from 2018 to 2020. Following this evaluation, six clones were selected from the initial pool of eleven based on criteria such as oil output, herb yield, and morphological characteristics. These selected clones were then advanced to the advanced varietal trial (AVT) phase, which took place from 2019 to 2021. The process was aimed to identify and further assess the performance of the most promising lemongrass clones for potential commercial cultivation and utilization.

Table 1 provides detailed information about the selected clones, their attributes, and their performance in the initial evaluation study, as well as the criteria that contributed to their advancement to the AVT phase. This step reflects a strategic and systematic approach to lemongrass breeding, focusing on traits that are important for enhancing oil yield, herb yield, and overall plant characteristics.

The progression of clones from the initial evaluation phase to the advanced varietal trial phase demonstrates a careful and rigorous selection

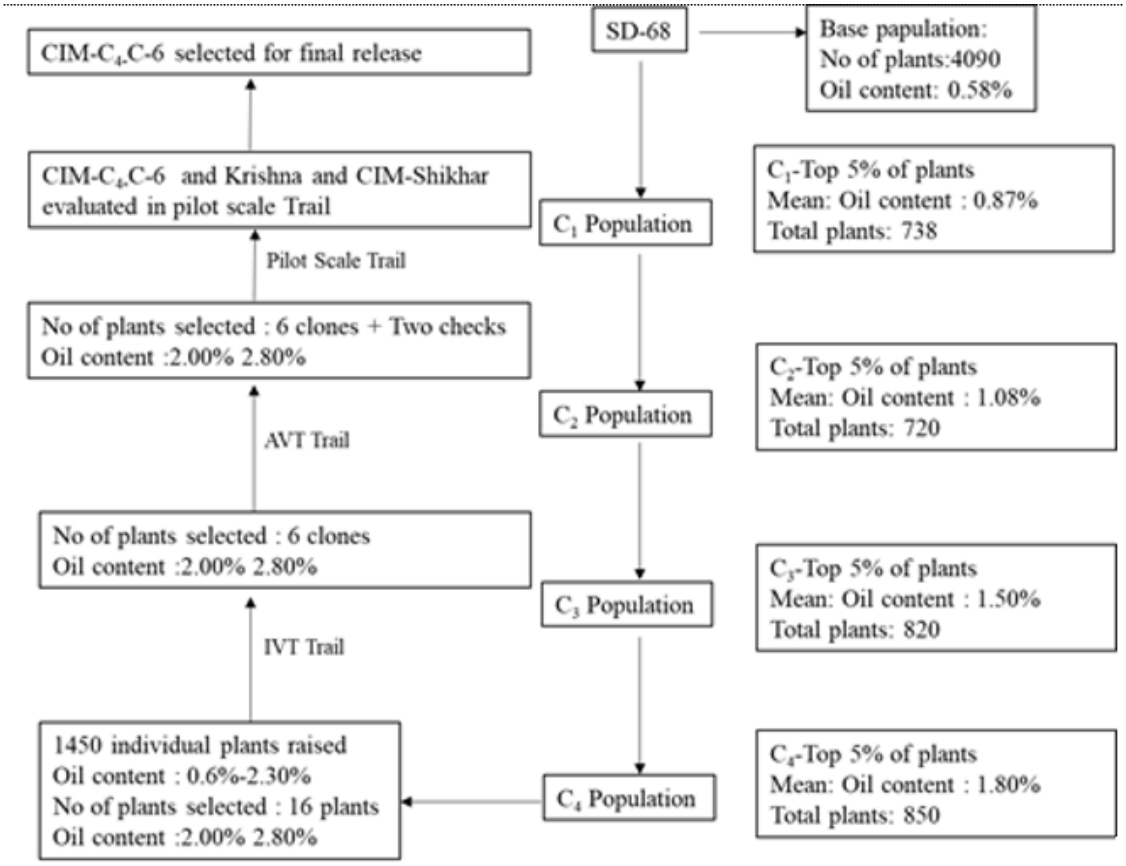

Figure 1: Flow chart showing breeding methodology used in proposed strain development

