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Registration of a high-yielding khusilal [nor-sesquiterpene (C14) aldehydes] rich variety CIM-Samriddhi of vetiver (*Chrysopogon zizanioides* (L.) Nash.

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Abstract

Vetiver (Khus) of the family 'Poaceae', is native to India and is mainly cultivated in tropical and subtropical countries as a perennial crop. It is cultivated for the production of its root derived hydro distilled essential oil that imparts a strong and persistent woody odor. The oil can also have earthy, grapefruit-like, flowery, smoked and ambery, undertones, depending upon the geographic origin of the crop. Vetiver oil is a high value basic ingredient of modern perfumery today. The total world production of this essential oil is estimated to be around 600-700 tonnes per year as compared to only 20-25 tonnes produced annually in India. Therefore, khus cultivation in Indian context is a viable option for increasing farmer's income as its oil demand for perfume and soap industries is constantly rising. However, its long gestation nature and poor oil content have always been a deterring factor for its acceptance among the farmers. Over last 10-15 years, CSIR-CIMAP has developed nine khus cultivars for maximizing the benefits of its cultivation to khus growers in different parts of the country. Khus cultivation often results an average net profit of over Rs 1.5 lacs in a span of 10-12 months with 25-30 kg/ha oil yield. In addition, co-cultivation of khus with wheat, lentil, peas, mint, basil etc. can further add to the profit margin by Rs. 30,000/ha. Looking at the huge import requirement of Vetiver oil in the country, the need to enhance the unit area productivity and quality of vetiver oil is evident. Continuing with our effort towards genetic enhancement in vetiver, we have now developed a new genotype, namely V-18 (Selection 23) that is capable of producing 35 kg/ha of high grade essential oil in comparisons to 25kg/ha oil yield of best available check i.e. CIM-Vriddhi (also developed by

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CSIR-CIMAP). The new genotype, in addition to improved root biomass 35q/ha and oil yields, also have a much desired quality profile with 31% khushilal and 19% khusol contents in its oil. The new genotype V-18 (selection 23) is ideally suited for its cultivation in entire North-Indian plains and southern region of the country. The unique yellow-green inflorescence and broad dark green leaves are the two unique distinctive features of this variety. It also fits in crop rotation/intercropping cycles between mint and paddy and with other vegetables crops grown by farmers with small land holding. Leaves of this variety are nutritive and can be used as fodder for milk producing animals. The new genotype has now been christening as "CIM-Samriddhi" and is being registered here as a new improved variety of vetiver for its commercial release.

INTRODUCTION

Vetiver (Khus) of family Poaceae, is an important perennial aromatic grass, native to India. It is cultivated for the production of essential oil derived from its roots. Vetiver oil therefore is a highly esteemed basic ingredient of modern perfumery. The total annual world production of vetiver oil is estimated to be 600-700 tonnes; India's contribution is hardly 20-25 tonnes. Therefore, khus cultivation in Indian context is definitely a profit-driven enterprise. However, its long duration nature and poor oil yield have always hindered its acceptance among the farmers. Short duration (6-18 months) varieties of vetiver with at least 1.0 to 1.5% oil content are in demand for maximizing the benefits to khus growers in India. Khus cultivation can results in a net profit of over Rs 1.5 lacs in a span of 10-12 month's if genotypes with 25-30 kg/ha oil yield potential are cultivated. In addition, co-cultivation of khus with wheat, lentil, peas, mint, basil etc. can bring an additional profit of about Rs. 30,000/ha. This report summarizes the result of an effort made in vetiver breeding where in a new high root biomass and oil yielding strain (CIM-Samriddhi) has been developed.

