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Cultivation Potential of Three Rose-scented Geranium (*Pelargonium graveolens*) Cultivars in the Kumaon Region of Western Himalayas

Amit Chauhan* • **Ram Swaroop Verma**

Central Institute of Medicinal and Aromatic Plants, Research Centre, Pantnagar, P.O. - Dairy Farm Nagla, Udham Singh Nagar, Uttarakhand 263149, India

Corresponding author: * **amitcimap@rediffmail.com**

ABSTRACT

A field experiment was conducted to evaluate the production potential of three cultivars of rose-scented geranium viz., 'Bourbon', 'CIM-Pawan' and 'Kelkar' in the temperate region of Uttarakhand. 'CIM-Pawan' had the highest essential oil yield (103.87 g plot^{-1}) followed by 'Kelkar' (79.93 g plot^{-1}) and 'Bourbon' (72.01 g plot^{-1}). The essential oil profile of 'Bourbon' was rich (relative percentages) in citronellol (29.05), geraniol (24.36), citronellyl formate (5.94), isomenthone (5.82); the oil of 'CIM-Pawan' was rich in citronellol (32.60), geraniol (21.38), 10-*epi*-γ-eudesmol (6.83), citronellyl formate (6.29) while the essential oil of 'Kelkar' showed a different profile with citonellol (61.48) and isomenthone (10.56) being almost twice that of other cultivars.

Keywords: composition, cultivars, essential oil yield
Abbreviations: FID, flame ionization detector; **GC**, gas chromatography; **GC-MS**, gas chromatography-mass spectrometry

INTRODUCTION

Pelargonium graveolens L'Herit *ex* Ait. (Family Geraniaceae), with the common name rose-scented geranium, is an important high value perennial, aromatic shrub. The essential oil (EO), which possesses a tenacious rose-like odour, is the most widely traded product of rose-scented geranium. The main constituents of the EO are citonellol, geraniol, isomenthone, citronellyl formate and geranyl formate. The EO is largely utilized in the perfumery, cosmetic and aromatherapy industries all over the world. It is one of the best skincare oils because it is good for opening skin pores and cleaning oily complexions (Swamy *et al*. 1960; Weiss 1997; Miller 2002; Peterson *et al*. 2006). The other use of geranium leaves is in the form of herbal tea to treat distress, fight anxiety, ease tension, improve circulation and cure tonsillitis (Peterson *et al*. 2006). A study between the EO of geranium and tropical capsaicin, a commonly prescribed conventional remedy for shingles pain, showed that geranium EO was extremely useful in reducing pain due to post-herpetic neuralgia followed by shingles (Greenman *et al*. 2003).

Worldwide, annual geranium EO production is estimated to be worth about US$ 12.5 million (Williams and Harborne 2002). Trade in EOs is expected to increase in the future as a result of the growing number and preferences of consumers, and the continuously widening uses of EO constituents (Sangwan *et al*. 2001). The current international demand of about 600 t of geranium oil is being met largely by China, Egypt, Morocco, Reunion Island and South Africa. Therefore, most of the 145 t requirement of geranium oil of the Indian industry is being met through imports (Ram *et al*. 2004).

In India, geranium is being grown in Nilgiri, the Pulney hills of Tamil Nadu, and on the plains of Andhra Pradesh, Karnataka, Maharashtra and Uttar Pradesh. It is cultivated as a rain-fed perennial crop in hills and an annual crop in plains of Northern India (Rao *et al*. 1990; Ram *et al*. 1995, 1996). The productivity and quality of different geranium cultivars has also been assessed in the Tarai region of Uttarakhand (Ram *et al*. 2004) and its possible cultivation in perennial conditions was exploited by CIMAP in the hills of Uttarakhand (Anonymous 2003; Verma *et al.* 2010). However, studies on the comparative performance of different cultivars of rose-scented geranium are not available from the hilly regions of Northern India.

Therefore, as part of our institute's mandate to develop the agricultural and processing technologies of economically viable crops and to disseminate these technologies to beneficiaries, the present study was conducted to assess the production and quality potential of different cultivars of rose-scented geranium in the valley region of western Himalaya.

