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Essential oil yield and quality in rose-scented geranium: Variation among clones and plant parts

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ABSTRACT

Rose-scented geranium (*Pelargonium* spp.) is an important aromatic plant whose essential oil is used in a variety of personal care products for imparting rose-like fragrance. It is obtained by distillation of fresh aerial biomass of rose-scented geranium cultivars. Although the essential oil is present mainly in the leaves, fresh aerial biomass consisting of both leaves and stems is distilled by farmers. Three clones of rose-scented geranium, viz., 'Bourbon', 'Narmada' and 'LTC-2', were evaluated for 10 morpho-economic traits and for the contents of 10 constituents in the essential oils of their leaves, and leaves + stems, to determine differences, if any, in the composition of their essential oils. The clones differed significantly for biomass yield, essential oil content, essential oil yield and for the contents of eight out of 10 studied essential oil constituents. Clone × plant part interactions were significant for contents of linalool, 10-epi-γ-eudesmol, free rhodinol (linalool + geraniol + citronellol) and total rhodinol (linalool + geraniol + citronellol + citronellol formate + geraniol formate) in the essential oil. The contents of 'rhodinol' (responsible for rose-like odour of geranium oil) were higher in essential oils of leaves + stems of 'Bourbon' but lower in 'LTC-2' than in their respective essential oils of their leaves. The contents of free and total 'rhodinol' were highest in 'Narmada' and, unlike in 'Bourbon' and 'LTC-2', were almost similar in essential oils of its leaves, and leaves + stems. The results suggested that the quality of the essential oil in rose-scented geranium may vary not only with clone but also with the composition of the biomass (in terms of plant parts) used for distillation. To the best of our knowledge, there is no report on genotype × plant part interaction for the content of essential oil constituents in aromatic plants.

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1. Introduction

Rose-scented geranium (*Pelargonium* spp.) is a perennial semi-shrub, native to South Africa. It is grown as an ornamental plant in landscapes, parks, home gardens and along walkways for its pleasantly fragrant leaves. Its leaves are used in garlands and bouquets. They are also used for flavouring jams, jellies, cakes, syrups, beverages etc., and for perfuming bath water.

Rose-scented geranium, however, derives its economic importance mainly from its essential oil. It is cultivated on a commercial scale in Algeria, Egypt, Morocco, Reunion Islands, France, China, and India for the production of its essential oil. The essential oil of rose-scented geranium is one of the highly valued essential oils in perfumery. It has a delicate rose-like fragrance and is used in wide range of products such as perfumes, scents, flavours, cosmetic creams, soaps and toiletries. Because of its rose-like fragrance, it is used as a substitute for the more expensive rose (*Rosa damascena*) oil and has been referred to as 'the poor man's rose oil' (Wells and Lis-Balchin, 2002). The oil is extracted by farmers on the farm by distillation of fresh aerial biomass of rose-scented geranium cultivars.

Geranium oil consists of more than 120 mono- and sesquiterpenes and low molecular aroma compounds, with linalool, citronellol, geraniol and their esters as main components (60–70%) and significant quantities of isomenthone, menthone, nerol, *cis*- and *trans*-rose oxides, α-terpineol, α-pinene, myrcene, and β-phyllandrene. Citronellol, geraniol, linalool and their esters are the main constituents which determine its odour (Charlwood and Charlwood, 1991). Geranium oils are traditionally characterized by the contents of their acetylisable alcohols, usually referred to as free 'rhodinol', with linalool, citronellol and geraniol as its components. These constituents together with their esters are referred to as total 'rhodinol'. In spite of the differences in the composition of different types of geranium oils, which are obtained from different

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Pelargonium species and their hybrids, it is the content of 'rhodinol' which is of commercial importance (Anon., 1990).

Geranium oil and its constituents, citronellol, geraniol, geranyl formate and *trans*-nerolidol have been shown to exhibit insecticidal, insect repellant, anti-fungal and anti-bacterial properties (Aggarwal et al., 2000; Bigos et al., 2012; Ali et al., 2013; Boukhatem et al., 2013). Many medicinal properties have also been attributed to geranium oil in folk medicine and it is used widely in aromatherapy (Ranade, 1988).

In essential oil crops, the content of essential oil in plant parts containing the essential oil is more important than the yield of plant parts as it determines the cost of its extraction and, therefore, the profitability of production of the essential oil. The quality of the essential oil is also equally important as it determines its market price for the farmer and its marketability for different end-uses. The quality of the essential oil is determined by its composition. Both these traits are well known to be affected by several factors such as genetic, ontogenic, environmental factors, parts of the plant, post-harvest drying of the herb, distillation methods, duration of distillation etc. (Akhila et al., 1984; Prakasa Rao et al., 1995; Herath et al., 1979; Cannon et al., 2012; Selmar and Kleinwächter, 2013).

