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Effects of drought stress and manure on dry herb yield and essential oil of dragonhead (*Dracocphalum moldavica*) in Jiroft erea

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Key words: Dragonhead, drought stress, essential oil content, manure, yield.

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Abstract

In the current study, the effect of water deficit stress or drought on relative water content and cell membrane stability of dragonhead (Dracocepha lummoldavica) was studied in a greenhouse experiment carried out at Islamic Azad University, Jiroftbranch, in 2009. It was a split plot experimentbased on Randomized Complete Block Design with three replications, in which vertical factor included three levels of drought stress (irrigation when soil moisture reached 75% of field capacity [mild stress], irrigation when soil moisture reached 50% of field capacity [moderate stress] and irrigation when soil moisture reached 25% of field capacity [severe stress]). The highest dry yield of vegetative body in dracocephalum was obtained by mild stress as 4868.27kg/ha. The highest dry yield of vegetative body in dracocephalum as 5719.67kg/ha was obtained by application of 40 ton/ha of manure. considering essential oil content as the main goal of dracocephalum production and concerning the fact that oil yield as 13.10, 9.91, 9.91 and 9.91 kg/ha was achieved by interaction of the two factors in mild stress and 40ton/ha manure, mild stress and 30ton/ha, medium stress and 40ton/ha manure and medium stress and 30ton/ha manure, respectively; the medium drought stress together with application of 30tpn/ha is recommended for Jiroft region as the superior treatment which resulted in production of 9.91kg/ha essential oils.

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Introduction

Medicinal herbs have been extensively studied in this century mainly because chemical medicines have proved to have side effects and humans tend to use natural products as much as possible (Azizi, 2000). Dragonhead or dragon'shead (*Dracocephalum moldavica*) is herb from mint family (Hussein et al., 2006). The effective substances of its body are sedative and appetizing. Its essence is antibacterial and is used in curing stomachache and flatulence as well as in food industries, soda manufacturing and health and make-up industries (Omidbeigi, 1997). Although the effects of drought stress on crops have been extensively studied, the researches on the behavior of medicinal and aromatic herbs under water deficit have not been so extensive (Letchamo and Gosselin, 1996). Nowadays water deficit is known as an important limiting factor of yield increase in arid and semiarid regions and growth decrease is much greater under water deficit than that under other environmental stresses (Rodrigues, 2006). It is more important in regions which experience the problem due to climate change but have not been paid attention (Chaves and Oliveira, 2004) because global environment change programs show the growth of water deficit in future and the recurrence of much more severe events in most parts of the world. Environmental stresses bring about a wide range of responses in plants from genetic changes to the changes in growth speed and yield (Reddy *et al.*, 2004). Therefore, in order to understand the conditions for the survival of medicinal herbs in arid regions, their responses to water deficit need to be evaluated and their appropriate growing conditions should be determined (Letchamo and Gosselin, 1994). The main objective of the present work was to study the effects of drought stress and manure dry herb yield and essential oil of Dragonhead (*Dracocphalum moldavica*) in Jiroft erea

Materials and methods

Cultivation Conditions

To study the effects of manure application on dragonhead and to evaluate its resistance to drought stress as well as to study dry herb yield and essential oil of drought resistance in the crop, a strip plot experiment was carried out based on a Randomized Completely Block Design with three replications as a pot experiment in the greenhouse of Islamic Azad University, Jiroft Branch, Iran in 2009.

Firstly, the soil was sampled and its physical and chemical parameters were measured (Table 1). The pots were 23 cm high with the diameter of 30 cm. Each one was filled with about 10 kg soil on average. Ten pots received enough water to become saturated. They were covered by plastic sheet and after 24 hours when the redundant water leaked from the bottom hole due to gravity, their soils were sampled and dried in oven for 24 hours at 105°C. Then, the field capacity of the pots was determined. Manure application level was determined according to pot level. After weighing, cattle manure was used in fertilizer treatments. After preparing the pots, the seeds were planted with the rate of 15 seeds/pot at the depth of 0.5-1 cm. After emergence, the plants were thinned twice a month. Finally, four plants were left in each pot.

