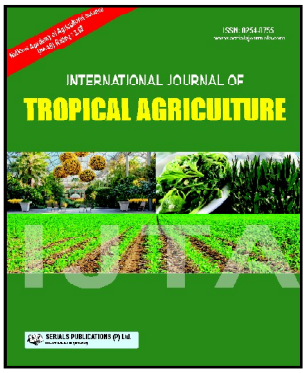

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Evaluation and screening of best variety of Citronella (*Cymbopogon winterianus* L.) for commercial scale cultivation in Tarai region of Uttarakhand

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Abstract: A field experiment was conducted at Central Institute of Medicinal and Aromatic Plants, Research Centre Pantnagar, Uttarakhand, India during 2014-15 and 2015-16 to screen the best variety of Citronella for commercial scale cultivation in the Tarai region of Uttarakhand. Under this experiment, a total of four varieties (Bio-13, CIM-Jeeva, Manjusha and Jorlab C-2) were planted in a randomized block design and grown following recommended agro-practices. The results revealed that variety Bio-13 provided significantly highest plant height (137 cm), number of tillers plant^{-1} (79), fresh herb yield (308.8 q ha^{-1}year^{-1}), and essential oil yield (386.41 kg ha^{-1}year^{-1}) on an average basis from two years as compared to the rest varieties of Citronella. However, the maximum essential oil content was observed in variety CIM-Jeeva (1.4%), followed by Bio-13 (1.3%) with the lowest in variety Manjusha (1.1%). This study concluded that variety Bio-13 can be grown as a profitable crop and it is able to play an important role in the sustainable socio-economic development in this region.

Keywords: *Cymbopogon winterianus*, citronella, variety, screening, essential oil yield, Bio-13.

INTRODUCTION

Cymbopogon winterianus L. is commonly known as Java citronella. It is an essential oil bearing grass in the *Cymbopogon* genus. Java citronella is a robust, aromatic, evergreen, perennial, clump-forming grass with numerous erect culms arising from a short rhizome. The plant is often cultivated, mainly in Java and other parts of Southeast Asia for the essential oil

production. This oil is widely used in the perfumery, various pharmaceutical, food and cosmetic preparations. This species yields up to twice as much essential oil as the related *Cymbopogon nardus* (which is grown mainly in Sri Lanka), and the oil is of better quality. It is extensively cultivated in India for the production of its aromatic essential oil. The essential oil of citronella is rich in citronellal, citronellol, and geraniol, which are important aromatic compounds, widely used in perfumery products and cosmetics, either directly or as a starting material for the production of other aroma compounds. Citronella oil possesses insect repellent, mosquito repellent, antibacterial, and antifungal properties (Nakahara, *et. al.,* 2003; Pattnaik, *et. al.,* 1996; Trongtokit, *et. al.,* 2005). Citronella oil is an effective repellent for body louse, head louse, stable flies and in aromatherapy (Mumcuoglu *et. al.,* 1996).

The leaves of the plant yield an essential oil up to 1.0-1.4% on hydrodistillation. The demand of Citronella essential oil is increasing gradually in national and international market. Therefore, it is necessary to develop and cultivate high yielding varieties to meet the industrial requirement and minimizes the demand and supply gap. Previously, a number of citronella 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, there is an urgent to evaluate the existing varieties/genotypes and screen out the best performing variety/varieties for different regions to get maximum yield and income in sustainable manner. Keeping in view of the above, the present investigation was undertaken to screen out the best variety of java citronella for commercial scale cultivation in the Tarai region of Uttarakhand.

MATERIALS AND METHODS

A field experiment was conducted at CSIR-Central Institute of Medicinal and Aromatic Plant, Research Centre, Pantnagar (Udham Singh Nagar) Uttarakhand, India during summer season 2014-15 and 2015-16 with an objective to screen the best performing variety of Citronella in terms of higher essential oil yield, return and profit to the farmers of Uttarakhand. The experimental site is located at 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 (0.57%), low in available nitrogen (136 kg ha^{-1}), and medium in available phosphorus (13 kg ha^{-1}) and potassium (142 kg ha^{-1}). The experiment was laid out in a Randomized Block Design with five replication keeping 4 treatments of prevailing varieties as, V_{-1}- Bio-13; $V-_2$- CIM-Jeeva; $V-_3$- Manjusha; and $V-_4$- Jorlab C-2.

