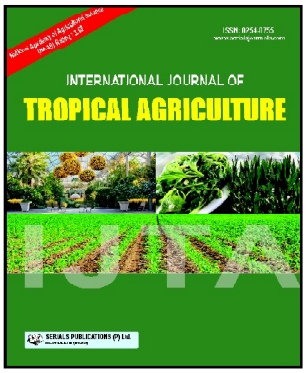

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Performance Evaluation for Essential Oil Yield, Quality and Trend Analysis of Different Palmarosa (*Cymbopogon martinii*) Varieties for Tarai Region of Uttarakhand

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Abstract: Palmarosa (*Cymbopogon martini* var. Motia) is a major essential oil bearing perennial crop. Due to presence of geraniol and geranyl acetate, it is used worldwide in the cosmetic and perfumery industries. The objective of this multiyear study was to screen the best cultivar(s) of palmarosa for commercial scale cultivation in Tarai region of Uttarakhand. In the present study, the six palmarosa varieties named (PRC-1, CIMAP-Harsh, Trishna, CK-10, CN-5 and Tawirosa) were planted to evaluate best performing variety of palmarosa for further recommendation of superior varieties for commercial scale cultivation in Tarai region of Uttarakhand. The results revealed that cultivar CIMAP-Harsh provided significantly highest fresh herb yield (398.58 q $ha^{-1}year^{-1}$), essential oil content (0.71%), and essential oil yield (283.20 kg ha^{-1} $year^{-1}$) average of two year as compared to other existing cultivars of Palmarosa. Finally, it is concluded that cultivar CIMAP-Harsh can be grown as a profitable crop and it is able to play an important role in the sustainable socio economic development in Tarai region of Uttarakhand.

INTRODUCTION

(Cymbopogon martinii L.), Family–"Poaceae" is commonly known as rosha or rosha grass. It is an essential oil bearing grass in the *Cymbopogon* genus originated in India. It is extensively cultivated in India for its aromatic essential oil. The essential oil of palmarosa is rich in geraniol, which is an important aromatic compound, used in cosmetic perfumery and various types of traditional medicinal and household purposes. Palmarosa oil possesses insect repellent, antifungal and nematicidal properties (Mallayarapu, *et. al.*, 1998; Rajeswara, *et. al.* 2005; Rajeswara, *et. al.*,

2014). It is extensively used for rose smelling odour/ perfumes and cosmetics around the world. It is also known to help to flavour tobacco products. Palmarosa oils also used in medicinal solutions for stiff joints, skin disease, bilious complaints, and in aromatherapy (Rajeswara *et. al.*, 2014)

The plant on hydro-distillation yields essential oil containing about 0.40-0.50 % essential oil, which is used in various pharmaceutical, food and cosmetic preparations. The demands of palmarosa essential oil are increasing day by day in national and international market. It is necessary to cultivate high yielding varieties to meet the requirement and minimizes the demand and supply gap. Previously a number of varieties have been developed by various Institutions located in different parts of India. However, these available varieties have not yet been evaluated for their suitability under varied agroclimatic conditions. Therefore, it is felt an urgent need to evaluate the existing varieties/cultivars for screen out the regional specific best performing cultivar(s) in term of maximum essential oil yield and income in sustainable manner. Keeping in view of the above, the present investigation was conducted to screen out the best cultivar of palmarosa for recommendation of commercial scale cultivation in Tarai region of Uttarakhand.

MATERIALS AND METHODS

A field experiment was conducted at the research farm of CSIR-Central Institute of Medicinal and Aromatic Plant, Research Centre, Pantnagar (Udham Singh Nagar) Uttarakhand, India during summer season 2014-15 and 2015-16. The experimental site is located between 29°N latitude and 79.38°E longitude and at an altitude of 243 m above mean sea level. The maximum temperature ranges between 35 to 45°C, and minimum between 2 to 5°C. At proper tilth, field was ploughed once with soil turning plough by tractor followed by cross-harrowing with the help of disk harrow. After harrowing, planking was done to level the field and obtain fine tilth which is necessary for proper plant growth. The experimental soil in field up to furrow slice level (15 cm depth) was sandy-loam in texture, neutral in reaction (7.4 pH), medium in organic carbon (0.58%), low in available nitrogen (138 kg ha^{-1}), and medium in available phosphorus (14 kg ha^{-1}) and potassium (145 kg ha^{-1}). The field experiment was laid out in a randomized block design with four replication keeping 6 treatments of prevailing cultivars as, T_1-PRC-1; T_2- CIMAP-Harsh; T_3- Trishna; T_4- CK-10; T_5- CN-5; and T_6- Tawirosa.