Table 1: Comparative Performance of selected clones and check varieties of lemongrass in Initial Varietal Trials for herb yield and Oil content (%) across the year (The year 2018-20)

LINES	Herbage Yield (g/clump)				Oil Content (%)			
	I Year		II Year		I Year		II Year	
	I	II	I	II	I	II	I	II
B1 5-2	728.20	870.00	874.8	736.00	2.50	2.46	2.33	2.43
B1 5-3	776.10	996.80	786.56	800.10	2.50	2.48	2.29	2.48
B1 1-2	1312.00	1140.10	1378	1309.00	2.60	2.52	2.42	2.48
B2 4-3	854.10	1096.60	1155.8	998.90	2.25	2.18	2.35	2.40
B2 6-4	1114.00	1250.40	1219.6	1130.80	2.50	2.52	2.43	2.43
B3 3-1	540.00	1000.00	734.6	601.30	2.60	2.46	2.32	2.53
B3 2-1	438.00	563.30	1322	550.50	2.55	2.52	2.35	2.48
B3 1-3	582.00	666.70	705.2	607.60	2.40	2.20	2.25	2.50
B4 4-2	752.50	996.00	647.2	545.60	2.30	2.42	2.265	2.30
B4 1-1	515.90	523.30	887.6	808.80	2.50	2.23	2.43	2.40
B5 7-2	430.10	1083.30	545.2	510.10	2.40	2.15	2.27	2.45
Krishna	1360.00	1596.60	1099.7	1035.40	1.70	1.68	1.52	1.45
Shikhar	728.10	953.30	649	612.50	2.26	1.51	1.64	1.68
CD (1%)	**206.03**	**132.92**	**17.37**	**456.64**	**0.18**	**0.13**	**0.21**	**0.33**
CD (5%)	**146.95**	**94.81**	**12.39**	**325.70**	**0.13**	**0.09**	**0.15**	**0.23**
Sem (±)	**47.69**	**30.77**	**4.02**	**105.69**	**0.04**	**0.03**	**0.05**	**0.08**

Table 2: Comparative Performance of selected clones and check varieties of lemongrass in Initial Varietal Trials for yield contributing traits (The year 2018-19)

LINES	Plant Height (cm)			Number of Tillers			Canopy (cm)			Leaf Length (cm)			Leaf Width (cm)		
	R1	R2	Mean	R1	R2	Mean	R1	R2	Mean	R1	R2	Mean	R1	R2	Mean
B1 5-2 (C1)	114.70	126.20	132.20	46.00	61.00	64.00	90.30	95.30	97.30	88.30	98.30	105.55	1.16	1.16	1.10
B1 5-3 (C2)	106.50	118.00	124.00	41.50	56.50	59.50	89.00	94.00	96.00	87.50	97.50	101.60	1.06	1.06	1.07
B1 1-2 (C4)	111.00	122.50	128.50	45.60	60.60	63.60	89.10	94.10	96.10	87.10	97.10	103.35	1.07	1.07	1.04
B2 4-3	114.00	125.50	131.50	36.00	51.00	54.00	74.60	79.60	84.50	91.70	101.70	101.83	1.18	1.18	1.13
B2 6-4 (C6)	105.80	117.30	123.30	42.40	57.40	60.40	71.30	76.30	90.70	86.90	96.90	103.20	1.10	1.10	1.10
B3 3-1 (C3)	109.70	121.20	127.20	39.00	54.00	57.00	72.50	77.50	79.50	87.60	97.60	101.55	1.18	1.18	1.21
B3 2-1	113.00	124.50	130.50	24.10	39.10	42.10	62.00	67.00	69.00	90.00	100.00	103.70	1.20	1.20	1.16
B3 1-3	123.00	134.50	140.50	33.30	48.30	51.30	55.70	60.70	62.70	92.40	102.40	104.80	1.11	1.11	1.11
B4 4-2	103.40	114.90	120.90	27.00	42.00	45.00	72.20	77.20	79.20	82.00	92.00	97.90	1.06	1.06	1.09
B4 1-1 (C5)	116.00	127.50	133.50	35.00	50.00	53.00	70.00	75.00	86.20	90.80	100.80	105.60	1.14	1.14	1.14
B5 7-2	118.80	130.30	136.30	40.50	55.50	58.50	75.20	80.20	82.20	86.00	96.00	99.80	1.16	1.16	1.16
Krishna	186.00	197.50	168.80	49.70	64.70	67.70	97.63	100.90	101.80	128.30	127.00	130.30	1.45	1.45	1.42
Shikhar	129.44	136.30	141.20	37.10	50.00	53.00	64.14	77.08	85.60	95.90	101.40	104.60	1.18	1.21	1.22
CD (1%)	10.16	10.67	6.65	4.35	4.40	4.40	10.97	11.97	11.91	5.69	13.89	9.70	0.29	0.29	0.31
CD (5%)	7.24	7.61	4.74	3.10	3.14	3.14	7.82	8.54	8.49	4.06	9.91	6.92	0.21	0.20	0.22
Sem (±)	2.35	2.47	1.54	1.01	1.02	1.02	2.54	2.77	2.76	1.32	3.22	2.24	0.07	0.07	0.07

