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Changes in the essential oil composition of rose-scented geranium (*Pelargonium graveolens* L'Herit. ex Ait.) due to date of transplanting under hill conditions of Uttarakhand

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A study was carried out to determine the effect of transplanting date on the essential oil composition of rose-scented geranium (*Pelargonium graveolens* L'Herit. ex Ait.) cultivar 'CIM-Pawan' under hill conditions of Uttarakhand, India. The crops were raised using five months of transplanting, viz. December, January, February, March and April. The oil was extracted by hydro-distillation and analyzed by capillary gas chromatography. The main components of the oil were citronellol (21.3-28.7%), geraniol (23.1-38.4%), linalool (4.2-6.5%), *iso*-menthone (6.5-7.9%), citronellyl formate (6.3-8.3%), 10-*epi*-γ-eudesmol (4.7-5.6%) and geranyl formate (3.3-4.3%). The results indicated that the essential oil components were affected significantly by transplanting time. The citronellol/geraniol ratio (C: G), quality determining factor was found to vary from 0.55 to 1.16 in these oils which was well within the desired limit. Nevertheless, oil with best C:G ratio was obtained from January (0.99) and February (0.92) planted crops; showing the effect of crop duration.

Keywords: Essential oil, *Pelargonium graveolens*, Rose-scented geranium, Transplanting time, Hill conditions.
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Introduction

The rose-scented geranium (*Pelargonium graveolens* L'Herit. ex Ait.), member of family Geraniaceae is growing in China, Egypt, Algeria, Morocco and Reunion Island for the production of essential oil. The essential oil of geranium, obtained by steam or hydro-distillation of the aerial parts, is one of the most important items in the perfumery, cosmetic, food and pharmaceutical industries[1,2]. It is known as the "women's oil" because of its menstrual and menopausal benefits. Beside this, it is also useful for problems like eczema and athlete's foot, and for mite control[3,4]. The geranium oils are characterized by presence of citronellol, geraniol, *iso*-menthone, linalool and wide range of esters, such as geranyl formate, citronellyl formate, geranyl acetate, geranyl propionate, citronellyl butyrate, 2-phenylethyl, citronellyl and geranyl tiglates. The oils also contained many sesquiterpenes of which guaia-6, 9-diene and 10-*epi*-γ-eudesmol are the most important[5-9].

Rose-scented geranium (Plate 1) is being cultivated in hilly tracks of North and South India as a potential aromatic crop. In practice, it's transplanting starts in winter and continues till spring and all farmers prefer to harvest and process it in summer i.e. before break of monsoon. Previous studies indicated that essential oil composition of rose-scented geranium is influenced by number of factors, viz. cultivars and method of distillation[10], type of distillation unit used[11, 12], storage of oil[13], plant part distilled[6], age of leaves[14], seasonal changes[15] and location of growing[16]. Literature survey revealed that there is no report on effect of date of transplanting on essential oil composition of rose-scented geranium grown in Kumaon region of Uttarakhand. Therefore, in paucity of such valuable information present investigation was undertaken.

Materials and Methods

Field studies, Soil and Climate

Two month old rooted cuttings of rose-scented geranium cultivar 'CIM-Pawan' were transplanted on five different dates, viz. 15 December, 15 January, 15 February, 15 March, and 15 April, at 50 × 50 cm plant spacing in the experimental field of Central Institute of Medicinal and Aromatic Plants, Research Center, Purara, Uttarakhand, India. The soil *p*H, organic carbon, available nitrogen, available phosphorus and

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Plate 1 — Rose-scented geranium (Field view)

available potassium were 6.5, 0.35%, 175, 7 and 135 kg/ha, respectively. The site is located between the coordinates 28° 60′ to 31° 29′ N, 77° 49′ to 80°60′ E and at a height of 1250 m in Kattyur valley. Climatologically, it is categorized as sub-temperate (1200-1700 m altitude) zone. The monsoon usually breaks in June and continues up to September. The crops were raised following standard agricultural practices and harvested on 15 June.

Isolation and analysis of essential oil

The essential oil from each crop was extracted by hydro-distillation of fresh herbage for 3 hours using Clevenger apparatus. The oil obtained were dehydrated over anhydrous sodium sulphate and kept in a cool and dark place before analyses.