ORIGIN OF THE VARIETY

Under a clonal selection scheme for genetic up gradation of vetiver crop, 89 accessions were collected from different parts of the country. These 89 selections were primarily screened for high essential oil yield and quality improvement in the year 2010-2011. The variety CIM-Vriddhi was used as a check in this screaming program. From this, 17 clones namely V1 to V16 + V17 (CIM-Vriddhi as check) +V18 (a selection that was earlier tagged as selection -23), were put in a replicated Initials Evaluation Trial (IET 3 replication; plot size =1.80m^2) in 2011-2012. These 17 promising clones were evaluated on the basis of yield contributing traits-like plant height, No of tillers/plants, Fresh root yield/plot, oil content and oil yield/plot (Table 1) Based on their yeild performance in IET, clones V1, V7, V11, V13 and V18 were then carried forward to Bench Scale Trial in 2012-2013 (BST; 5+1 (check) entries, RBD, 3 replications, plot size =16m^2) and then to a Pilot Scale Trial (PST; plot size =100m^2) for two consecutive years 2013-2014 and 2014-2015. Finally, entry V-18 (selection 23) is now selected as an improved khus variety with a unique essential oil quality in terms of high khusilal (31%) and khusol (19%) content (Table 2, 3). The V-18 clone has now been named as variety CIM-Samriddhi and is released for its large scale commercial cultivation.

RESULTS

Table 1 summarizes the performance yield data of 17 (V-1 to V-16 and V-18) selected clones of vetiver in comparison to check variety CIM-Vriddhi

Table 1: Initial evaluation trial* (IET, RBD, Replications 3, Plot size =1.8m²)

Entries	Plant height (m)	No. of tillers/plant	Fresh root yield/plot (g)	Dry root yield/plot (g)	Oil content (%)	Oil yield/plot (g)
V-1 (Hybrid)	1.65	70.00	193.33	176.67	1.77	3.12
V-2	1.77	28.33	176.67	123.33	0.12	0.16
V-3	1.38	26.67	156.67	93.33	1.06	0.99
V-4	1.47	33.33	101.67	146.67	0.00	0.00
V-5	1.64	38.33	106.67	56.67	0.50	0.31
V-6	1.72	28.33	106.67	56.67	1.07	0.63
V-7 Selection1	1.92	66.67	241.67	163.33	2.04	3.28
V-8	1.85	30.00	113.33	83.33	0.89	0.75
V-9	1.60	38.33	123.33	76.67	1.34	1.02
V-10	1.47	71.67	120.00	70.00	2.02	1.38
V-11	1.73	70.00	193.33	103.33	2.48	2.57
V-12	1.43	45.00	126.67	76.67	1.02	0.78
V-13	1.63	55.00	173.33	86.67	1.92	2.02
V-14	2.40	51.67	216.67	150.00	1.48	2.22
V-15	1.40	38.33	136.67	96.67	1.69	1.64
V-16	1.83	31.67	146.67	83.33	1.58	1.33
V-17 (CIM Vriddhi)	1.62	48.33	200.00	133.33	1.75	2.32
V-18 (Selecton-23)	1.82	78.33	300.00	153.33	2.07	3.14
$CD_{(5\%)}$	0.134	8.19	43.72	22.51	0.197	0.453
$CD_{(1\%)}$	0.179	10.98	58.59	30.22	0.264	0.608

*P<0.01

Table 2: Bench Scale trial* (BST, RBD, Replications 3, Plot size = 16m²)

Entries	Root yield/ plot (g)	Oil content (%)	Oil yield/ plot (g)	Khusimol content (%)	Khusilal content (%)	Khusol content (%)	Preeizeza-7 (15)-en-12-ol
V-1 (Hy)	669.00	1.62	10.82	-	31.15	18.90	-
V-7 (Selection-1)	1142.33	1.78	20.38	21.56	-	8.72	-
V-11	683.33	1.52	10.37	-	-	8.85	26.50
V-13	903.33	1.17	10.49	23.84	-	-	-
V-17 (CIM Vriddhi)	783.33	1.62	12.66	24.21	-	-	-
V-18 (Selection 23)	1055.67	1.80	19.00	-	31.763	19.499	-
CD (5%)	58.74	0.17	1.41				
CD (1%)	83.48	0.23	2.00				

Table 3: Pilot Scale trial (PST, Plot size = 100m²)