Six selected clones were named as follows B1 5-2 -C1, B1 5-3 -C2, B3 3-1-C3 B1 1-2-C4, B4 1-1-C5, B2 6-4-C6
Layout: RCBD, Replication: Two Plot Size: 3 sqm
Date of Planting: 03-11-2018, Date of harvest first harvest: 7 months after planting-10-06-2019, Second Harvest: 3 months after planting-15-08-2019, Third Harvest:20-11-2019, Fourth Harvest:18-02-2020.

Table 3: Performance of CIM-Krishnapriya and check varieties of lemongrass in Advance Varietal Trials (AVT) (The year 2019-21)

LINES	Herb yield (g/plant)				Oil content (%) (Clevenger Distillation)			
Harvests	I Year		II Year		I Year		II Year	
	I	II	III	IV	I	II	III	IV
C1	473.30±103.17	422.30±24.08	408.20±21.48	738±17.14	2.15±0.02	1.80±0.01	2.15+0.04	2.00±0.02
C2	606.90±102.82	864.70±43.47	864.80±43.47	704.8±43.47	2.21±0.03	1.84±0.02	2.21+0.02	2.04±0.04
C3	423.55±35.79	562.20±81.64	562.07±81.63	803±81.63	2.12±0.01	1.80±0.05	2.01+0.03	1.82±0.03
C4	524.90±77.53	682.20±31.06	631.30±59.35	673±30.45	2.01±0.05	1.78±0.01	2.03+0.03	2.14±0.03
C5	439.90±45.66	538.10±4.68	538.23±4.67	612±8.14	1.89±0.09	1.85±0.04	1.91+0.12	2.02±0.02
CIM-Krishnapriya	**383.30±33.33**	**873.40±6.93**	**658.30±13.10**	**882±18.87**	**2.34±0.01**	**1.95±0.06**	**2.33+0.17**	**2.06±0.02**
Krishna	444.40±11.54	1156.00±3.46	950.50±14.44	819.2±76.78	1.35±0.02	1.30±0.01	1.35+0.01	1.25±0.01
Shikar	438.60±14.89	412.00±10.39	402.16±4.62	659±4.61	1.41±0.04	1.23±0.03	1.41+0.04	1.21±0.04
CD (1%)	173.57	222.31	154.72	201.25	0.37	0.21	0.10	0.14
CD (5%)	125.06	169.75	111.48	145.00	0.27	0.18	0.07	0.10
CV (%)	15.29	11.13	9.24	13.22	7.98	7.25	2.54	3.19

Note: C6-CIM-C4-C-6 CIM-Krishnapriya, Lab level oil content data, 1. Design: RCBD, Replication:3 Treatments: 8, Plot size: 12.96 m^2

Table 4: Performance of CIM-Krishnapriya and check varieties of lemongrass in Advance Varietal Trials (AVT) for yield contributing traits (The year 2019-21)