Planting of Citronella cultivars as per treatment was done at 60×30 cm spacing during first fortnight of July in two consecutive years (2014 and 2015) through the slips. 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. The 30 kg N was applied after each harvest in second year. Total four harvests were taken in each year 2014-15 and 2015-16 at the interval of three months. The observation on different parameters, viz. plant height (cm), numbers of tillers per plant, fresh herb yield (q $ha^{-1}year^{-1}$), oil content (%) by Clevenger apparatus (Clevenger, J.F. 1928), and oil yield (kg $ha^{-1}year^{-1}$) were observed and presented in Table-1. Statistical analysis

of two year polled data was done for analysis of variance (ANOVA) (Table-2) following standard procedures (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSIONS

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}) is presented in Table 1. The scrutiny of data (Table 1 and Fig. 1) indicates that Citronella variety Bio-13 (V_1) provided significantly highest plant height (137 cm), numbers of tillers plant^{-1} (79), fresh herb yield (308.8 q ha^{-1}year^{-1}), and oil yield (386.41 kg ha^{-1}year^{-1}), followed by CIM-Jeeva (V_2) having plant height (129 cm), fresh herb yield (250.8 q ha^{-1}year^{-1}), and oil yield (343.99 kg ha^{-1}year^{-1}); and the lowest performance indicators were observed in citronella variety Manjusha (V_3). However the maximum essential oil content was observed in CIM-Jeeva (1.4%), followed by Bio-13 (1.3%), and the lowest was observed in Manjusha (1.1%). Among the varieties, the essential oil yield was decreases in following order: V_1-Bio-13 (386.41 kg ha^{-1}year^{-1})> V_2-CIM-Jeeva (343.99 kg ha^{-1}year^{-1})> V_4-Jorlab C-2 (320.95 kg ha^{-1}year^{-1}, and lowest was recorded in V_3-Manjusha (282.71 kg ha^{-1}year^{-1}). The variety Bio-13 gave higher yield, because it bears wider and elongate leaves as compared to other varieties that are bearing narrow leaves. Results obtained, makes it clear that the variety 'Bio-13' can provide higher essential oil yield as well as return and income to the farmers of Uttarakhand.

CONCLUSIONS

Citronella variety 'Bio-13' provided highest fresh herb yield (308.8 q ha^{-1}year^{-1}) and oil yield (386.41 kg ha^{-1}year^{-1}) with good quality essential oil on an average of two year from four harvests per year, as compared to other varieties. Therefore, it is recommended that farmers of the Tarai region of Uttarakhand can grow

