

# Morphological traits of Dragon's head (*Lallemantia iberica* Fish. et Mey.) affected by drought stress and plant density

**Parisa Aghaei-Gharachorlou, Safar Nasrollahzadeh\* and Jalil Shafagh-Kolvanagh**

Department of Plant Eco-physiology, Faculty of Agriculture, University of Tabriz, Tabriz, Iran

**Corresponding author:** Safar Nasrollahzadeh

**ABSTRACT:** In order to investigate the effect of different irrigation treatments and plant density on morphological traits of Dragon's head (*Lallemantia iberica* Fish. et Mey.), an experiment was carried out as split block based on randomized complete block design with four replications. Irrigation treatments (I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub> and I<sub>5</sub>: irrigation after 70, 100, 130, 160 and 190 mm evaporation from class A pan, respectively) were assigned to main plots and four plant density levels (D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub>: 200, 300, 400, 500 plant/m<sup>2</sup>) were allocated to the sub plots. Plant height, number of lateral stem, capsule per node, leaf number in main branch, lateral steam length, node per plant, stem diameter and grain yield were recorded. Results showed that irrigation intervals had significant effects on all of the characteristics. Superior effects of irrigation on these traits were achieved in Irrigation after 70 mm evaporation (I<sub>1</sub>) treatments. In addition, regarding to the interaction effects between irrigation treatments and plant density, highest amount of leaf number, stem diameter, node number per plant and lateral stem length were recorded at I<sub>1</sub>D<sub>1</sub> treatments, but difference between I<sub>1</sub> and I<sub>2</sub> treatments was not significant. According to the results obtained, irrigation after 100 mm evaporation from class a pan and density of 400 plant/m<sup>2</sup> is the best combination for Dragon's head grain production.

**Keywords:** Dragon's head, drought stress, morphological traits, plant density

## INTRODUCTION

Water is one of the most important environmental factors regulating plant growth and development. The sensitivity of crop plants to water stress is acknowledged a major constrain in crop production. Water deficit affects many morphological features and physiological processes associated with plant growth and development (Toker and Cagiran, 1998). In drylands, water is the major limiting factor to agricultural production. Drought stress is one of the most important environmental stresses affecting agricultural productivity around the world and may result in considerable yield reductions (Ludlow and Muchow, 1990). Decreasing the growth trend of roots and shoots, leaf area, photosynthesis, transpiration, plant height and dry weight are some the drought-induced losses reported by (Jiang and Huang, 2000). Plant responses to drought stress are very complex and include adaptive changes or deleterious effects (Chaves et al., 2002). The effects of drought stress are observed in the form of phenological responses, morphological adaptations, physiological changes and biochemical adaptations. Plant reactions are affected by the amount of soil water directly or indirectly. All physiological processes like photosynthesis, transpiration, cell turgidity, and cell and tissue growth in plants are directly affected by water availability (Sarker et al., 2005). For achieve high yield, an adequate water supply is required during the growing season. The period at the beginning of the flowering stage is most sensitive to water shortage, while maximum yield and yield

components were obtained with full irrigation, almost the maximum yield generally were obtained when irrigation was made to provide adequate water during flowering and fruit formation periods (Blum, 2005).

On the other hand, plant density is one of the main factors determining seed yield (Long et al., 2001). In fact, the yield of plant is the result of the competition within and outside of the plant on the environmental factors and the maximum yield will be obtained when, this competition has decreased and the plant has the maximum using of these environmental factors. Several reports indicate that yield and yield components of chicory (Taheri et al., 2006), and pumpkin (Babayee et al., 2010), change under the effect of the different planting densities.

Medicinal plants are valuable sources in Iranian natural resources whose understanding and scientific cultivation can play an important role in people's health and job creation. Dragon's head (*Lallemantia iberica* Fish. et Mey.) is an important annual medicinal plant that belongs to the Labiatae family (Naghbi, 2005). Dragon's head originates in the Caucasian region and may be locally naturalized in East and Central East Europe. *Lallemantia iberica* cultivated for its oil seeds, the seed contains up to 30% of a drying oil (Usher, 1974).

The better understanding effects of irrigation frequency and planting density on local and neglected crops can help to determine optimal irrigation scheduling. A question that also needs to be resolved is if different plant populations are relevant factors determining the final crop yield under different irrigation frequencies. The purposes of this study were to determine the effect of irrigation levels and plant density on morphological properties of Dragon's head and develop the relationship of morphological traits with yield of this medicinal plant.