LINES	Plant Height (cm)				Canopy (cm)				Number of Tillers				Leaf Length (cm)				Leaf Width (cm)			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
C1	130.90	117.27	130.80	192.33	40.80	54.10	42.80	47.13	41.55	83.50	56.70	97.00	97.37	107.80	98.00	151.60	1.32	0.73	1.42	1.13
C2	145.40	110.93	144.90	183.00	43.60	55.70	60.70	62.73	56.00	83.00	61.07	106.40	104.72	96.53	107.47	125.87	1.41	0.80	1.44	1.17
C3	137.55	124.60	135.10	184.20	36.10	58.60	50.20	54.53	41.00	84.00	55.97	101.40	100.77	109.07	103.33	146.73	1.36	0.85	1.35	1.37
C4	140.10	115.60	138.09	178.47	39.10	67.10	44.54	62.73	41.60	84.50	53.03	104.27	107.33	97.47	113.73	139.13	1.33	0.77	1.37	1.44
C5	136.10	106.87	136.00	189.67	38.20	77.10	52.30	54.00	45.20	82.90	56.00	93.40	106.62	93.80	109.07	130.07	1.40	0.75	1.42	1.58
CIM-Krish-napriya	145.80	110.20	145.67	194.33	38.20	97.00	42.40	57.33	41.05	75.80	52.97	75.80	110.43	100.33	109.07	151.13	1.36	0.73	1.36	0.87
Krishna	153.30	133.40	152.87	211.73	44.20	75.40	44.00	56.60	43.05	89.80	57.37	92.10	120.12	120.07	118.73	166.67	1.41	0.85	1.45	1.09
Shikhar	128.50	115.27	128.87	189.47	39.60	62.90	43.40	54.13	45.00	85.10	51.80	86.48	102.42	106.87	115.33	141.27	1.41	0.84	1.40	1.19
CD (1%)	7.09	20.95	8.04	11.12	9.38	6.33	18.60	3.38	10.94	13.45	12.84	10.49	10.24	7.36	10.15	11.04	0.06	0.23	0.11	0.23
CD (5%)	5.11	15.10	5.79	8.01	6.76	4.56	13.40	2.44	7.88	9.69	9.25	7.56	7.38	5.31	7.31	7.95	0.04	0.17	0.08	0.16
Sem (±)	1.68	4.98	1.91	2.64	2.23	1.50	4.42	0.80	2.60	3.19	3.05	2.49	2.43	1.75	2.41	2.62	0.01	0.06	0.03	0.05

Date of planting -3/11-2019, First Harvest: 14-06-2020, Second Harvest: 02-09-2020, Third Harvest: 4-03-2021, Fourth Harvest: 13-06 2021

Table 5: Performance of CIM-Krishnapriya and check varieties of lemongrass in Advance Varietal Trials (AVT)

Lines Harvests	Plot Yield (Kg)				Oil yield (ml) (Asvika Distillation)				Oil content (%)			
	I Year		II Year		I Year		II Year		I Year		II Year	
	I	II	III	IV	I	II	III	IV	I	II	III	IV
C1	16.07±2.44	14.13±1.290	20.00±0.58	48.50±1.04	208.21±31.63	240.03±34.77	284.67±8.37	687.32±3.06	1.30	1.67	1.42	1.35
C2	19.49±0.86	14.90±0.195	18.83±0.60	37.33±0.88	324.80±14.32	258.18±02.71	230.33±7.54	494.92±1.86	1.67	1.72	1.22	1.32
C3	18.57±0.57	14.25±0.032	18.30±0.62	40.50±0.50	422.20±13.03	244.64±03.15	273.33±9.21	494.18±9.33	2.27	1.68	1.50	1.29
C4	22.34±2.04	18.57±0.718	17.60±0.55	44.00±0.58	336.86±30.67	340.68±21.25	286.00±8.72	540.25±3.71	1.51	1.80	1.62	1.26
C5	18.73±2.12	15.74±0.918	15.87±0.69	37.17±1.17	309.50±34.93	252.40±24.08	258.33±11.32	438.48±19.17	1.65	1.60	1.70	1.26
CIM-Krishnapriya	**22.19±2.55**	**18.35±0.571**	**17.88±2.14**	**51.67±0.33**	**308.66±35.42**	**318.65±41.00**	**380.67±45.78**	**715.44±1.45**	**1.39**	**1.73**	**2.10**	**1.32**
Krishna	17.55±3.42	27.65±0.867	18.67±0.44	48.83±0.73	187.00±36.37	230.24±08.37	171.33±4.10	410.38±4.18	1.07	0.84	0.88	0.87
Shikar	16.90±0.87	14.611±0.635	15.28±1.15	44.00±0.50	137.73±07.09	140.53±20.45	168.00±12.49	383.15±14.38	0.82	1.00	1.10	0.92
CD (1%)	6.48	4.04	2.91	3.33	92.75	67.91	60.80	40.50				
CD (5%)	4.67	2.91	2.10	2.40	66.83	48.93	43.80	29.18				
Sem (±)	1.54	0.96	0.69	0.79	22.03	16.13	14.44	20.11				