Treatments

In this study, low irrigation by applying water stress in three levels – mild stress (irrigation at field capacity of 75%), moderate stress (irrigation at field capacity of 50%) and severe stress (irrigation at field capacity of 25%) – constituted the vertical factor and manure application in five levels of 0, 10, 20, 30 and 40 t/ha constituted the horizontal factor.

Statistical Analysis

Analysis of variance was performed using standard techniques and differences between the means were compared through LSD Significant Difference test [$P < 0.05$] using MSTAT-C software package.

Results and discussion

Soil analysis showed that it was loam-sandy, alkaline and had no limitation from salinity and minerals viewpoint. It was poor in nitrogen and good in absorbable phosphorous and potassium (Table 1).

Table 1. Results of the analysis of soil used in experimental pots.

Depth (cm)	PH	EC ($ds.m^{-1}$)	SP (%)	Total N (%)	AWP (%)	AWK (%)	Texture
0-30	8.1	0.89	25	0.03	12	220	Loamy sand

According to Table (2), ANOVA results considering drought stress and manure treatments effect on dry body yield f aerial part and essential oil yield in hectare and vase suggest that effect of drought stress on vegetative organ yield showed significant difference ($p<0.05$) and the effect on the two other traits was very significant ($p<0.01$). Significant difference was observed about effect of manure and its interaction with drought on vegetative part yield, essential oil amount and oil amount per pot ($p<0.01$). results showed that the difference was due to application of experimental treatments.

Table 2. Analysis of variance for the effects of manure and water deficit stress on Dragonhead plant.

S.O.V	df	MS		
		Dry herb yield (kg/ha)	Essential oil content (ml/pot)	Essential oil yield (kg/ha)
Replication		83975.48 ^{ns}	0.0001 ^{ns}	6.937 ^{ns}
Drought Stress	2	10182108.02*	0.004**	87.087
Error A	2	1592662.22	0.0001	1.618
manure	4	25831360.63**	0.004**	87.760**
Error B	4	1365132.93	0.00013	1.729
Drought Stress × manure	8	4271322.13**	0.001**	19.468**
Error C	8	682346.70	0.00013	1.959
CV%	16	21.05	22	24.2

Dry Herb Yield

According to (fig 1), there is significant difference among effects of different levels of water shortage on dry weight of vegetative organs. The highest yield of vegetative organs as 4868.3kg/ha was achieved in mild stress and the lowest yield of aerial parts was obtained in severe stress. It looks that by increase in drought stress, shoot dry matter is reduced. According to some authors reduction of the weight due to drought stress is attributed to morphological, biochemical and physiological changes such as reduction of leaf area, leaf abscission and reduction of growth (Kafi and Mahdavi, 2001) and stomata closure (Safar Nezhed, 2003). There is difference between medium and severe drought regarding vegetative organs but the difference is not significant. Safikhani *et al* (2007) reported the highest yield of flowering shoots of Dracocephalum as 4123 and 34033 kg/ha in the first and second years in no-drought stress which is in agreement with our results.

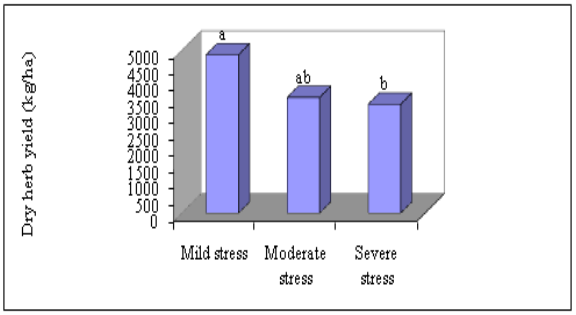

Fig. 1. Means comparison of effect of water deficit stress level on dry herb yield in dragonhead.