## MATERIALS AND METHODS

### Site description and experimental design

The field experiment was conducted in 2012 at the Research Farm of the University of Tabriz, Iran (latitude 38°05'\_N, longitude 46°17'\_E, altitude 1360 m above sea level). The climate of research area is characterized by mean annual precipitation of 285 mm, mean annual temperature of 10°C, mean annual maximum temperature of 16.6°C and mean annual minimum temperature of 4.2°C. The experiment was arranged as split plot design with three replications. Irrigation treatments ( $I_1$ ,  $I_2$ ,  $I_3$ ,  $I_4$  and  $I_5$ : irrigation after 70, 100, 130, 160 and 190 mm evaporation from class A pan, respectively) were assigned to main plots and four plant density levels ( $D_1$ ,  $D_2$ ,  $D_3$  and  $D_4$ : 200, 300, 400, 500 plant/ m<sup>2</sup>) were allocated to the sub plots. All plots were irrigated immediately after sowing. Irrigation treatments were applied after seedling establishment. Hand weeding of the experimental area was performed as required.

### Measurement of traits

To specify leaf number, node number per plant, capsule per node, plant heights, lateral stem number, lateral stem length and stem diameter ten plants were selected from the middle of the plots and then, they were measured. Also to determine of grain yield and biological yield an area equal to 1 m<sup>2</sup> was harvested from middle part of each plot considering marginal effect. Harvested plants were dried in 25° C and under shadow and air flow then grains were separated from their remains by threshing.

### Statistical analysis

Statistical analysis of the data was performed with MSTAT-C software. Duncan multiple range test was applied to compare means of each trait at 5% probability.

## RESULTS AND DISCUSSION

Effects of irrigation treatments on height of plant, lateral stem number, capsule per node and grain yield were significant ( $P < 0.01$ ) (Table 1 and 2), but interaction between irrigation treatments and plant density was not significant for this traits. Highest grain yield (158.1 gr/m<sup>2</sup>), height of plant (37.27 cm), capsule per node (5.508) and lateral stem number (2.05 stem/plant) were achieved under  $I_1$  treatment (Table 3). Lowest lateral stem number (1.237) obtained in  $I_5$  treatment and between other treatments had not significantly different (Table 3). The Dragon's head grain yield, height of plant and capsule per node between  $I_1$  and  $I_2$  treatments were not significantly different. These results are in line with the findings of (Yang et al., 2001 and Jaleel et al., 2008). Reduction in these traits under water stress can be attributed to competition of plants for water (Ehdaie, 1995). Plant density had a significant effect on grain yield, height of plant, lateral stem number and capsule per node (Table 1 and 2), but interaction between irrigation treatments and plant density was not significant for this traits. Highest grain yield (123.0 gr/m<sup>2</sup>), height of plant (36.17 cm), lateral stem number (2.442 stem/plant) and capsule per node (4.785)

were achieved under planting density of 400, 500, 200 and 300 plant/m<sup>2</sup> respectively (Table 4). But, differences between D<sub>1</sub> and D<sub>2</sub> treatments was not significant for the lateral stem number and capsule per node traits. Mean comparisons showed that with increasing plant density, number of lateral stem per plant and capsule per node decreased. The reduction in number of lateral stem per plant and capsule per node as increase density per area unit can be due to in high densities compare to lower densities, plant would have less space and possibilities. This problem causes interplant competition to increase and so that cause yield components to decrease. On the other hand, number of lateral stem per plant and capsule per node is dependent on plant density. These results are consistent with finding of (Share ,2007 and Kafi and Rashed-Mohasel ,1992) on green cumin.

Interaction of irrigation and planting density treatments had significantly affected leaf number, lateral steam length, stem diameter and node number per plant (Table 1 and 2). Highest lateral steam length (16.97 cm) (Figure 1), leaf number per plant (32.05) (Figure 2), node number per plant (16.02) (Figure 3) and stem diameter (2.85 mm) (Figure 4) were achieved under I<sub>1</sub> irrigation treatment and planting density of 200 plant/m<sup>2</sup>. I<sub>1</sub>D<sub>1</sub> and I<sub>2</sub>D<sub>1</sub> treatments had similar results for these traits.