Note: Data shown for oil yield derided from 30 kg distillation Unit, Design: RCBD, Replication: 3 Treatments

Table 6: Performance of CIM-Krishnapriya and check varieties of lemongrass in Pilot Scale Trial (Year 2022)

Lines	Herb Yield (kg/100 m²)	Herb Yield (t/ha/year) estimated	Oil Yield (kg/ha/year) estimated
CIM-Krishnapriya	136.75	25-35	300-320
Krishna	142.78	25-36	220-240
Shikar	112.24	20-25	240-260
SEm ((±))	9.53	3.51	24.03

Note: Herb yield and oil yield per ha per year are estimated data. Bed Size: 100m² each clone repeated 4 times

Table 7: Description of the new variety CIM-Krishnapriya

Attributes	CIM-Krishnapriya	Krishna	CIM-Shikhar
Plant height (cm)	193.50±3.55	217.50±4.25	189.47±9.66
Leaf Length (cm)	151.13±4.03	166±5.15	115.33±3.15
Leaf Width (cm)	0.87±0.06	1.09±0.08	1.20±0.11
Growth habit	Semi-erect to drooping	Erect to semi-erect	semi erect
Leaf color	Dark green	Dark green	Dark green
Stem	Purple	Purple	Purple
Herb yield (t/ha/year) (estimated)	29.5±2.12	30.5±1.53	24±1.45
Oil content (%) (Clevenger)	2.17±0.09	1.31±0.02	1.41±0.001
Oil content (%) (30 kg capacity unit)	1.63±0.17	0.91±0.05	0.97±0.05
Oil yield (kg/ha/year) (estimated)	310±1.5	230±1.64	245±1.08
Citral (%) (30 kg capacity unit)	79.52±1.25	76.50±1.34	84.12±0.08

Table 8: Physical properties and citral content of CIM-Krishnapriya and check varieties of Lemongrass essential oils

Sample code	Relative density (20.6 °C)	Optical rotation (20.0 °C)	Refractive index (20.0 °C)	Solubility in ethanol, 70 % (mL) (volume fraction) (22.5 °C)	Citral (%) †
CIM-Krishnapriya	0.8889-0.8903	-3.20°-3.78°	1.4851-1.4850	1.4 -2.6	78.69-80.58
Krishna	0.8873-0.8877	-2.48°-3.12°	1.4849-1.4855	1.3 -2.2	75.56-79.50
Shikar	0.8877-0.8938	-0.80°-1.21°	1.4857-1.4867	1.4 -2.4	80.52-84.90
ISO 4718[a]	0.885-0.9050	−4°-+1°	1.483-1.489	Not > 3.0	60-82

†Neral + Geranial; [a]ISO (20.0 °C);

Table 9: Chemical profile of CIM-Krishnapriya and check varieties of lemongrass essential oil.