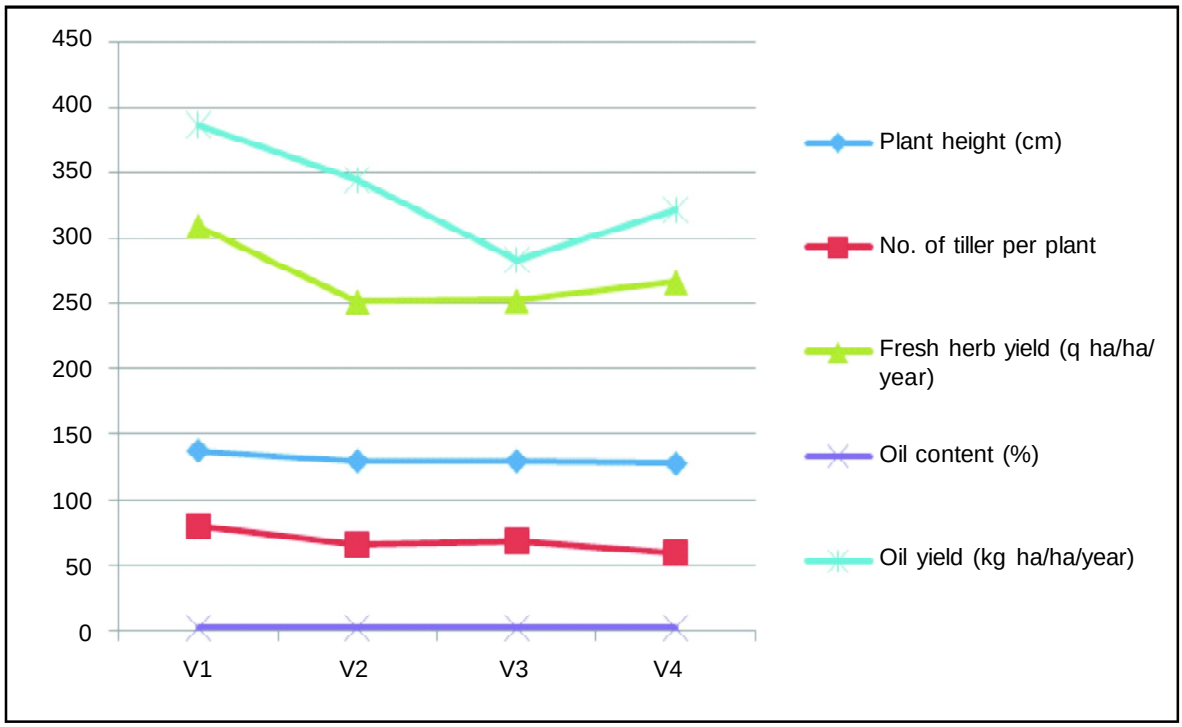

Figure 1: Performance of different cultivars of Citronella (*Cymbopogon winterianus*) under the Tarai region of Uttarakhand

V_{-1}- Bio-13; V_{-2}- CIM-Jeeva; V_{-3}- Manjusha; V_{-4}- Jorlab C-2.

Table 1
Performance of different cultivars of Citronella (*Cymbopogon winterianus*) under the 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})*
V_1	137	79	308.8	1.3	386.41
V_2	129	65	250.8	1.4	343.99
V_3	129	68	251.5	1.1	282.71
V_4	127	59	265.7	1.2	320.95
$SEm_{\pm}$	1.04	0.96	5.04	0.01	6.42
$LSD_{(P=0.05)}$	3.20	2.95	15.52	0.03	19.84

V_{-1}- Bio-13; V_{-2}- CIM-Jeeva; V_{-3}- Manjusha; V_{-4}- Jorlab C-2.

Table 2
Analysis of variance (ANOVA)

SV	*DF*	*SS*	*MSS*	*F cal.*	*F tab.*
Plant height					
Rep.	4	27.8125	6.953125	1.284889	3.26
Treat.	3	275.6094	91.86979	16.9769	3.49
Error	12	64.9375	5.411458		
Total	19	368.3594	19.38734		
No. of tiller					
Rep.	4	30.29375	7.573437	1.654454	3.26
Treat.	3	1027.975	342.6583	74.85539	3.49
Error	12	54.93125	4.577604		
Total	19	1113.2	58.58947		
Fresh herb yield					
Rep.	4	499.2031	124.8008	0.983807	3.26
Treat.	3	11166.68	3722.227	29.34239	3.49
Error	12	1522.259	126.8549		
Total	19	13188.14	694.1129		
Oil content					
Rep.	4	0.001804	0.000451	1.183682	3.26
Treat.	3	0.158103	0.052701	138.2892	3.49
Error	12	0.004573	0.000381		
Total	19	0.164481	0.008657		
Essential oil yield					
Rep.	4	871.4836	217.8709	1.051228	3.26
Treat.	3	28231.73	9410.576	45.40608	3.49
Error	12	2487.044	207.2536		
Total	19	31590.25	1662.645		

'Bio-13' variety of Citronella for commercial scale cultivation to get higher essential oil yield as well as income in sustainable manner.

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