As it was shown in the results of this study, water deficit stress had a negative effect on all of the Dragon's head morphological characteristics under study, which was in agreement with the results of (Albright et al., 1989 and Taheri et al., 2006). (Silvius et al., 1977) stated that the effects of water stress on soybean yield appeared to be related to limited availability of photosynthate and nitrogen for developing plant and seed. Also, increase of planting density causes increase in grain yield. The effect of high density on increasing grain yield of green cumin was also reported, by( Mashayekhi et al., 2011). In the present investigation, there was not found statistically difference between irrigation after 70 mm evaporation and 100 mm evaporation on grain yield and morphological traits of Dragon's head. Thus, irrigation after 100 mm evaporation recommended as the best irrigation interval for the semi-arid regions. On the other hand, it seems that plant density of 400 plant/m<sup>2</sup> is most suitable for grain yield of Dragon's head.

Table 1. Analysis of variance of selected parameters of Dragon's head affected by irrigation and plant density treatments

S.O.V	df	Height of Plant	Lateral stem	Lateral stem length	Capsule per node
Block	3	11.661	0.057	4.464	0.620
Irrigation	4	157.688**	1.834**	162.272**	9.200**
Error	12	6.919	0.163	2.093	0.393
Plant density	3	87.815**	10.389**	190.184**	1.976**
Interaction	12	3.691	0.164	14.356*	0.141
Error	45	3.517	0.103	1.988	0.219

Ns=Non significant; \* and \*\* = Significant at 5% and 1% probability level, respectively

Table 2. Analysis of variance of selected parameters of Dragon's head affected by irrigation and plant density treatments

S.O.V	df	Leaf number	Node number per plant	Stem diameter	Grain yield
Block	3	2.713	0.678	0.019	15.339
Irrigation	4	650.288**	162.572**	1.296**	34582.660**
Error	12	2.573	0.643	0.016	45.683
Plant density	3	338.761**	84.69**	1.383**	1552.410**
Interaction	12	12.463**	3.116**	0.202**	34.703
Error	45	4.218	1.054	0.033	58.313

Ns=Non significant; \* and \*\* = Significant at 5% and 1% probability level, respectively

Table 3. Mean comparisons for different traits of Dragon's head under different irrigation treatments

Irrigation	Height of Plant (cm)	Lateral stem (stem/plant)	Capsule per node	Grain yield (gr/m <sup>2</sup> )
I <sub>1</sub>	37.27 <sup>a</sup>	2.05 <sup>a</sup>	5.508 <sup>a</sup>	158.1 <sup>a</sup>
I <sub>2</sub>	35.36 <sup>a</sup>	1.696 <sup>a</sup>	4.900 <sup>a</sup>	152.8 <sup>a</sup>
I <sub>3</sub>	34.37 <sup>ab</sup>	1.65 <sup>a</sup>	3.979 <sup>b</sup>	118.3 <sup>b</sup>
I <sub>4</sub>	31.98 <sup>bc</sup>	2.056 <sup>a</sup>	3.966 <sup>b</sup>	80.53 <sup>c</sup>
I <sub>5</sub>	29.17 <sup>c</sup>	1.237 <sup>b</sup>	3.723 <sup>b</sup>	50.18 <sup>d</sup>

The means with same letters in each column are not significantly different at p ≤ 0.05. (I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub> and I<sub>5</sub>: irrigation after 70, 100, 130, 160 and 190 mm evaporation from class A pan, respectively).

Table 4. Mean comparisons for different traits of Dragon's head under plant density

Plant density	Height of Plant (cm)	Lateral stem (stem/plant)	Capsule per node	Grain yield (gr/m <sup>2</sup> )
D <sub>1</sub>	31.17 <sup>c</sup>	2.442 <sup>a</sup>	4.498 <sup>ab</sup>	101.5 <sup>c</sup>
D <sub>2</sub>	33.01 <sup>b</sup>	2.215 <sup>a</sup>	4.785 <sup>a</sup>	110.4 <sup>b</sup>
D <sub>3</sub>	34.17 <sup>b</sup>	1.41 <sup>b</sup>	4.347 <sup>bc</sup>	123.0 <sup>a</sup>
D <sub>4</sub>	36.17 <sup>a</sup>	0.885 <sup>c</sup>	4.030 <sup>c</sup>	113.1 <sup>b</sup>

The means with same letters in each column are not significantly different at  $p \leq 0.05$ . (D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub>: 200, 300, 400, 500 plant/m<sup>2</sup>)