Sample	Component (%)						
	Limonene	6-Methyl-5-heptene-2-one	β-Caryophyllene	Neral	Geranial	Geranyl acetate	Geraniol
CIM-Krishnapriya	0.32-0.76	0.42-0.59	1.22-1.50	31.15-32.70	45.99-48.0	0.5-1.00	2.69-7.5
Krishna	0.32-0.81	0.41-0.69	0.85-1.70	32.14-33.11	451-46.39	0.6-1.56	2.93-7.2
Shikar	0.03-0.46	0.55-0.72	0.28-1.56	31.95- 35.28	49.62-51.1	0.6-1.01	1.30-5.0
ISO 4718	0.5-3.5	0.1-2.0	0.2-3.5	25-35	35-47	0.5-6.0	1.5-8.0

Table 10: Agronomic features of new variety CIM-Krishnapriya

S. No.	Agronomic features	Comments
1.	Fertilizer application	60:20:20 NPK kg/acre
2.	Slips required for planting	15000 slips/acre
3.	Spacing	45*45 cm
4.	I[st] Harvesting	7-8 months after transplanting
5	I Harvesting onwards	90 Days after the first harvest
6	Herb Yield (t/ha/year) (Estimated)	25-35
7	Oil content (%)	1.20-1.25
8	Oil yield (kg/ha/year) (Estimated)	300-320

Table 11: Package of practices for CIM-Krishnapriya

1.	**Climate**	Warm and humid climate suitable for good growth and yield.
2.	**Soil**	Rich loam to poor laterite. The grass grows best on well-drained sandy-loam soil.
3.	**Propagation and spacing**	By cuttings 45*45
4.	**Manures and fertilizers**	FYM: 10 t/ha Fertilizer – N: P2O5: K2O = 150: 40: 40 kg/ha/yr
5.	**Irrigation**	Irrigation has to be provided once in 4 – 5 days till the establishment of the plant. Later on, once in 10 days depending on the requirement.
6.	**Pest and diseases**	No pests and disease have been observed.
7.	**Harvesting**	First harvesting after 7-8 months after planting in sunny days and subsequent harvesting at 3 months days after the first harvesting.
8.	**Yield**	Herb yield: 20-35 t/ha/year (Estimated) Oil content: 1.20-1.25 % Oil yield: 300-320 kg/ha/year (Estimated),
11.	**Economics**	Cost of cultivation/ha : Rs. 1,00,000– 1,10,000 (Estimated) Gross return/ha : Rs. 3,00,000- 3,20,000 (@ Rs. 1,000/kg) Net return : Rs. 2,00,000–2,10,000

Figure 2: General field view of CIM-Krishnapriya (CIM-C4-C-6)

process, ensuring that the most promising and high-performing varieties are identified and further developed. This methodology contributes to the successful development of improved lemongrass varieties, such as the CIM-C4-C-6 (CIM - Krishnapriya) clone, which you mentioned earlier.

Second Stage Evaluation

The advanced varietal trial (AVT) and pilot scale trial (PST) conducted in the 2019-21 period involved testing six lemongrass clones and two control varieties. The trials were set up using a randomized complete block design (RCBD) with three replications. The plot size was 3.25 m × 3.25 m, and the spacing between plants was 45 cm x 45 cm. These trials aimed to evaluate the performance of the different clones in terms of various factors, including oil content, herb yield, oil yield, and oil quality.

The results consistently demonstrated that the superior clone, CIM-C4-C-6 (CIM-Krishnapriya), outperformed the existing control variety Krishna across the AVT and PST trials. This superior performance was observed in terms of estimated oil content, herb yield, oil yield, and oil quality. Tables 2, 3, and 4 provide detailed data and comparisons showcasing the performance of different clones and varieties in these trials.

Furthermore, a pilot scale trial (PST) was conducted in 2022, where the CIM-C4-C-6 clone was evaluated alongside the control varieties using larger plot sizes (100 m2). Once again, the clone CIM-C4-C-6 (CIM-Krishnapriya) demonstrated strong performance in terms of herb yield, oil yield, and oil quality in the PST. Based on the consistently positive outcomes in these trials, the CIM-C4-C-6 (CIM-Krishnapriya) clone was selected for formal release as a new lemongrass variety.