Entries	Root yield (q/h)	Oil content (%)	Oil yield (kg/ha)	Khusimol content (%)	Khusilal content (%)	Khusol content (%)	Preeizeza-7 (15)-en-12-ol
V-1 (Hybrid)	30.00	1.65	29.70	-	33.04	22.89	-
V-7 (Selection-1)	34.50	2.15	44.51	21.964	-	8.818	-
V-11	32.50	1.45	28.28	-	-	8.94	26.492
V-13	29.00	1.80	31.32	24.210	-	-	-
V-17 (CIM Vriddhi)	32.00	1.80	34.56	23.977	-	-	-
V-18 (Selection 23)	36.50	1.95	42.71	-	33.231	25.474	-

(V-17). Based on this IET data, 5 high root biomass and essential oil yielding clones namely, V1, V7, V-11, V-13, V-18 (selection 23) were advanced to BST and PST (Table 2, 3) CIM-Vriddhi was again used as a check entry in these trials. In terms of root yield/plot clones V-18, (1055.67); V-7 (1142.33) and V-13 (903.33) consistently performed significanly better over the control variety (Table 2).

The oil content in the roots of these clones varied from 1.17% in V-13 to 1.80% in V-18, 1.78% in V-7, 1.62% in both V-1 & V-17, 1.17% in V-13 and 1.52% in V-11 clones in the BST. When essential oil samples of these clones were qualitative analyses through gas chromatography, oil of clones V-7, V-13 and V-17 (check) only showed the presence of 21.56 to 24.21% khusinol. Interestingly, oil of only