MATERIALS AND METHODS

The experiment was performed at the experimental farm of the Central Institute of Medicinal and Aromatic Plants, Research Centre, Purara, Bageshwar, Uttarakhand, India, during 2008-2009. The experimental location experiences a temperate (Western Himalayan region of India) climate; the soil is sandy loam with pH 6.8 (soil: water, 1:2.5), 0.40% organic carbon, 145 kg ha^{-1} available nitrogen, 11.0 kg ha^{-1} available P, 130 kg ha^{-1} exchangeable K (Verma *et al*. 2009).

The experiment was initiated on the 15th February 2009. Well developed one-month-old rooted cuttings (which were taken from 2-year-old mother plants with 2-3 leaflets and were planted in a polybag containing local farm soil on the 15th January 2009 under polyhouse conditions) of three cultivars (treatments), namely 'Boubon', 'CIM-Pawan' and 'Kelkar', were transplanted. Transplanting was done in plots of 5 m × 3 m replicated three times in a completely randomized block design. The spacing was maintained at 50 cm × 50 cm with the total number of plants per plot = 60. The recommended dose of fertilizers, i.e., N: P: K at 100: 60: 60 kg ha^{-1}, was applied. Before transplanting, a full dose of P, K and a half-dose of N together with vermicompost, at the rate of 2.5 t ha^{-1}, were applied. The remaining N was top dressed in two equal splits at monthly intervals. The plots were irrigated immediately after

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Research Note

Table 1 Growth and yield performance of rose-scented geranium cultivars in temperate region of Uttarakhand.

Cultivars	Plant height (cm)	Canopy (cm^2)	Branches/plant	Leaf/stem ratio	Oil content* (%)	Herb yield (kg/plot)	Oil yield (g/plot)
Bourbon	59.56	65.30	5.66	2.06	0.19	42.86	72.01
CIM-Pawan	85.53	80.66	7.33	1.61	0.22	51.70	103.87
Kelkar	93.00	69.16	5.66	1.31	0.11	80.76	79.93
CD 5 %	4.50	2.93	1.41	0.37	0.02	2.68	12.05

*calculated on a laboratory basis

transplanting and further irrigation was provided at monthly intervals in spring (March-April) and at fortnightly intervals in summer (May-June). Other agronomic practices needed during the cropping period were applied uniformly.

In each plot 20 plants replication^{-1} were randomly selected for observations on morphological characters such as plant height, canopy, number of branches plant^{-1} and leaf/stem ratio. The crop was harvested 120 days after planting; herb yield, EO content and EO yield from harvested biomass was determined. Oil yield was computed by multiplying herbage yield with oil content.

Essential oil extraction and analysis

The EO was extracted by hydro-distillation for 3 h using a Clevenger-type apparatus. The oil content (w/v %) was estimated on a fresh weight basis. The oil samples obtained were dehydrated over anhydrous sodium sulphate and kept in a cool and dark place prior to GC analysis.

The oil samples were subjected to GC analysis on a Nucon gas chromatograph model 5765 equipped with an FID using a CP-WAX 52CB fused silica capillary column (30 m × 0.32 mm × 0.25 µm film thickness). Hydrogen was used as a carrier gas at the rate of 1.0 ml min^{-1}. Injector and detector temperatures were 200 and 230°C, respectively. The oven temperature was programmed from 70-230°C at 4°C/min with an initial hold time of 2 min. Identification was done on the basis of retention index (determined with reference to homologous series of *n*-alkanes (C9-C24) under identical experimental conditions), co-injection with known compounds, and MS Library search (NIST and WILEY), by comparing with the MS literature data (Davies 1990; Adams 1995). The retention times of standards/marker constituents of known EOs were also used to confirm the identities of constituents. The relative amounts of individual components were calculated based on GC peak area (FID response) without using a correction factor.

Statistical analysis

The experimental data were statistically analyzed by analysis of variance. Estimation of the significance of differences between means was based on a probability of $p < 0.05$ (Snedecor and Cochran 1989).

RESULTS AND DISCUSSION

The data in **Table 1** shows the comparative growth and yield attributes of the three cultivars of rose-scented geranium. 'Kelkar' attained maximum plant height and was significantly superior to the other two cultivars. Maximum canopy extent was recorded in 'CIM-Pawan' (80.66 cm), significantly higher than 'Kelkar' (69.16 cm) and 'Bourbon' (65.30 cm). A similar trend was also observed in the Tarai region of Uttarakhand in the case of 'CIM-Pawan' (Ram *et al*. 2004). 'CIM-Pawan' also recorded the maximum number of branches plant^{-1} (7.33), while 'Bourbon' and 'Kelkar' had the same number of branches plant^{-1} (5.66). 'Bourbon' had the maximum leaf/stem ratio (2.06), followed by 'CIM-Pawan' (1.61) and 'Kelkar' (1.31).