Description of Proposed Strain

Information about the morphological traits, chemical properties, and physical characteristics

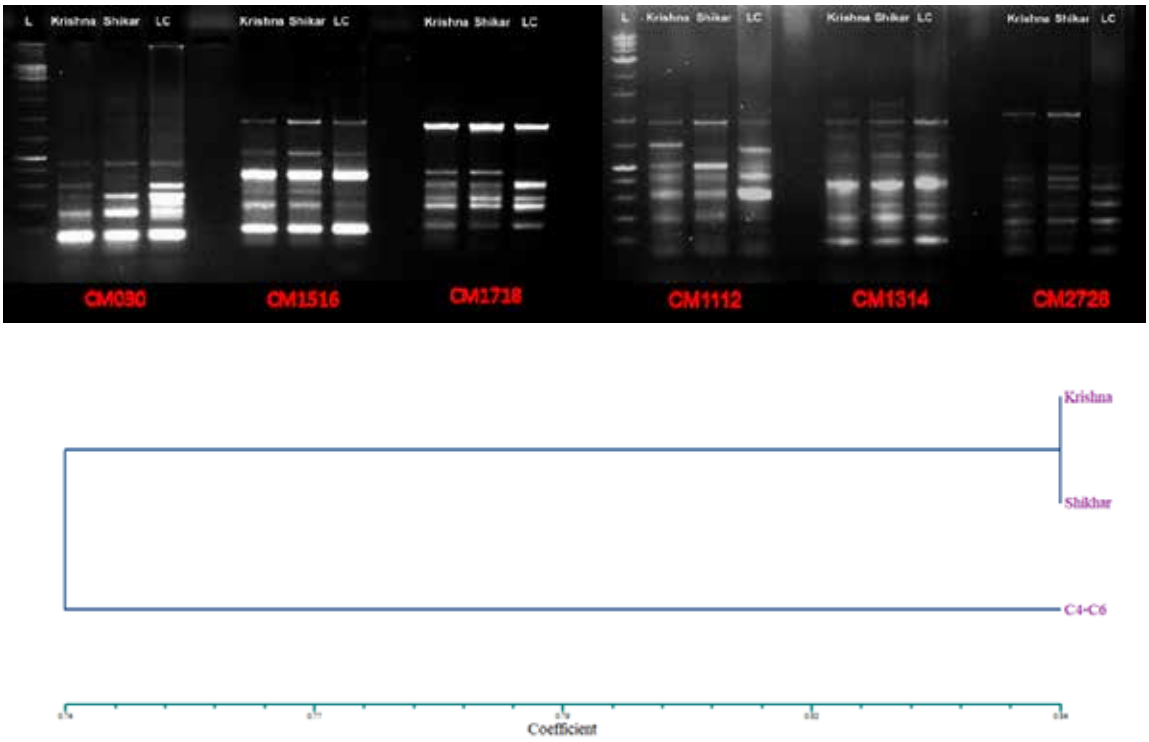

Figure 3: SSR Markers Molecular profile and phylogenetic relationship of CIM-C4-C-6 clone and Checks (Note: LC= CIM-C4-C-6)