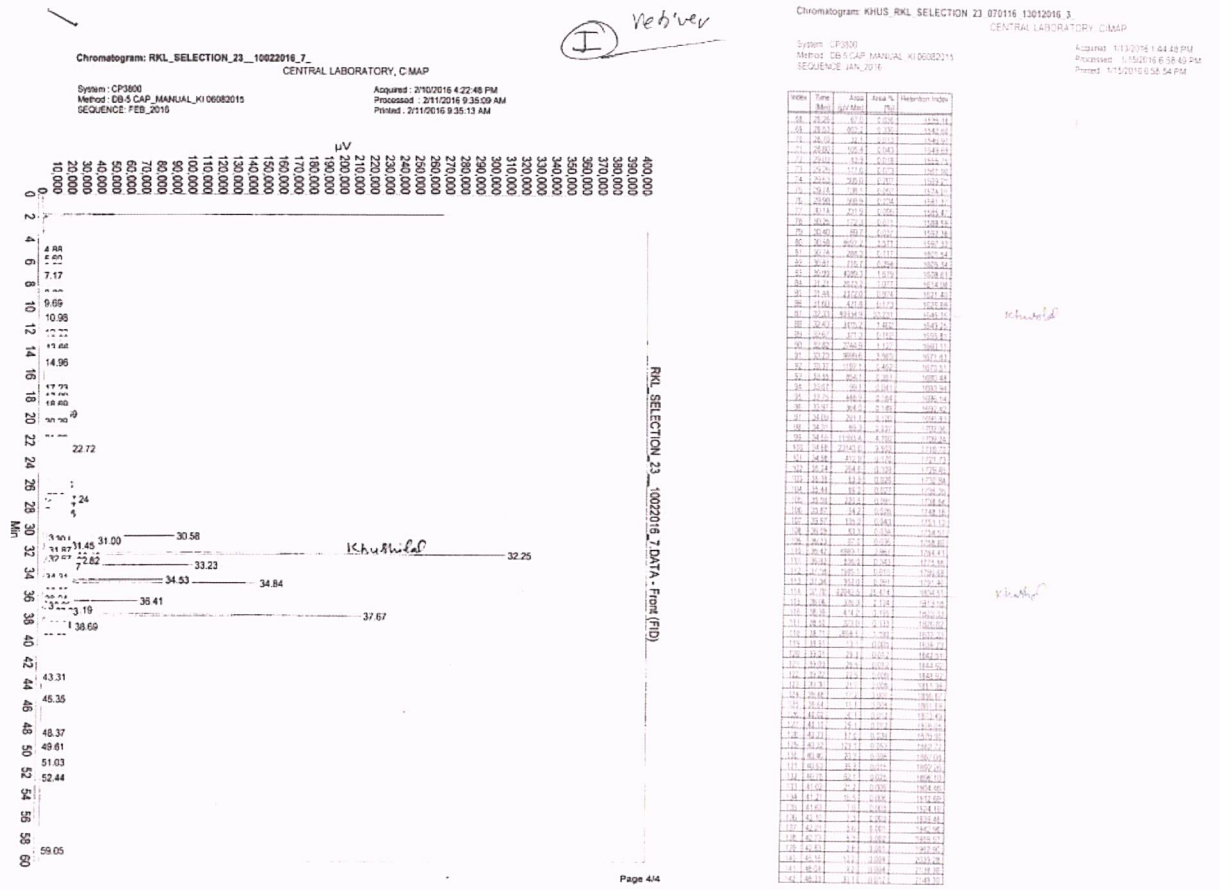

Fig. 1: Gas chromatography data of essential oil of V-18 (selection 23) showing prominent peak of khushilal.

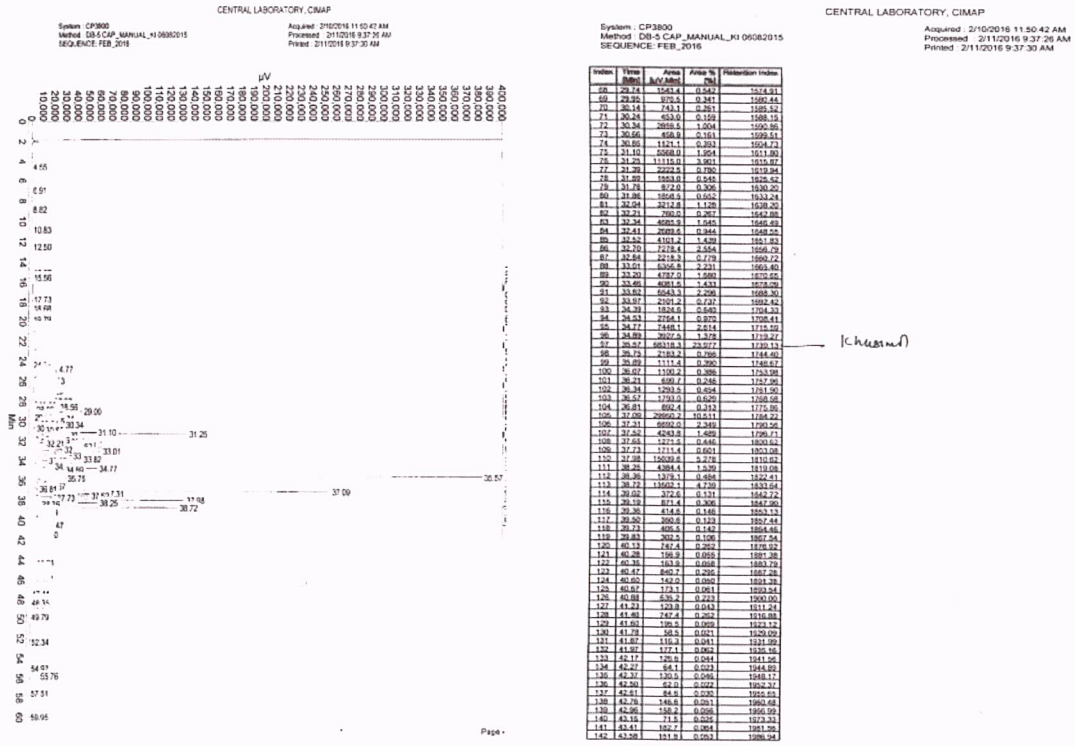

Fig. 2: Gas chromatography data of essential oil of check variety CIM-Vriddhi showing absence of khusilal.