Transplanting of palmarosa cultivars as per treatment was done at 60 × 30 cm spacing during first fortnight of July 2014 and July 2015 through nursery raised seedling at 35th day stage. The experimental field was fertilized with 150 kg N, 80 kg P_2O_5, and 60 kg K_2O ha^{-1}. The full dose P&K were applied as basal, and N was applied in five equal doses as 1/5 basal, 1/5 at 35 days after transplanting (DAT), and remaining three doses were applied after each harvest. Total four harvests were taken in each year 2014-15 and 2015-16 at the interval of three months. The observation were recorded on different parameters, *viz.* plant height (cm), numbers of tillers per plant, fresh herb yield (q ha^{-1} $year^{-1}$), oil content (%) (The oil was distilled using Cleavenger type apparatus) and oil yield (kg. $ha^{-1}year^{-1}$). Statistical analysis of two year pooled data was done following as per standard procedures (Snedecor & Cochran, 1967).

RESULTS AND DISCUSSIONS

The analysis of variance over years and in pooled data of both years indicated that mean square due to varieties/cultivars were found to be highly significant for all the traits indicating the existence of substantial variability in productivity different characters. The relative mean value provides important information on the magnitude of yield potential of the all varieties in the Tarai region of Uttarakhand. The data pertaining to plant height

(cm), numbers of tillers plant^{-1}, fresh herb yield (q ha^{-1} year^{-1}), oil content (%), and oil yield (kg ha^{-1} year^{-1}) are presented in table 1. The wide range of variability among all the six varieties/cultivars as plant height tallest variety was T3 (cultivar Trishna) 185 cm followed by T2-CIMAP Harsh (182cm) and T1-PRC-1.181 cm the varieties was T6-Tawirosa (Verma *et. al.*, 2010). The no. of tillers/plant were found highest in the variety CIMAP Harsh (138) followed by Trishna = 118. The highest herb yield was recorded in the variety CIMAP Harsh 395.58 ql/hac/year followed by variety T_4 (CK-10) 385.20 ql/hac/year. The oil content was highest in the variety T_2 -CIMAP Harsh 0.71% The lowest oil content was obtained in the variety T_4 CK-10(0.37%) in order (Table 1 and 2; Figure 1). The oil yield was highest in the cultivar T_2-CIMAP Harsh (283.20kg/ha/year) followed by T1-PRC-1 262.18kg/ha/year. The T_4-(CK-10) was the lowest oil yielding (142.25 kg/ha/year) variety in our experiment.

Overall in nutshell scrutiny of data indicates that palmarosa variety CIMAP-Harsh (T_2) released by CSIR-CIMAP in the year 2010 (Lal et.al., 2010) provided significantly highest plant height (182 cm), highest numbers of tillers plant^{-1} (138), fresh herb yield (398.58 q ha^{-1}year^{-1}), oil content (0.71%), and oil yield (283.20 kg ha^{-1}year^{-1}), followed by PRC-1 (T_1) having plant height (181 cm), numbers of tillers plant^{-1} (114), fresh herb yield (374.00 q ha^{-1}year^{-1}), oil content (0.70%), and oil yield (262.18 kg ha^{-1} year^{-1}) except plat height highest for T_3-Trishna = (185 cm) however lowest performance were observed in palmarosa variety T4-CK-10 for oil content(0.37%) and oil yield 142.25 kg ha^{-1}year^{-1}.

Among the varieties, the essential oil yield was decreases in following order T_2-CIMAP-Harsh (283.20 kg ha^{-1} year^{-1})> T_1-PRC-1 (262.18 kg ha^{-1} year^{-1})> T_3-Trishna (236.55 kg ha^{-1} year^{-1})> T_6-Tawirosa (184.27 kg ha^{-1} year^{-1})> T_5-CN-5 (174.93 kg ha^{-1} year^{-1})>, and lowest was recorded in T_4-CK-10 (142.25 kg ha^{-1} year^{-1}). Similar observations were also made by Jayalakshmi, *et. al.* (2013) and Rajeswara *et. al.* (2014). Notwithstanding the fact that among all the palmarosa cultivar the variety CIMAP-Harsh was highest essential oil yielding, because it's bearing thin stem and long inflorescence as compared to others those having thick hardy stem and small inflorescence. The meticulous study of result indicated that the cultivar "CIMAP-Harsh" had capacity to provide highest quantity with better quality essential oil as well as high return and income to the farmers of Uttarakhand with minimum inputs.

Table 1

Performance of different cultivars of Palmarosa (*Cymbopogon martinii*) under Tarai region of Uttarakhand*.

Treatment	*Plant height (cm)*	*No. of tiller plant^{-1}*	*Fresh herb yield (q ha^{-1}year^{-1})*	*Oil content (%)*	*Oil yield (kg ha^{-1}year^{-1})*	*Geraniol (%)*
V_1	181	114	374.00	0.70	262.18	83.1
V_2	182	138	398.58	0.71	283.20	88.6
V_3	185	118	343.55	0.69	236.55	75.9
V_4	176	95	385.20	0.37	142.25	89.9
V_5	161	103	345.95	0.51	174.93	64.2
V_6	143	105	347.23	0.53	184.27	58.2
$SEm_{\pm}$	3.60	0.59	5.89	0.01	4.42	–
$LSD_{(P=0.05)}$	10.87	1.79	17.75	0.02	13.33	–

V_{-1}- PRC-1; V_{-2}- CIM-Harsh; V_{-3}- Trishna; V_{-4}- CK-10; V_5- CN-5; V_{-6}- Tawirosa.

