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NEW VARIETY RELEASE

CIM-Suras: A menthol rich, erect growth habit, sucker producing and high yielding peppermint (*Mentha piperita* L.) variety

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ABSTRACT

Peppermint (Mentha piperita L., Lamiaceae), is an essential oil-bearing crop cultivated in temperate and sub-tropical countries for perfumery and aroma industries. The plant is vegetatively propagated through runners derived from mother stalks of the plants, resulting in a low genetic base. Induced mutagenesis is a unique and supplemental breeding approach to overcome the limitations of a low genetic base. A few popular varieties, namely Kukrail, Tushar, Pranjal and CIM-Madhuras, have already been released for commercial cultivation. However, all of those have creeping growth habit, propagation only by runners, low oil content, low oil yield, and higher than 5% menthofuran content. Due to these drawbacks of previously released varieties, CSIR- CIMAP has used mutation breeding to develop a peppermint variety with erect growth habit, sucker-producing ability, and increased oil yield with high menthol and low menthofuran content. CIMAP/MPS-36, a half-sib seed progeny of variety Kukrail, served as the mother genotype for mutation breeding using different doses of gamma irradiation. A mutant, MPS-3633, was identified as a novel and promising mutant with a distinct quality of peppermint oil and released for its commercial cultivation in the name of variety CIM-Suras. CIM-Suras displayed novel and industrially useful characteristics, i.e. high menthol (68–78%) content with low menthofuran (0.2-0.8%) content, sucker generating, erect growth habit, flower-bearing and an increase in herb yield, oil content, and oil yield. This cultivar could be a sustainable solution to bottlenecks of already released peppermint varieties. Further, dementholisation (DMO) can be used as peppermint oil and to extract menthol from oil.

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INTRODUCTION

Peppermint (*Mentha piperita* L.; Fam. Lamiaceae), is a major essential oil-bearing crop, predominantly dispersed in temperate and sub-temperate regions of the world (Jedrzejczyk and Rewers, 2018). Its essential oil has broad applications in the pharmaceutical, cosmetic and perfumery industries. India's peppermint oil market demand is estimated to be worth Rs 555 crore in 2021-22. India still imports a considerable amount (136.04

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tons) of peppermint oil to meet its indigenous demand (Anonymous, 2021-22). The lack of interest in farmers towards peppermint cultivation is due to its creeping growth habit, low biomass/oil yield, and propagation through runners. Even though just a few popular varieties, namely Kukrail, Tushar, Pranjal and CIM-Madhuras, have been released for commercial cultivation by the CSIR-CIMAP. These varieties still have creeping growth habit, propagation only by runners, low oil content and oil yield, and higher than 5% menthofuran content. A broad genetic improvement is needed to overcome these constraints and develop improved peppermint varieties.

Induced mutagenesis, a unique and supplementary breeding approach, has resulted in producing and documenting more than 3222 commercial varieties around the world, of which more than 67% are developed through gamma irradiation (IAEA mutant database, 2015; Ahloowalia & Maluszynski, 2001). Peppermint is vegetatively propagated crop through runners derived from the mother stalks of the plants. Genetic improvement in the peppermint industry aims to develop cultivars with erect growth habits and increased oil yield with high menthol and low menthofuran content (Croteau *et al.*, 2005). The CSIR-CIMAP exploited mutation breeding to overcome shortcomings of the existing varieties/genotypes. This led to the development of a peppermint variety with an erect growth habit and high oil yield with high menthol and low menthofuran content. This report summarizes the result of our efforts in this direction that has led to the development of the menthol-rich peppermint variety CIM-Suras. The details of this new variety are presented here for its official registration and commercial release.

