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Chemical compositions of essential oil and antioxidant activity of dragonhead (*Dracocephalum moldavica*) in sole crop and dragonhead-soybean (*Glycine max*) intercropping system under organic manure and chemical fertilizers

Sina Fallah[a,*], Maryam Rostaei[a], Zahra Lorigooini[b], Ali Abbasi Surki[a]

[a] Faculty of Agriculture, Shahrekord University, Shahrekord, Iran
[b] Medical Plants Research Center, Basic Health Sciences Institute, Shahrekord University of Medical Sciences, Shahrekord, Iran

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ABSTRACT

Organic manure can be used as an alternative for chemical fertilizers in sustainable agriculture. In addition, compared with sole cropping systems, intercropping is a promising approach for the crop production due to its lower reliance to chemical fertilizers. In this study, grain yield of soybean and biomass, chemical compositions and antioxidant activity of dragonhead essential oil in sole crop and dragonhead-soybean intercropping system under organic and chemical fertilizers were investigated. Land equivalent ratio (LER) was calculated as well. Results indicated intercropping and application of organic manure, increased soybean grain yield and dragonhead biomass. The LER value for soybean: dragonhead with ratios of 1:1 and1:2 under organic manure was greater than 1, indicating superiority of intercropping versus sol crop systems. GC–MS analysis showed that geranial, geranyl acetate, neral and piperitone were major compounds of dragonhead. The geranial and neral contents were increased in sole cropped dragonhead with application of chemical fertilizer, while the piperitone content was enhanced in sole cropped plants fertilized with organic manure. The highest of geranyl acetate content was observed in intercropped dragonhead plants fertilized with chemical fertilizer. Addition of organic manure lead to increase the antioxidant capacity of dragonhead in intercropped plots. The highest antioxidant activity of dragonhead (IC_{50} = 1.45 μgmL^{-1}) was observed in one row of soybean + two rows of dragohead treated with organic manure. Overall, one row of soybean + two rows of dragohead with use of organic manure was more productive and had the highest LER value, antioxidant activity and a large amount of chemical compositions of essential oil. Thus this treatment could be adopted by the medicinal plant growers for appropriate production of dragonhead.

1. Introduction

Legume crops provide an important method of alleviating the constraints related to nitrogen limitations in the soil and enhance crop productivity (Rusinamhodzi et al., 2012). The capacity of legumes to fix atmospheric nitrogen and make it available to other plants (Askegaard and Eriksen, 2007; Fustec et al., 2010) is of particular interest for organic farming (Lithourgidis et al., 2011). Intercropping of legumes with other plants is a practical multi-cropping technique (Li et al., 2006) to increase land-use efficiency and enhance crop yield (Bhatti et al., 2006; Gao et al., 2010). Furthermore, intercropping can suppress weeds (Corre-Hellou et al., 2011), decrease damage caused by pests and diseases (Hauggaard-Nielsen et al., 2001) and improve the quality of the products (Caviglia et al., 2011).

Medicinal plants are reservoirs of useful secondary metabolites for humans. Essential oils and their aromatic constituents are relevant to the production of perfumes, fragrances, food flavoring, pharmaceuticals, as spices and natural food preservatives, for aromatherapy and related medicinal practices (Hadian et al., 2014). Dragonhead (*Dracocephalum moldavica* L.) is an annual herb belonging to the Lamiaceae family (Hussein et al., 2006; Dastmalchi et al., 2007). Extracts and essential oils of this plant are used in the cosmetic, pharmaceutical, food and flavoring industries (Dmitruk and Weryszko-Chmielewska, 2010). Essential oil extracts of dragonhead are reported to possess antioxidant, antimicrobial and antibacterial activities (Dastmalchi et al., 2007).

Most previous studies have focused on 'the quantity of production of

* Corresponding author at: Faculty of Agriculture, Shahrekord University, P.O. Box 115, Shahrekord, Iran.
E-mail addresses: falah1357@yahoo.com, fallah-s@agr.sku.ac.ir (S. Fallah), maryamrosta318@yahoo.com (M. Rostaei), zahrlorigooini@gmail.com (Z. Lorigooini), aabasi59@yahoo.com (A. Abbasi Surki).

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