*Average of two years (2014-15 and 2015-16).

Table 2
Analysis of variance (ANOVA)

SV	*DF*	*SS*	*MSS*	*F cal.*	*F tab.*
Plant height					
Rep.	3	281.6771	93.89236	1.804658	3.29
Treat.	5	5264.021	1052.804	20.23542	2.9
Error	15	780.4167	52.02778		
Total	23	6326.115	275.0485		
No. of tiller					
Rep.	3	90.57031	30.1901	21.33419	3.29
Treat.	5	4526.492	905.2984	639.7398	2.9
Error	15	21.22656	1.415104		
Total	23	4638.289	201.6647		
Fresh herb yield					
Rep.	3	659.2233	219.7411	1.584312	3.29
Treat.	5	11007.6	2201.521	15.87275	2.9
Error	15	2080.472	138.6981		
Total	23	13747.3	597.7087		
Oil content					
Rep.	3	5.286	1.762	0.108359	3.29
Treat.	5	0.3826513	0.0765303	470.6035	2.9
Error	15	0.0024393	0.0001626		
Total	23	0.3851435	0.0167454		
Essential oil yield					
Rep.	3	358.9019	119.63397	1.529429	3.29
Treat.	5	60708.677	12141.735	155.2228	2.9
Error	15	1173.3201	78.221339		
Total	23	62240.899	2706.126		

CONCLUSION

Palmarosa variety "CIM-Harsh" provided highest fresh herb yield (398.58 q $ha^{-1}year^{-1}$), oil content (0.71%), and oil yield (283.20 kg ha^{-1} $year^{-1}$) an average of two year from four harvests per year, as compared to other existing varieties. Therefore, it is recommended that farmers of Tarai region of Uttarakhand can grow "CIMAP-Harsh" variety for the commercial scale cultivation to get higher essential oil yield as well as income in sustainable manner.

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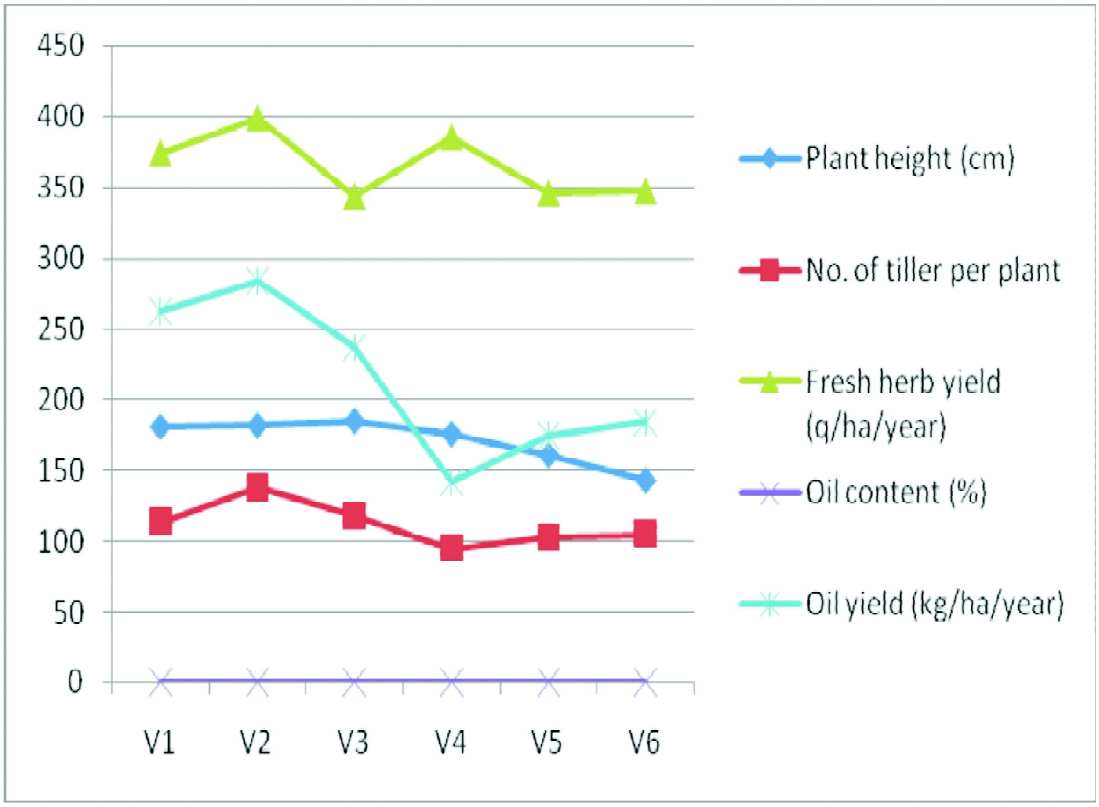

Figure 1: Performance of different cultivars of Palmarosa (*Cymbopogon martinii*) under Tarai region of Uttarakhand

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