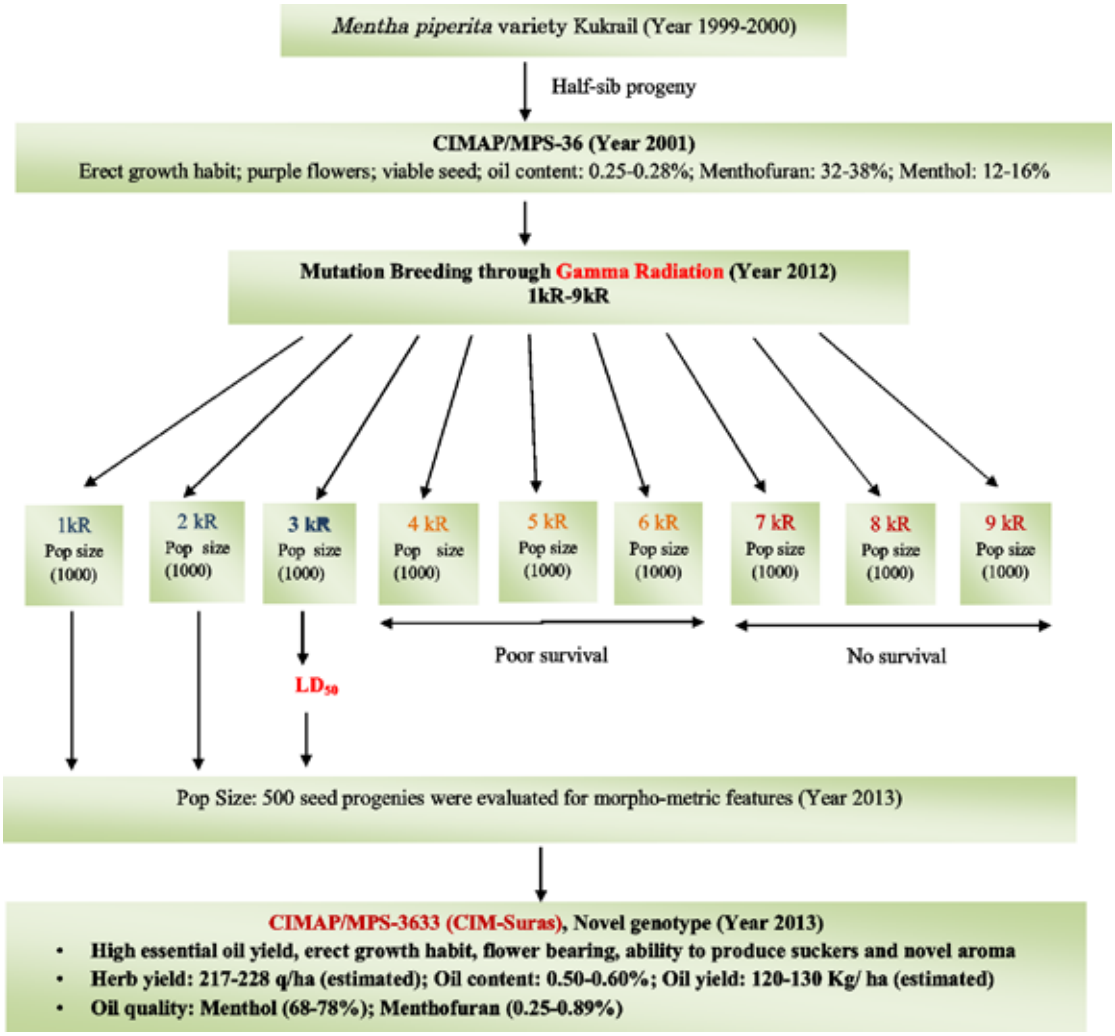

Figure 1: Flow diagram of origin and breeding of peppermint variety, CIM-Suras

MATERIALS AND METHODS

Under a mutational breeding program for genetic upgradation of desired traits of peppermint crop, the genotype CIMAP/MPS-36, a half-sib seed progeny of variety Kukrail, that is distinguished by an upright growth habit, viable seed production with the capacity to produce runners and suckers, dark purple leaves and stems, high herb yield, high menthofuran content (32-38%), low menthol content (12-16%), and low oil content (0.25 - 0.28%) was selected as mother parent. During the 2012-2013 cropping season, seeds from CIMAP/MPS-36 were subjected to gamma radiation doses ranging from 1 kR to 9 kR. To establish the nursery, about 1000 gamma-irradiated seeds of each of nine doses (1kR, 2kR, 3kR, 4kR, 5kR, 6kR, 7kR, 8kR, and 9kR) of CIMAP/MPS-36 were sown and plants were raised. During the 2013 cropping season, about 500 seedlings were assessed for morpho-metric observations and a sense of a new aroma. One seedling/ variant, CIMAP/MPS-3633, later released as var. CIM-Suras was found to have valuable characteristics and was chosen for further evaluation (Fig. 1).

The variant CIM-Suras and two released varieties, Kukrail and CIM-Madhuras were placed in Initial Yield Evaluation Trail during the 2015 and 2016 cropping season at the experimental farm of CSIR-CIMAP, Lucknow (IET; RBD; Plot size: 20.0 m^2 (4m × 5m); Row-Row: 50 cm; Replication: 3). Variety CIM-Suras (based on yield assessment trial concerning essential oil yield, oil content, and high suckers producing ability) along with two released varieties Kukrail and CIM- Madhuras were placed in Pilot Scale Yield Trial during the cropping season of 2017-2019 at the experimental farm of CSIR-CIMAP, Lucknow and CSIR-CIMAP, Research Centre, Pantnagar (PST; RBD; Plot size: 50.0 m^2 (10m × 5m); Row-Row: 50 cm: Replication: 3). Variety CIM-Suras and two released varieties, Kukrail and CIM-Madhuras were further advanced to Final Pilot Scale Yield Trial at the Experimental farm of CSIR-CIMAP, Lucknow (PST; RBD; Plot size: 80.0 m^2 (10m × 8m); Row-Row: 50 cm; Replication: 3). The menthol-rich variety CIM-Suras maintained its superiority and out yielded the check varieties in the economic traits.

RESULTS AND DISCUSSION

The genotype CIMAP/MPS-3633 (later released as variety CIM-Suras) exhibited consistency in performance for different yield and quality attributes during the initial and pilot scale evaluations. It remained stable and homogeneous for its morpho-metric and quality traits.

Initial Yield Evaluation Trial (2015-16)

Variety CIM-Suras, and two released varieties, Kukrail and CIM-Madhuras of peppermint, were tested in Randomized Block Design (RBD) during the 2015 and 2016 cropping seasons at the experimental farm of CSIR-CIMAP Lucknow with three replications having a plot size of 20.0 m^2. The runners/suckers of said varieties and CIM-Suras were planted at a row-to-row spacing of 50 cm between 15-20 January 2015 and 2016. Data were collected on plant height (cm), leaf length (cm), leaf width (cm), L: S ratio, oil content (% v/w), herb yield (kg/plot), estimated herb yield (q/ha), estimated oil yield (kg/ha), and major essential oil constituents (menthone, iso-menthone, menthofuran, neo-menthol, menthol, and pulegone). A yield assessment trial revealed that CIM-Suras excelled over varieties Kukrail and CIM-Madhuras for essential oil yield, oil content, and high suckers-producing ability (Table 1a, 1b). Variety CIM-Suras was the best in oil yield and novel aroma among the varieties/accessions mentioned above. The per cent improvement in oil yield of varieties CIM-Suras was about 22% and 18% over varieties Kukrail and CIM-Madhuras in 2015 and 37% and 29% in 2016, respectively (Tables 1a, 1b).