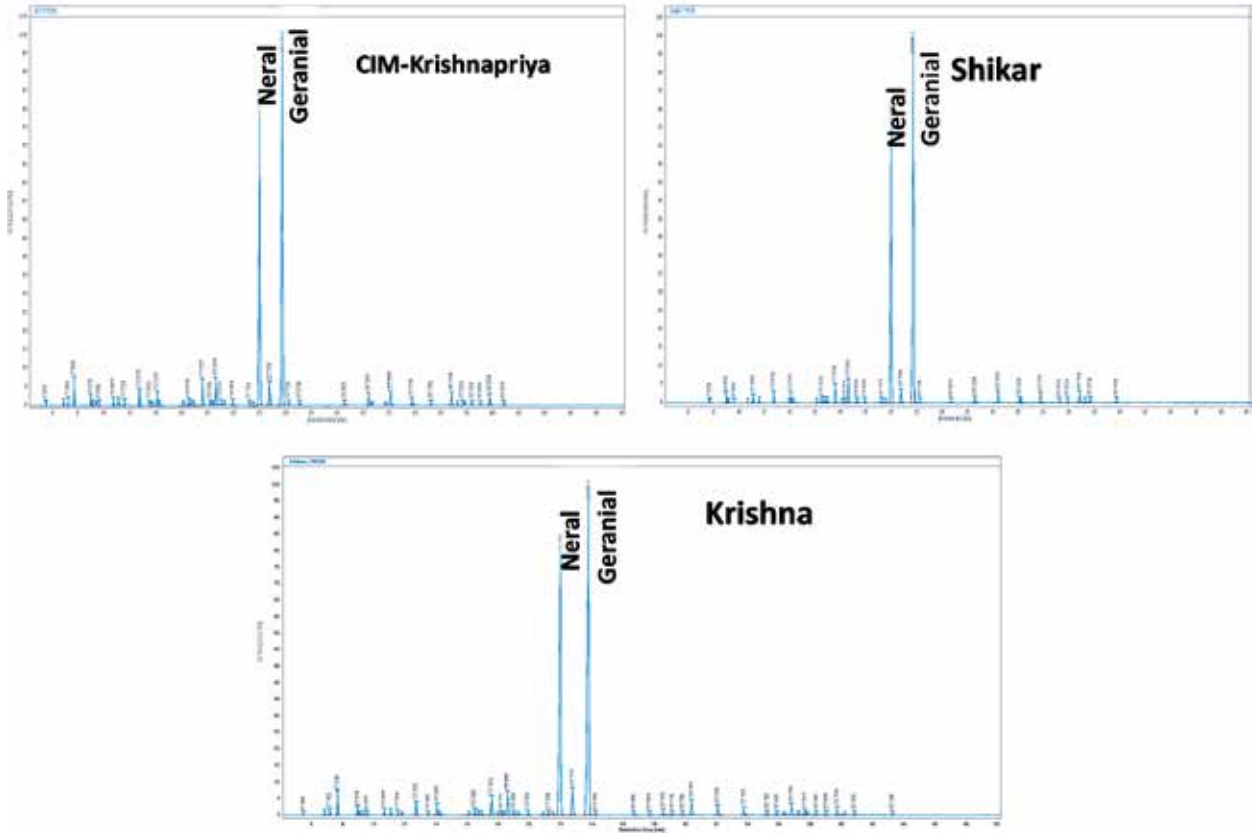

Figure 4: Chemical profile of CIM-C4-C-6 clone CCIM-Krishanpriya and check varieties

of the lemongrass varieties CIM-Krishnapriya, Krishna, and CIM-Shikhar is in Tables 6, 7, and 8 respectively. Morphological traits include features like plant height, leaf size, and growth habits. Chemical properties encompass essential oil composition and concentrations of key compounds, while physical characteristics involve aspects like leaf size, stem diameter, and overall appearance. These tables likely provide comprehensive data to compare and contrast these lemongrass varieties in terms of their morphology and chemical and physical attributes.

Statement of Distinction (DUS criterion)

The morphological comparison between CIM-Krishnapriya (CIM-C4-C-6) and the check variety Krishna reveals distinct differences in their leaf colour, leaf shape, and growth habits. CIM-Krishnapriya (CIM-C4-C-6): The leaves are dark green. Possesses narrow leaves. Exhibits a semi-erect growth habit, and displays a dwarf nature. Check Variety Krishna: Leaves are broader in shape. Shows a taller and erect to semi-erect growth habit.

These differences are visually represented in Figure 2 and Figure 3, providing a clear visual comparison between the two varieties. The unique characteristics of CIM-Krishnapriya, such as its light green colour, narrow leaves, semi-erect growth habit, and dwarf nature, distinguish it from the taller, broader-leaved Krishna variety.

This detailed morphological description is crucial for understanding the varietal differences and can be valuable for farmers, researchers, and industries seeking specific traits in lemongrass varieties for various purposes, such as cultivation, processing, and product development.

Recommended Package of Practices and Area of Adoption

This recently introduced CIM-Krishnapriya variety demonstrates adaptability to a range of environmental conditions, encompassing both rainfed and irrigated settings, as well as soils with limited fertility. This variety has been meticulously tailored to suit the specific requirements of southern regions in India, as well as the central and northern plains. Comprehensive guidelines for the cultivation of this new variety have been presented in Tables 10 and 11, offering a comprehensive package of recommended practices.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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NOTE: The lemongrass variety CIM-Krishnapriya was officially introduced for commercial cultivation on the occasion of CSIR Foundation Day, which took place on September 30, 2022 at CSIR-CIMAP, Luclnow, India.

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