As can be seen from (fig 2), vegetative part yield of Dracocephalum was enhanced by increase in manure rate so that the highest yield of vegetative body as 5719.7kg/ha was achieved by application of 40ton/ha of manure and the lowest yield was obtained when no manure was applied. There was no significant difference between 0 and 10 kg/ha application of manure. Moreover there was no significant difference between 20 and 30 ton/ha of manure concerning dry weight of aerial parts. Sherma (2000) and Chatterjee (2002) suggested manure application as a successful factor in medical plants and maintained that the enhancement of yield is due to improvement of physical, chemical and biological properties of soil. Investigating effect of organic manure on eight medical plants, Khalil *et al* (2007) reported the highest fresh weight as 86.5gr per plant and the highest dry weight as 26.8g for Dracocephalum.

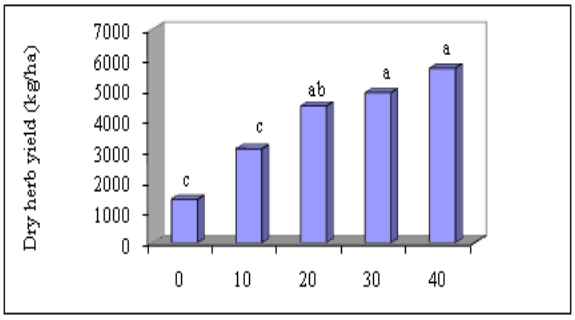

Fig. 2. Means comparison of effect of manure level on dry herb yield in dragonhead.

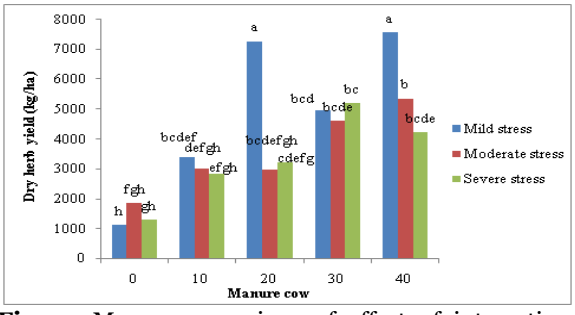

Fig. 3. Means comparison of effect of interaction between manure and water deficit stress on dry herb yield in dragonhead.

According to (fig 3), considering interaction of the treatments, the highest yield of vegetative body was achieved by application of 40ton/ha of manure and 30ton/ha of manure in mild stress as 7573.7 and 7274.7kg/ha, respectively. Application of 30ton/ha of manure in mild stress was not significantly different from 40ton/ha of manure in medium stress with 5354.3kg but showed significant difference from other treatments.

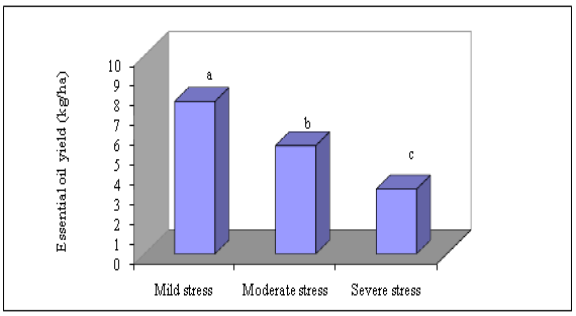

Fig. 4. Means comparison of effect of water deficit stress level on Essential oil yield in dragonhead.

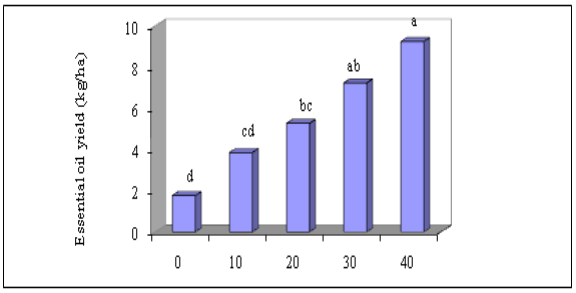

Fig. 5. Means comparison of effect of manure level on Essential oil yield in dragonhead.