Pilot Scale Yield Trial (2017-19)

I. CSIR-CIMAP, Lucknow

Variety CIM-Suras along with two existing varieties, Kukrail and CIM-Madhuras, were evaluated in RBD in 2017, 2018, and 2019 cropping season at CSIR-CIMAP experimental farm Lucknow, with three replications having a plot size of 50 m^2 (10.0 m × 5 m). The healthy suckers and runners were planted at a row-to-row spacing of 50 cm during the second week of January 2017, 2018, and 2019. Data were collected on yield attributes, yield, and oil quality. Yield assessment trials revealed that the variety CIM-Suras out-yielded all other check varieties/accessions in economic traits (Tables 2a, 2b). The per cent improvement in oil yield of variety CIM-Suras was about 36% and 30%, respectively, over varieties Kukrail and CIM-Madhuras in 2017, 39% and 30%, respectively in 2018, and 46% and 38%, respectively in 2019 (Tables 2a, 2b).

Table 1a: Performance of different *Mentha piperita* varieties/accessions in Initial Yield Evaluation Trial (PYT) at Lucknow during 2015-16

Name of Variety/ accessions	Plant Height (cm)		Leaf Length (cm)		Leaf Width (cm)		L:S Ratio		Oil Content (%)		Herb yield (Kg/20m²)		Estimated herb yield (q/ ha)		Estimated oil yield (kg/ha)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Kukrail	45.5	45.7	4.4	4.2	2.4	2.0	0.95	1.0	0.45	0.46	43.9	40.7	219.5	203.7	99.4 (22.7)	93.1 (37.5)
CIM-Madhuras	56.0	55.0	5.1	5.3	2.0	1.7	1.11	1.0	0.48	0.48	42.6	41.1	212.9	205.6	102.7 (18.7)	99.3 (29.0)
MPS-36	70.5	71.7	6.3	6.3	3.4	3.2	1.06	1.06	0.35	0.36	48.3	46.7	241.4	233.8	84.5 (44.3)	83.5 (53.4)
MPS-363	85.2	83.5	7.2	7.5	3.8	3.7	1.11	1.36	0.45	0.42	47.5	48.9	237.8	244.8	107 (14.0)	101.7 (25.9)
CIM-Suras	94.5	92.0	8.2	8.3	4.4	4.6	1.36	1.36	0.56	0.58	43.9	44.3	219.6	221.7	122	128.1
C.D. (5%)	5.61	5.03	0.43	0.70	0.63	0.53	0.20	0.19	0.05	0.05	4.44	3.33	22.18	16.67	16.45	12.33

Plot size: 20 m² (5m × 4m); Replication: Three; Spacing: 50 cm × 50 cm; Percent improvement shown in bracket.

Table 1b: Performance of different *Mentha piperita* varieties/accessions in Initial Yield Evaluation Trial (PYT) at Lucknow during 2015-16

Name of variety/accession	Menthone (%)		Menthofuran (%)		Iso-menthone (%)		Neo-menthol (%)		Pulegone (%)		Menthol (%)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Kukrail	27.21	20.75	3.93	3.64	3.61	4.03	3.7	3.81	5.07	5.47	34.14	38.86
CIM-Madhuras	24.16	23.83	5.65	6.08	3.9	4.07	3.33	3.78	2.41	3.06	31.62	33.09
MPS-36	1.87	1.92	37.27	35.23	3.77	2.08	2.73	2.45	31.75	33.24	7.21	6.9
MPS-363	8.85	9.23	0.17	0.2	3.51	2.61	3.36	3.76	0.17	0.2	45.58	48.32
CIM-Suras	11.9	11.7	0.66	0.56	2.04	1.31	1.74	2.32	1.14	0.54	68.71	74.95
C.D. (5%)	2.13	1.47	1.78	0.94	0.62	0.22	0.6	0.48	1.18	1.01	2.55	8.29

Table 2a: Performance of different varieties/accessions in Pilot Scale Yield Evaluation Trial (PST) during 2017-19 at CSIR-CIMAP, Lucknow

Name of Variety/ accessions	Plant Height (cm)			Leaf Length (cm)			Leaf Width (cm)			L:S Ratio			Oil Content (%)			Herb yield (Kg/50m²)			Estimated herb yield (q/ha)			Estimated oil yield (kg/ha)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
Kukrail	45.7	49.7	47.5	4.2	4.2	4.6	2	2	2.1	1	0.91	1.09	0.46	0.45	0.45	100.3	101.7	100.7	200.6	203.4	201.4	91.9 **(36.7)**	92.2 **(39.0)**	90.1 **(46.2)**
CIM-Madhuras	52.5	54.2	54	5.3	4.3	4.5	2.5	2.1	2.5	1	1.06	1	0.48	0.46	0.46	100.6	107	103.3	201.2	214.1	206.6	96.1 **(30.8)**	98.4 **(30.3)**	95.1 **(38.5)**
MPS-36	71.7	71.2	75.2	6.3	6	6.3	3.2	3.5	3.4	1.06	1.06	1.06	0.37	0.38	0.37	109.1	109.7	109.6	218.2	219.4	219.2	80.1 **(57.0)**	83 **(54.5)**	80 **(64.6)**
MPS-363	83.5	85.5	91.2	7.5	7.2	7.9	3.8	3.2	4.5	1.26	1.18	1.11	0.5	0.51	0.5	108	103.6	107.2	216	207.2	214.4	108.6 **(15.7)**	105.7 **(21.3)**	107.2 **(22.9)**
CIM-Suras	86.8	87.3	93.5	8.3	9.1	9.2	5.1	4.6	5.2	1.26	1.36	1.39	0.58	0.58	0.59	108.5	110.1	111	217	220.2	222	125.7	128.3	131.8
C.D. (5%)	3.39	3.79	5.53	0.7	1	0.53	0.68	0.64	0.44	0.09	0.22	0.4	0.04	0.05	0.05	7.75	3.49	3.2	15.5	6.97	6.4	13.41	7.88	9.59