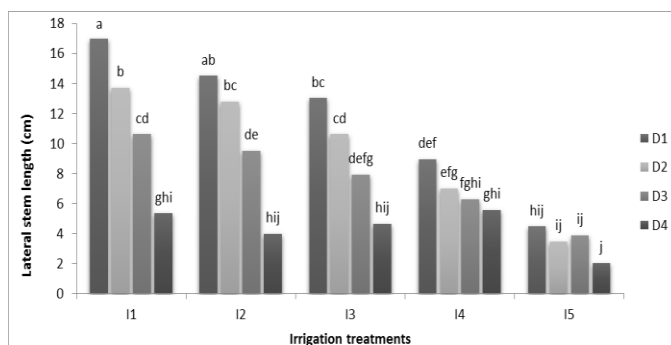


Figure 1. Effect of different irrigation treatments (I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub> and I<sub>5</sub>: irrigation after 70, 100, 130, 160 and 190 mm evaporation from class A pan, respectively) and four plant density levels (D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub>: 200, 300, 400, 500 plant/ m<sup>2</sup>) on lateral stem length of Dragon's head (Different letters indicate significant difference at  $p \leq 0.05$ )

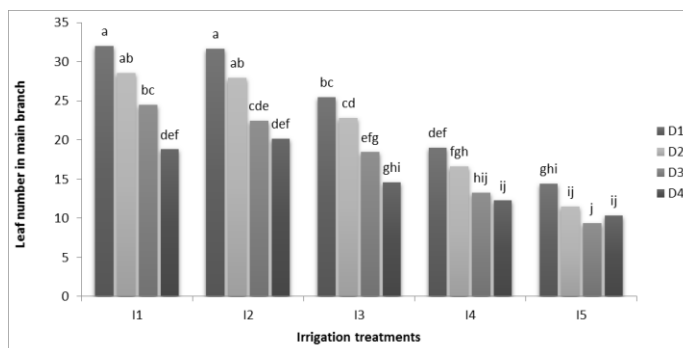


Figure 2. Effect of different irrigation treatments (I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub> and I<sub>5</sub>: irrigation after 70, 100, 130, 160 and 190 mm evaporation from class A pan, respectively) and four plant density levels (D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub>: 200, 300, 400, 500 plant/ m<sup>2</sup>) on leaf number of Dragon's head (Different letters indicate significant difference at  $p \leq 0.05$ )

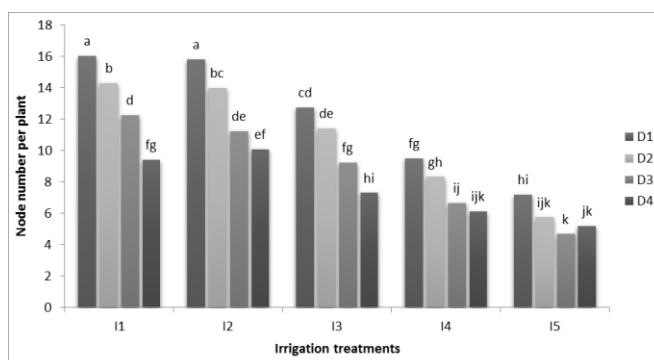


Figure 3. Effect of different irrigation treatments (I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub> and I<sub>5</sub>: irrigation after 70, 100, 130, 160 and 190 mm evaporation from class A pan, respectively) and four plant density levels (D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub>: 200, 300, 400, 500 plant/ m<sup>2</sup>) on node number per plant of Dragon's head (Different letters indicate significant difference at  $p \leq 0.05$ ).

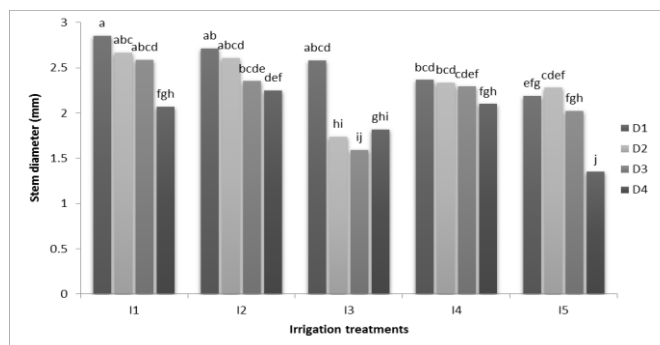


Figure 4. Effect of different irrigation treatments (I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub> and I<sub>5</sub>: irrigation after 70, 100, 130, 160 and 190 mm evaporation from class A pan, respectively) and four plant density levels (D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub>: 200, 300, 400, 500 plant/ m<sup>2</sup>) on stem diameter of Dragon's head (Different letters indicate significant difference at  $p \leq 0.05$ )

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