The GC analysis of the oil samples was carried out on a Nucon gas chromatograph model 5765 and Perkin-Elmer Auto XL GC equipped with FID and two different stationary phases, BP-20 (coated with a Carbowax 20M, 30 m × 0.25 mm × 0.25 µm film thickness) and PE-5 (60 m × 0.32 mm; 0.25 µm film coating) fused silica capillary columns, respectively. Hydrogen was the carrier gas at 1.0 ml/min. Temperature programming was done from 70 to 230°C at 4°C/min with initial and final hold time of 2 min (for BP-20) and from 70 to 250°C at 3°C/min (for PE-5). Split ratio was 1:30. The injector and detector temperatures were 200 and 230°C on BP-20 and 220 and 300°C on PE-5 column, respectively. The GC-MS analysis of the oils was carried out on a Perkin-Elmer Turbomass Quadrupole Mass spectrometer fitted with PE-5 fused silica capillary column (50 m × 0.32 mm; 0.25 µm film coating). The column temperature was programmed from 100 to 280°C at 3°C/min, using helium as carrier gas at a flow rate of 1 ml/min. The injector temperature was 220°C and MS conditions were: EI mode operating at 70 eV, ion source temperature was 250°C. Identification of components was done by comparing retention times of GC peak with those reference compounds run under identical conditions; by comparison of retention indices with literature data[7, 17-19], by peak enrichment on co-injection of authentic samples, by comparing mass spectra of the peaks with MS Library search (NIST & Wiley). The peak area percentage was computed from the peak areas without applying FID response factor correction.

Results and Discussion

The essential oils obtained from geranium crops, transplanted in different months were analyzed by capillary gas chromatography. The data on quality of these essential oils are summarized in Table 1. The most abundant components of the oils were citronellol (21.3-28.7%), geraniol (23.1-38.4%), linalool (4.2-6.5%), *iso*-menthone (6.5-7.9%), citronellyl formate (6.3-8.3%), geranyl formate (3.3-4.3%), 10-*epi*-γ-eudesmol (4.7-5.6%), geranial (0.9-2.7%), 2-phenyl ethyl tiglate (0.4-1.1%), nerol (0.7-1.6%), α-pinene (0.5-1.6%), β-bourbonene (0.3-1.0%), β-caryophyllene (0.1-0.9%) and citronellyl acetate (0.6-0.9%). It was observed from the data that the essential oil composition of the rose-scented geranium was significantly affected by crop duration. Geraniol content was found maximum in the crop transplanted in the month of April (60 days old) followed by February (120 days old), January (150 days old), March (90 days old) and December (180 days old). But unlike geraniol, citronellol content was higher in February (28.7%) followed by December (27.0%) and January (26.5%) transplanted crops. Although these two alcohols produced from same precursor, geranyl pyrophosphate[20] but it is presumed that different enzymes produced these two alcohols. This could be the reason of variation in the concentration of geraniol and citronellol with respect to date of transplanting of rose-scented geranium. Temperature and post harvest storage dependent nature of citronellol/geraniol ratio (C:G) in *Pelargonium* species oil has been reported[18,20]. But it is interesting to note that C:G decrease with the decrease of crop duration (Fig. 1). Therefore, crop duration could be an indicator of maturity (in term of C:G ratio) of the rose-scented geranium crop under climatic conditions of Uttarakhand. It is imperative to mention here that the geranium oil possesses C:G ratio equivalent to one which is considered as the oil with best odour quality and hence, preferred by industry[21,22]. Further, the amount of citronellyl formate (8.3%), *p*-cymene

Table 1 — Essential oil composition of rose-scented geranium (*Pelargonium graveolens*) as affected by date of transplanting in Kumaon region, western Himalaya