Table 2b: Performance of different varieties/accessions in Pilot Scale Yield Evaluation Trial (PST) during 2017-19 at CSIR-CIMAP, Lucknow

Name of variety/accession	Menthone (%)			Menthofuran (%)			Iso-menthone (%)			Neo-menthol (%)			Pulegone (%)			Menthol (%)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
Kukrail	26.26	25.45	22.6	3.67	3.34	3.34	2.9	3.09	4.1	3.69	3.26	3.42	5.32	4.71	2.2	35.96	36.72	30.5
CIM-Madhuras	23	20.2	25.6	6.47	6.03	3.61	3.68	3.9	4.1	3.41	3.3	3.37	2.53	2	3.2	30.77	35.4	28.3
MPS-36	4.59	5.23	3.36	36.96	34.89	34.89	2.81	2.32	2.76	3.87	4.39	2.96	22.34	23.43	21.34	11.93	10.35	9.56
MPS-363	9.86	8.06	8.89	0.18	0.18	0.12	3.69	3.6	3.51	3.09	3.2	3.28	0.11	0.12	0.17	45.36	45.19	47.28
CIM-Suras	10.2	12.2	8.2	0.09	0.06	0.08	0.31	1.8	3	2	2.11	2.7	0.2	0.4	0.4	77.61	71	75.6
C.D. (5%)	2.21	1.61	0.80	0.66	1.19	1.10	0.56	0.44	0.89	0.44	0.47	0.43	0.49	0.81	0.52	2.54	3.01	1.92

Table 3: Performance of different varieties/accessions in Pilot Scale Yield Evaluation Trial (PST) during 2017-19 at CSIR-CRC, Pantnagar

Name of Variety/ acces-sions	Plant Height (cm)			Leaf Length (cm)			Leaf Width (cm)			L:S Ratio			Plant Spread (cm)			Oil Content (%)			Herb yield (Kg/50m²)			Estimated herb yield (q/ha)			Estimated oil yield (kg/ha)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
Kukrail	58.5	57.5	65	4.2	4	5.1	1.9	1.9	2.2	1.03	1.08	1.14	63.2	65	65.5	0.49	0.48	0.48	106.7	101.7	104	213.5	203.5	208	105.2	97.5	99.8
																									(25.9)	**(39.9)**	**(37.1)**
CIM-Madhu-ras	57.2	60.5	64.2	4.2	3.6	5	2.2	1.8	2	1.1	1.14	1.1	52	53.7	53.5	0.48	0.47	0.47	94	97.1	102.7	188	194.2	205.5	90.1	90.4	95.7
																									(47.0)	**(51.0)**	**(43.0)**
MPS-36	66	77.5	82	6.6	6.1	6.3	3.5	3.1	3.5	1.15	1.27	1.2	71	70	71	0.37	0.36	0.36	101.4	101.6	101.8	202.9	203.2	203.6	73.8	73.1	72.7
																									(79.4)	**(86.6)**	**(88.1)**
MPS-363	69	83.5	91.5	7.4	7.7	7.3	3.3	3.2	3.5	1.23	1.34	1.25	65	64.2	66.7	0.53	0.53	0.52	110.1	112.7	111	220.2	225.5	222	115.9	120.1	114.7
																									(14.3)	**(13.6)**	**(19.3)**
CIM-Suras	71	84.5	94.5	8.1	9	9.1	4.6	4.4	4.9	1.23	1.36	1.38	74	72	73	0.59	0.6	0.6	112.2	114.6	114	224.5	229.2	228	132.5	136.5	136.9
C.D. (5%)	5.29	3.54	2.04	0.19	0.23	0.50	0.18	0.16	0.21	0.16	0.24	0.16	4.8	3.9	5.3	0.11	0.11	0.11	5.28	6.9	9.86	10.56	13.79	19.73	23.8	24.07	27.21

Table 4a: Performance of different varieties/accessions in Final Pilot Scale Yield Evaluation Trial (PST) during 2020-2022 at Lucknow