The highest oil content (0.22%) was recorded in the fresh biomass of 'CIM-Pawan', which was significantly superior to the other two cultivars. The oil content of 'Kelkar' was lowest (0.11%), although it produced the highest herb yield (80.76 kg plot^{-1}) among the three cultivars. Earlier studies showed a more or less similar trend except that the herb yield of 'Kelkar' was lower than the superior cultivar 'CIM-Pawan' in the Tarai region when compared with the herb yield in the valley regions of western Himalaya (Ram *et al*. 2004). 'Bourbon' had intermediate oil content (0.19%) and herb yield (42.86 kg plot^{-1}) among the three cultivars. The oil content of 'Bourbon' was higher than in previous studies from South India (Rao *et al*. 1990), north Indian Plains (Jain *et al*. 2001) and even in the Kashmir valley (Shawl *et al*. 2006).

Table 2 Qualitative performance of three cultivars of rose-scented geranium in temperate region of Uttarakhand.

Compound	Relative peak area (%)		
	'Bourbon'	'CIM-Pawan'	'Kelkar'
Menthone	0.23	0.17	0.23
(*E*)-Linalool oxide	t	t	1.26
Isomenthone	5.82	5.80	10.56
β-Bourbonene	0.16	t	t
Linalool	4.83	3.25	0.32
β-Caryophyllene	0.15	0.17	0.56
Citronellyl formate	5.94	6.29	1.18
Citronellyl acetate	0.97	0.80	0.22
Geranyl formate	3.70	2.62	t
Geranial	1.03	1.17	1.79
γ-Cadinene	0.51	0.15	t
Geranyl acetate	t	0.23	t
Citronellol	29.05	32.60	61.48
Nerol	0.29	0.37	t
Citronellyl butyrate	0.32	0.32	-
Geraniol	24.36	21.38	0.61
Geranyl isovalerate	0.64	0.21	t
Geranyl butyrate	0.44	0.26	t
10-*epi*-γ-Eudesmol	5.50	6.83	0.27
Geranyl tiglate	1.41	1.85	0.18
2-Phenyl ethyl tiglate	0.29	0.76	0.30
C/G ratio	1.19	1.52	100.78

There was an obvious disparity in the percentage of different EO components in all three cultivars (**Table 2**). The major components of the EO of 'Bourbon' were citronellol (29.05%), geraniol (24.36%), citronellyl formate (5.94%), isomenthone (5.82%); the EO of 'CIM-Pawan' was represented with major proportions of citronellol (32.60%), geraniol (21.38%), 10-*epi*-γ-eudesmol (6.83%), citronellyl formate (6.29%). Unlike the EO of the other two cultivars, that of 'Kelkar' showed marked variation in percentage of major components. The major component, citonellol was almost twice (61.48%) that of the EOs of 'Bourbon' and 'CIM-Pawan'. Another major component in the EO of 'Kelkar' was isomenthone (10.56%). However, the other major components in the oils of 'Bourbon' and 'CIM-Pawan' viz., linalool, citrnellyl formate, geranyl formate and 10-*epi*-γ-eudesmol were found in very small quantities in the EO of 'Kelkar'.

The citronellol to geraniol (C/G) ratio is an important factor which determines the quality of EO of geranium. Generally, geranium oil with a C/G ratio 0.5-2.0 possesses a good odor value and is accepted by the perfume industry (Saxena *et al*. 2000). Thus, the present study showed that the cultivars 'CIM-Pawan' and 'Bourbon' with a C/G ratio 1.52 and 1.19, respectively were superior to 'Kelkar'. Furthermore, 'Kelkar' may be used as a rich source of natural citronellol.

In conclusion, 'CIM-Pawan' outperformed other culti-

vars in fresh biomass and EO yield followed by 'Bourbon' in the valley region of western Himalayas. There was considerable variation in the chemical composition of the EO, possibly due to the genetic makeup of the cultivars and also due to geographical regions of cultivation (Ram *et al*. 2004).

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