Fig. 3: Field view of clone V-18 (selection-23) of vetiver

Fig. 4: Field view of Check variety CIM-Vriddhi of vetiver

clone V-1 and V-18 indicated the presence of high content (31%) of khushilal (Fig.1). This was absent in CIM-Vriddhi (Fig. 2). These two clones (V-1 & V-18) in addition, also registered high content (18-19%) of another important aroma molecule khusol in their essential oil. Khusol was also detected in oil samples of V-7 and V-11 clones but in lower concentration (8.72 and 8.85 %) respectively. Clone V-11 was the only clone whose root oil had preeizeza 7(15)en-12-ol constituent. Data obtained in PST further substanteated the yield and oil quality data of these selected clones (Table 3; Figs 3-6).

STATEMENT OF DISTINCTION/ BREEDER'S CLAIMS

Clove V-18 (selection 23) of vetiver which is now christened as CIM–Samriddhi is a vigorous and unique chemotype. The unique yellow green

Fig. 5: Root architecture of clone V-18 (left) and Check variety CIM-Vriddhi (right) of vetiver

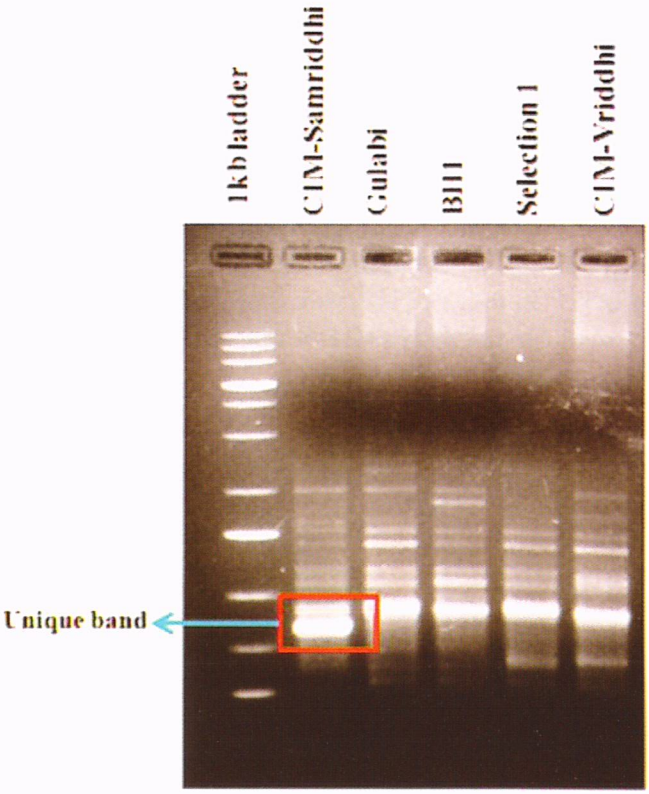

Fig. 6: Differential molecular profile of new variety CIM-Samriddhi of Vetiver (*Chrysopogon zizanioides* (L.) using ISSR primer.

inflorescence and broad dark green leaves are the two main distinguishing morphological features fulfilling the DUS (distinctiveness, uniformity and stability) criteria also. The others distinguishing morphological features of this variety are given in Table-4 below:

Table 4: Description of the new improved variety CIM Samriddhi in comparison to check variety CIM-Vriddhi

Characters	CIM Samriddhi	CIM Vriddhi (Check)
Growth habit	Tall	Medium tall
Mean Plant Height (m)	1.82	1.65
Mean No. of tillers/ plants	78	60
Leaf morphology	Broad	Medium broad
Upper leaves colour (RHS 5th FAN3)	146A,Yellow green	137B, green
Lower leaves colour	146B,Yellow green	138C, green
Inflorescence colour	150B,Yellow green	72C, Red purple
Stem colour	151C,Yellow green	144B,Yellow green
Inflorescence colour	White	Purple
Stigma colour	150C,Yellow green	72B
Mean Root yield (ql/ha)	35	30
Mean Oil content (%)	1.95*	1.75
Mean Oil yield (kg/ha)	35	25
Khusilal content	31 (%)	-
Khusol (%) content	19%	-

Commercially oil content = 1.00%; Year of development: 2011-2015; Year of release: 2016; Amount of planting material available: 1000 slips

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