Name of Variety/ accessions	Plant Height (cm)			Leaf Length (cm)			Leaf Width (cm)			L:S Ratio			Oil Content (%)			Herb yield (Kg/50m²)			Estimated herb yield (q/ha)			Estimated oil yield (kg/ha)		
	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022
Kukrail	51	54.6	56	3.5	3.1	4.8	1.3	1.8	2	0.92	1.08	0.88	0.45	0.46	0.44	166.2	168.2	169	207.8	210.3	211.3	93	96	93.48
																						(38.7)	**(38.5)**	**(44.5)**
CIM-Madhuras	45.6	53.3	47.6	4.9	3.4	4.4	2.3	2.1	1.4	1.01	1.18	1.03	0.47	0.48	0.45	168	171.4	185.6	210.1	214.3	232	98.77	103.4	104.4
																						(30.5)	**(28.6)**	**(29.4)**
MPS-36	65	70.3	72.6	6.2	5.2	7.1	3.2	2.6	2.7	1.07	1.23	1.07	0.32	0.33	0.35	220.7	216.3	197.4	275.9	270.4	246.8	88	89.3	86.38
																						(46.5)	**(48.9)**	**(56.4)**
MPS-363	93.6	94.6	93	7.7	4.2	8.1	4.1	3.2	4.1	1.15	1.28	1.13	0.46	0.48	0.49	188.3	184.1	184.9	235.4	230.2	231.1	109	110.5	112.08
																						(18.3)	**(20.3)**	**(20.5)**
CIM-Suras	94.6	98.3	93.6	9.5	4.2	8.9	4.3	3.3	4.2	1.37	1.38	1.32	0.56	0.6	0.6	183.9	176.6	181.7	229.9	220.8	227.2	129	133	135.16
C.D. (5%)	3.56	4.22	5.26	0.46	0.56	0.96	0.33	0.16	0.56	0.28	0.6	0.09	0.06	0.03	0.03	1.18	3.88	0.92	1.48	4.85	1.15	13.6	7.45	7.22

Table 4b: Performance of different varieties/accessions in Final Pilot Scale Yield Evaluation Trial (PST) during 2020-2022 at Lucknow

Name of variety/ accession	Menthone (%)			Menthofuran (%)			Iso-menthone (%)			Neo-menthol (%)			Pulegone (%)			Menthol (%)		
	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022
Kukrail	21.48	18.02	17.7	3.6	4.77	4.35	4.42	4.42	4.11	3.9	4.57	4.63	3.33	1.57	0.93	29.99	35.51	35.93
CIM-Madhuras	19.37	20.45	17.82	5.52	5.72	5.88	4.34	4.34	3.61	3.9	4.09	4.67	2.26	2.02	1.7	32.23	33.89	33.97
MPS-36	3.37	5.13	5.77	33.21	36.98	33.98	2.4	2.4	2.44	4.25	4.46	4.7	24.87	21.96	21.23	13.28	10.56	13.24
MPS-363	10.25	7.65	7.48	1.17	4.84	4.83	3.51	3.51	2.48	3.87	2.96	2.89	0.18	4.82	4.72	47.32	64.52	64.63
CIM-Suras	7.7	7.2	6.2	0.14	1.1	1	1.4	1.4	1.2	3	2.4	3.3	0.1	0.6	0.2	79.7	74.5	73.75
C.D. (5%)	0.89	0.56	0.54	0.39	0.63	0.23	0.41	0.41	0.3	0.77	0.58	0.44	0.47	0.51	0.62	2.08	2.29	0.66

II. CSIR-CIMAP, Resource Centre, Pantnagar

The yield assessment trial of CIM-Suras, alongwith two existing varieties, Kukrail and CIM-Madhuras was laid out in RBD with three replications during the 2017, 2018, and 2019 cropping seasons at the CSIR-CIMAP Research Centre, Pantnagar, with a plot size of 50 m². Healthy suckers/runners were planted during the third week of January 2017, 2018, and 2019 at the row-to-row spacing of 50 cm.

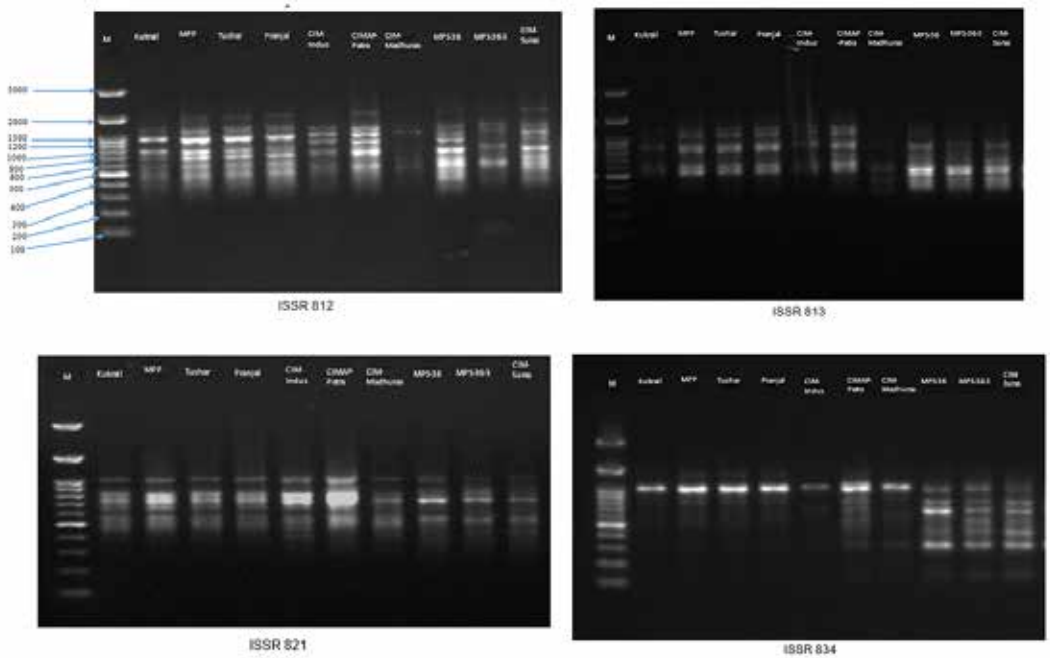

Figure 2: ISSR Marker profiles of CIM-Suras and other peppermint varieties.