The essential oil may be mainly present in only one part of the plant; however, the whole aerial biomass is distilled in quite a few crops. In citronella (*Cymbopogon winterianus*), lemongrass (*Cymbopogon flexuosus*), rose-scented geranium (*Pelargonium* spp.) and patchouli (*Pogostemon cablin*), the essential oil is present mainly in their leaves but whole aerial biomass consisting of leaves and stems is distilled. Generally, the genotype largely determines both content and composition of the essential oil. However, the composition of essential oil may vary according to the plant parts distilled (Franz and Novak, 2010). No information is available on the effect of composition of the biomass in terms of plant parts distilled on the quality of the essential oil in these crops. This information should be useful for producing the required quality of the essential oil for different end-uses. We studied the effect of the composition of the aerial biomass in terms of plant parts distilled on the quality of the essential oil in three clones of rose-scented geranium which differed for aerial biomass yield, essential oil content and essential oil composition. The results are presented here.

2. Materials and methods

2.1. Plant material

Three clones of rose-scented geranium viz., Indian cultivar, 'Bourbon' and two somaclones, 'Narmada' and 'LTC-2', both obtained from 'Bourbon', were used in the study. The essential oil of 'Bourbon' resembles the 'Reunion' geranium oil (International) of commerce for citronellol: geraniol ratio (≈1:1) but because of its relatively low content of 6,9 guaiadiene and high content of 10-epi-γ-eudesmol than 'Reunion' geranium oil, it is considered as 'African' geranium oil, in trade. 'Narmada' has similar aerial biomass yield as 'Bourbon' but, in comparison with 'Bourbon', has low contents (<1–3%) of isomenthone and 10-epi-γ-eudesmol in its essential oil. Somaclone 'LTC-2' has higher aerial biomass yield than 'Bourbon'. Cultivars of rose-scented geranium grown all over the world for the commercial production of rose-scented geranium oil are exclusively vegetatively propagated as they are inter-specific hybrids between *Pelargonium capitatum* (L.) L'Herit. and *Pelargonium graveolens* L'Herit. or *P. capitatum* (L.) L'Herit. and *Pelargonium radens* H.E. Moore, and are sterile (Demarne, 2002). The three clones of rose-scented geranium used in this study are also exclusively vegetatively propagated and are propagated through stem cuttings.

2.2. Field evaluation

Stem cuttings of the three clones were raised in poly-bags filled with sand, soil and vermi-compost in the ratio of 2:1:1 (v/v/v), from their respective plants maintained in a glass house. Three-month old rooted cuttings were transplanted in the field in a randomized complete block design (RCBD) with six replications. Each plot consisted of seven rows with seven plants within each row. Plants were spaced at 60 cm between rows and 45 cm within a row. Plots were fertilized with 20:40:40 kg ha^{-1} of N, P_2 O_5 and K_2O, respectively, at planting. An additional dose of 20 kg of N ha^{-1} was applied two months later. Plots were irrigated once a week or as and when required. Plants were harvested when they were four months old. Observations were recorded at harvest on plant height, plant width, number of primary branches per plant, leaf size, leaf form, leaf shape, aerial biomass yield per plot and essential oil content. Leaf size (length × width), leaf form (width/waist), leaf shape (length/width) were determined according to Skirvin and Janick (1976). Leaf observations were recorded on the fifth leaf (fully expanded) from the tip of the shoot. Oil yield was calculated as the product of aerial biomass yield, essential oil content and specific gravity of the oil (0.89).

A 200 g random sample of the aerial biomass containing only leaves or leaves + stems was distilled in a Clevenger's type apparatus for 2 h to determine essential oil content. Essential oils obtained were collected, dried over anhydrous sodium sulfate and stored in a refrigerator till their analysis by Gas Chromatography (GC). The proportion of stem in leaves + stems samples was determined. Essential oil content in the distilled sample was calculated on volume/weight basis. Random samples of 200 g of only stems (obtained after separation of leaves and stems) were also distilled.

2.3. GC analysis of the essential oil

The contents of 10 major constituents of the essential oil viz., linalool, *cis*-rose oxide, *trans*-rose oxide, menthone, isomenthone, citronellol, geraniol, citronellyl formate, geranyl formate and 10-epi-γ-eudesmol were determined by using a Varian CP-3800 Gas Chromatograph fitted with flame ionization detectors, split/splitless capillary injectors and Star workstation software. Peak areas and retention times were measured by an electronic integrator. The individual components were identified by the comparison of their retention data with previously analyzed authentic compounds which ever were available and by calculation of Kovat's indices obtained from the gas chromatograms by comparing with the natural homologous series of hydrocarbons and their comparison with literature values (Adams, 2001). The relative amounts of individual constituents were computed from GC peak areas without FID response factor correction. The contents of free 'rhodinol' (linalool + citronellol + geraniol) and total 'rhodinol' (linalool + citronellol + geraniol + citronellyl formate + geranyl formate) were calculated (Anon., 1990).

2.4. Statistical analysis

Data on morpho-economic traits were subjected to analysis of variance (ANOVA) for a RCBD while data on essential oil constituents were subjected to ANOVA for a split plot experiment, with clones as main plots and plant parts distilled (leaves only or leaves + stems) as sub plots. The differences between means were tested by 'LSD_t' (Steel and Torrie, 1981).

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