S. No.	Compound[a]	Area (%)/date of transplanting[b]				
		December	January	February	March	April
1.	α-Pinene	1.5	0.6	1.4	1.6	0.5
2.	β-Myrcene	t	t	t	t	t
3.	Limonene	t	0.3	-	0.3	t
4.	*(Z)*-β-Ocimene	-	0.2	-	0.1	t
5.	γ-Terpinene	-	t	-	-	t
6.	*p*-Cymene	0.8	0.2	-	-	t
7.	*(Z)*-Rose oxide	0.5	0.5	0.3	t	0.2
8.	*(E)*-Rose oxide	t	t	0.1	-	-
9	*(Z)*-Linalool oxide	0.2	0.1	t	-	-
10.	Menthone	t	t	-	-	-
11.	*(E)*-Linalool oxide	t	0.1	t	-	-
12.	*iso*-Menthone	6.5	6.7	7.9	6.2	5.9
13.	β-Bourbonene	0.6	0.7	0.5	1.0	0.3
14.	Linalool	5.4	6.5	4.2	6.3	6.5
15.	β-Caryophyllene	0.6	0.5	0.1	0.9	0.2
16.	6,9 Guaiadiene	-	t	t	t	t
17.	Citronellyl formate	8.3	7.2	7.7	6.3	6.3
18.	Citronellyl acetate	0.6	0.7	0.9	0.9	0.6
19.	α-Humulene	0.3	0.5	0.3	0.5	0.3
20.	Neral	0.2	0.2	0.2	0.4	0.2
21.	α-Terpineol	0.3	-	0.3	0.7	0.3
22.	Geranyl formate	3.3	4.3	3.4	4.1	3.6
23.	Germacrene-D	t	t	-	-	t
24.	Geranial	1.9	0.9	2.1	2.7	1.1
25.	γ-Cadinene	t	0.5	t	t	0.2
26.	Geranyl acetate	t	t	0.1	t	t
27.	Citronellol	27.0	26.5	28.7	22.7	21.3
28.	Nerol	0.7	0.7	1.3	1.2	1.6
29.	Geranyl propanoate	0.4	0.3	t	0.2	t
30.	Citronellyl butyrate	t	0.1	t	0.1	1.1
31.	Geraniol	23.1	26.6	31.0	26.2	38.4
32.	Phenylethyl butyrate	0.2	t	-	-	-
33.	Geranyl *iso* valerate	t	t	t	-	t
34.	Geranyl butyrate	t	0.1	t	-	-
35.	10-*epi*-γ-Eudesmol	5.3	5.6	4.7	4.8	4.9
36.	Geranyl tiglate	1.8	1.8	1.4	1.4	1.7
37.	2-Phenylethyl tiglate	1.1	1.1	0.9	1.4	0.4
	C:G ratio	1.16	0.99	0.92	0.86	0.55

[a] Compounds are listed in the order of elution from BP-20 column
[b] 15th of each month; t=trace (<0.1%)

(0.8%) and geranyl propanoate (0.4%) was higher in December transplanted crop while the concentration of geranyl formate (4.3%), 10-*epi*-γ-eudesmol (5.6%) and γ-cadinene (0.5%) was higher in the oil of January transplanted crop. However, linalool concentration was similar in January and April transplanted crops (6.5%) and it was at par with March transplanted crop (6.3%). Interestingly similar to citronellol, the percentage of

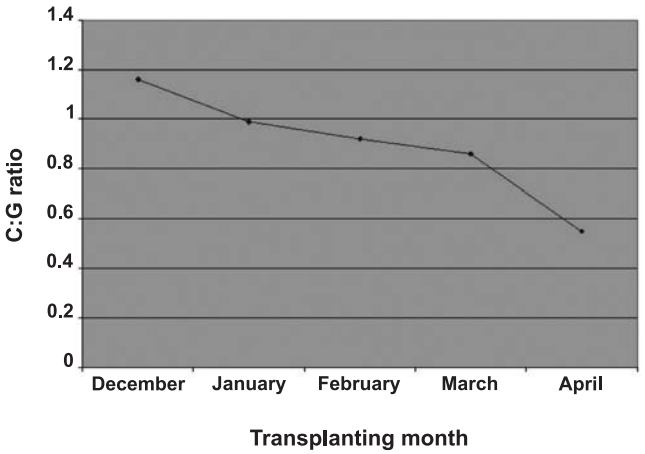

Fig. 1 — Change of Citronellol/Geraniol (C:G) ratio in rose-scented geranium due to different transplanting date (15th of each month)

iso-menthone (7.9%) was also higher in the crop transplanted in the month of February. On the other hand, geranial (2.7%), α-pinene (1.6%), β-bourbonene (1.0%), β-caryophyllene (0.9%), α-terpineol (0.7%) and neral (0.4%) concentrations were found relatively higher in March transplanted crop. The comparative results showed that the date of transplanting had notable effect on essential oil composition of rose-scented geranium grown in Kumaon region, Uttarakhand. Therefore, the results of present study reinforced the fact that there were quantitative and qualitative differences in the essential oil obtained from different transplanting times[23].

Conclusion

The above study clearly indicated that the essential oil obtained from January and February transplanted rose-scented geranium crops was most acceptable as the C:G ratio of these oil was closer to one. Therefore, planting of geranium could be done in January or February in rain-fed sub-temperate hills of Uttarakhand. This study could also be extended in other geranium cultivating areas to standardized planting time/crop duration as an indicator of C:G ratio and hence the quality of high value geranium oil.

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