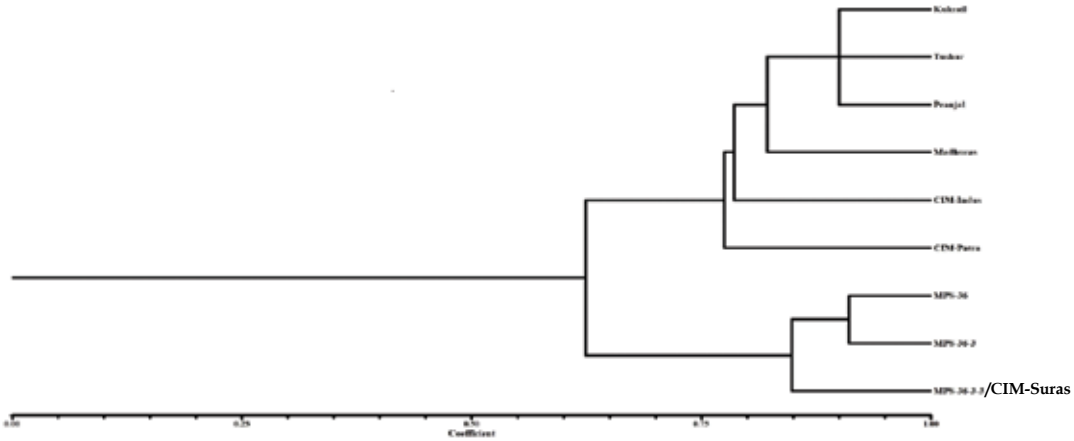

Figure 3: UPGMA (based on Nei's genetic distance) dendogram, showing the relationship between CIM-Suras and other peppermint varieties.

Figure 4: Field view of the peppermint variety CIM-Suras

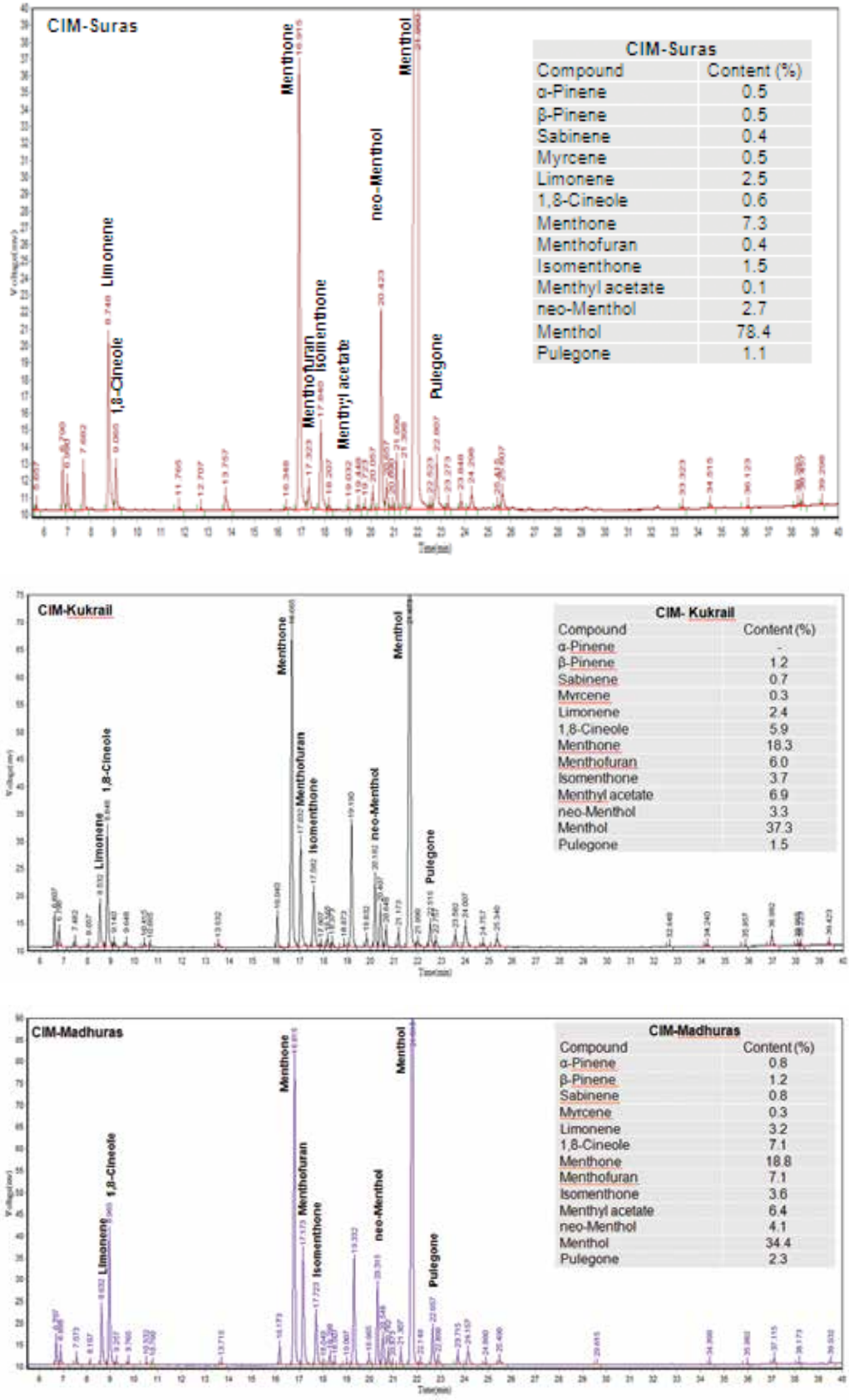

Figure 5: Chromatograms of peppermint variety CIM-Suras with varieties CIM-Madhuras and Kukrail