Essential Oil Yield

According to (fig 4), mean comparison of drought stress effect on Dracocephalum essential oil yield show that oil yield is decreased by increase in drought level. The highest oil as 7.69kg/ha was achieved in mild stress and the lowest oil as 3.27kg/ha was obtained in severe stress. In a similar experiment, Safikhani *et al* reported that by increase in drought stress, essential oil percentage was increased but total amount of the oil was reduced; so that essential oil yield in Fc100% was 11.100kg/ha which was reduced to 9.10kg/ha in Fc=60%; the result which is in agreement with our results. Hassani *et al* (2006) reported that regarding essential oil percentage of Dracocephalum, there was no significant difference among drought stress treatments but the highest oil amount as 0.35ml per 100gr of plant dry matter was achieved in 70% and 100% of Fc. Reduction of essential oil yield was due to reduced soil moisture and can be attributed to harmful effects of water shortage on growth and yield of plant vegetative body

yield; the effect that has been reported by many investigators in various crops. Omidbeigi *et al* (2003) reported reduced yield of basil essential oils due to water shortage which is in accordance with our results.

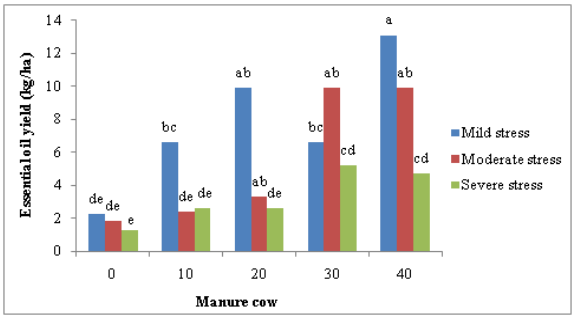

Fig. 6. Means comparison of effect of interaction between manure and water deficit stress on Essential oil yield in dragonhead.

According to (fig 5), mean comparison of manure effect on Dracocephalum essential oils yield shows that by increase in manure rate, essential oils yield was enhanced but the increase was tangible up to 30kg/ha over which application of manure had almost identical effect on oil yield. The highest oil yield as 9.241kg/ha and the lowest oil yield as 1.77kg/ha was obtained by no application of manure. Positive effect of manure on improvement of medicinal properties has been reported by Mallanagoula (1995). Having properties such as water retention in soil and possessing nutrients, manure can improve plant essential oils yield by enhancing growth of vegetative parts which have the highest oil content. Hussein *et al* (2006) maintained that increased oil content of Dracocephalum as a result of application of compost manure is due to acceleration of metabolic reactions and stimulation of enzymes.

According to (fig 6), representing mean comparison of interaction of drought stress and manure on dracocephalum essential oils, the highest oil yield as 13.10kg/ha is achieved by mild stress which didn't show a significant difference with 9.91kg/ha obtained by application of 30 and 40tpn/ha of manure (irrigation after soil moisture reached to Fc50%) in medium stress. Probably retention of soil moisture by manure has resulted in high essential oil production.

Conclusion

The highest dry yield of vegetative body in dracocephalum was obtained by mild stress as 4868.27kg/ha.

The highest dry yield of vegetative body in dracocephalum as 5719.67kg/ha was obtained by application of 40 ton/ha of manure.

The highest essential oil content as 9.241kg was achieved by application of 40ton/ha of manure.
The highest essential oil yield as 7.69kg/ha was obtained by mild drought stress.

considering essential oil content as the main goal of dracocephalum production and concerning the fact that oil yield as 13.10, 9.91, 9.91 and 9.91 kg/ha was achieved by interaction of the two factors in mild stress and 40ton/ha manure, mild stress and 30ton/ha, medium stress and 40ton/ha manure and medium stress and 30ton/ha manure, respectively; the medium drought stress together with application of 30tpn/ha is recommended for Jiroft region as the superior treatment which resulted in production of 9.91kg/ha essential oils.

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