Table 5: Nei's measures of genetic distance (matrix) among the varieties/genotypes

	Kukrail	Tushar	Pranjal	CIM-Indus	CIMAP-Patra	CIM-Madhuras	MPS-36	MPS-363	CIM-Suras
Kukrail	1.00								
Tushar	0.90	1.00							
Pranjal	0.90	0.90	1.00						
CIM-Indus	0.79	0.79	0.79	1.00					
CIMAP-Patra	0.80	0.80	0.80	0.73	1.00				
CIM-Madhuras	0.82	0.82	0.82	0.79	0.73	1.00			
MPS-36	0.63	0.63	0.63	0.63	0.75	0.63	1.00		
MPS-363	0.64	0.64	0.64	0.61	0.80	0.68	0.91	1.00	
CIM-Suras	0.55	0.55	0.55	0.48	0.68	0.52	0.86	0.84	1.00

Table 6: Characteristics of the peppermint variety CIM-Suras with check variety CIM-Madhuras.

Characters	CIM –Suras	CIM-Madhuras
Growth habit	Erect	Prostrate to erect
Plant height (cm)	80-95	50-55
Leaf length (cm)	8.2-9.2	4.2-4.5
Leaf width (cm)	4.2-5.2	1.9-2.0
Leaf colour	Dark Green	Dark Green to Purplish
Stem colour	Purple to Purplish green	Dark Purple
Propagule formation	Sucker and Runner	Runner
Oil content (%)	0.50 – 0.60	0.40-0.50
Menthol (%)	68–78	30-38
Menthofuran (%)	0.25-0.89	5-6
Menthyl acetate (%)	0.1-0.8	6-7
Menthone (%)	9–11	15-20
Herb yield (q/ha)	217-228	190-200
Oil yield (kg/ha)	120-130	90-100

Data were collected on plant height (cm), leaf length (cm), leaf width (cm), L:S ratio, herb yield (kg/ plot), oil content (%), oil yield (g/plot), estimated herb yield (q/ha), estimated oil yield (kg/ha) and essential oil profile (Table 3). The yield assessment trial revealed that the variety CIM-Suras produced a significantly higher herb and oil yield than Kukrail and CIM-Madhuras. The variety CIM-Suras has shown improvement in oil yield by 25% and 47% over varieties Kukrail and CIM-Madhuras in 2017, 39% and 51% in 2018, and 37% and 43% in 2019, respectively (Table 3).

Final Pilot Scale Yield Trial at CSIR-CIMAP, Lucknow (2020-22)

Variety CIM-Suras, along with two existing varieties, Kukrail and CIM-Madhuras, were evaluated in RBD in 2020, 2021, and 2022 cropping seasons at CSIR-CIMAP experimental farm, Lucknow, with three replications having a plot size of 80 m^2 (10.0 m × 8 m). Healthy suckers and runners were planted at a row-to-row spacing of 50 cm during the second week of January 2020, 2021, and 2022. Data were collected on yield attributes, yield, and oil quality. Yield assessment trials revealed that the variety CIM-Suras out-yielded all other check varieties in economic traits (Table 4a, 4b). The per cent improvement in oil yield of CIM-Suras was 38% and 30% higher over varieties Kukrail and CIM-Madhuras in 2020, 38% and 28% in 2021, and 44% and 29% in 2022, respectively (Table 4a, 4b).

Molecular Profile

Variety CIM-Suras, when assessed for genetic makeup using ISSR (812, 813, 821 and 834) markers, showed a unique profile compared to check varieties

Table 7: Recovery details of menthol crystal and DMO from essential oil of the peppermint variety CIM-Suras.

Essential oil	Menthol crystal		DMO	
	Recovery from essential oil	Percent recovery from essential oil	Recovery from essential oil	Percent recovery from essential oil
4.350kg	1.150kg	26.4%	2.749kg	63.19%

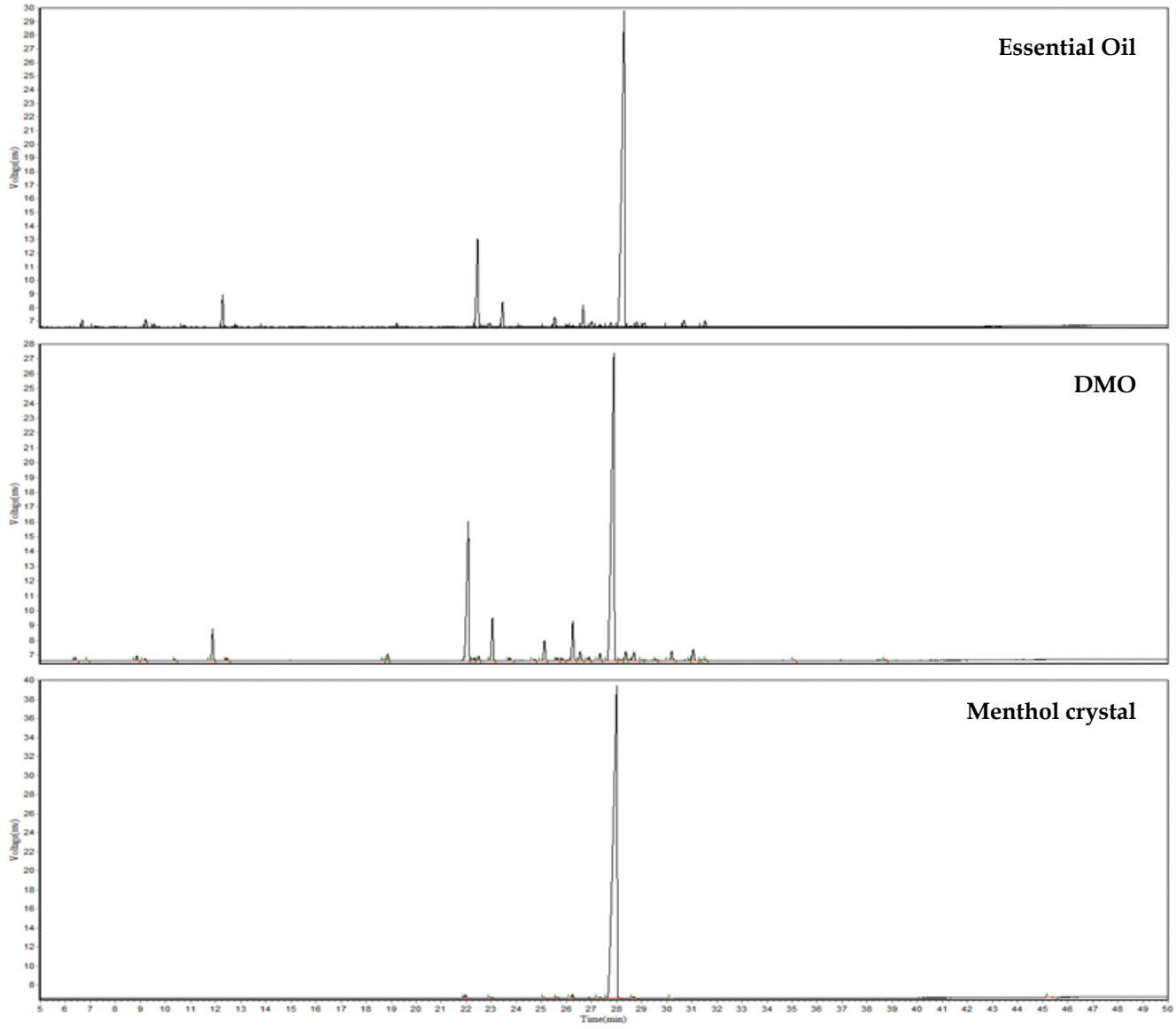

Figure 6: Chromatograms of Essential oil, DMO and Menthol crystal of peppermint variety CIM-Suras

(Fig. 2). It is further validated in Table 5 and UPGMA dendrogram in Fig. 3.

Statement of Distinction/ Breeder's Claim

Menthol-rich peppermint variety CIM-Suras have high menthol (68-78%), less than 1% menthofuran (0.2-0.8%) and menthyl acetate (0.1-0.8%) content white flowers, erect growth habit, underground sucker-producing ability and purple to purplish green stem colour (Fig. 4 and 5). Table 6 summarizes other remarkable attributes of the new peppermint variety CIM-Suras. CIM-Suras is a sustainable solution to overcome the drawbacks of available genotypes/varieties of peppermint. Further, dementholisation (DMO) can be used as such as peppermint oil in addition to extracting menthol from oil (Table 7, and Fig. 6). The agro-practice of peppermint variety CIM-Suras is summarized in Table 8.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Table 8: Agro-practices for the peppermint variety CIM-Suras

Common name	Peppermint
Botanical name	*Mentha piperita* L.
Family	Lamiaceae
Uses	Essential oil is conventionally used as a source of flavour in foods and beverages. Its oil is used for making cough syrup, toothpaste and respiratory medicines. Its DMO is used as peppermint oil and to extract menthol from oil.
Plant description	Erect, tall, branched, shallow-rooted annual aromatic plant. Stem quadrate, dark green; leaves elliptic, dark green, serrated margin; inflorescence white in colour.
Climate	Temperate to sub-tropical.
Soil	The plant prefers well-drained sandy-loam to loam soils with fertile and neutral pH (6.5-7.5).
Propagation	It is propagated through suckers and runners. 3.0-3.5 q suckers are required for one hectare. 125-130 q suckers may produce from one hectare. 250 m^2 areas are sufficient for producing planting material for one hectare of land.
Transplanting and preparation	Suckers are planted in the second to the third week of January at 50-60 cm spacing between row to row in well prepared and levelled field.
Manures and fertilizers	Apply FYM @ 8-10 tonnes along with 60:40 kg of P_2O_5 and K_2O/ha at the time of planting and 120 kg N/ha in 3 equal splits.
Irrigation	Light irrigation should be given just after transplanting; 5-6 irrigations will be required during the total crop period.
Pest and diseases	No insect/pest or disease is observed up to the extent of commercial loss.
Harvesting	Crop should be harvested between 100-110 days after planting on sunny days.
Yield	Herb yield: 217-228 q/ha (Estimated) Oil content: 0.50 -0.60% (in Clevenger); About 0.48% in CIM-Ashwika Oil yield: 120-135 kg/ha (Estimated); 100ml from 21kg herb
Oil quality	Menthol (68-78%), menthofuran (0.25-0.89%), menthone (9.5-11.1%), iso-menthone (1.5-1.7%), neo-menthol (2.1-3.3%), menthyl acetate (0.1-0.8%), limonene (0.6-1.8%) are major constituents of its oil.
Economics	Cost of cultivation/ha: Rs. 45,000-50,000 Gross Return/ha: Rs. 1,00,000 to 1,20,000 (120 kg oil @ Rs 1000/kg) Net return /ha: Rs. 60,000 to 70,000

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