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Effects of Plant Density and Planting Pattern on Physiology Effect of Medicinal Plant of *Echium amoenum* Fisch and Mey in Latmahalleh Village, Iran

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Abstract: Appropriate planting densities are very important in crops production. Planting density, not only competition for light and food does not set dry split between the limbs too to control. In this matter, this study was accomplished for assessing the effects of planting pattern and plant density on physiological characteristics of Iranian ox-tongue (*Echium amoenum* Fisch and Mey). Also, this study was implemented in the form of two-factor, planting pattern and plant density in two levels (square and rectangular shape) and four levels (2, 4, 6 and 8 bush per m^2) in the form of two-factor factorial exam and via the base of randomize complete block design with three replications in agricultural year of 2009-2010 in Eshkevarat region of Iran located in the northern part of Iran. The results showed that there was a significant difference between different treatments regarding the plant density effect on variables of number of flower in shrub ($p<0.01$), number of stem ($p<0.01$), altitude of shrub ($p<0.05$) and abscissa of flower ($p<0.01$).

Key word: Medicinal plant · Iranian ox-tongue · *Echium amoenum* fisch and mey · Plant density · Planting pattern · Physiology effect

INTRODUCTION

Appropriate planting densities are very important in crops production. Planting density, not only competition for light and food does not set dry split between the limbs too to control [1, 2]. Way by farming are usually designed to receive light come through complete ground cover plant with changing density and spacing of plants and speed up the spread sheet, drawn up [3].

The Iranian ox-tongue (Gol-e-Gavzaban) is a kind of medicinal plant which is from Boraginaceae family, Echium genus and amoenum species [4]. *Echium amoenum* Fisch & Mey is an herbaceous and perennial plant and has got lint-covered elements. Stem is erected or sometimes curved that has simple leaves (unbranched) with a unique nervure. Its flower consists of a coarse calyx with styloid and perennial structures. The corolla is big and is three times higher than calyx that is covered by fuzz. The stamens inside calyx contain floccose filament and have bicorn shape. Also its purple or purplish blue sturdy flower appears on one side of the stem. The pistillate inflorescence is simple and high. All the aerial organs of this plant are covered with uncinate lints that look bossy (white and small) after falling. The fruit is a kind of achene with an acuminate look and is covered with several small bosses. Seeds are brown having swollen lines with length of 3-4 mm and width of 2 mm [5-10]. The Iranian ox-tongue grows in mountain moderate and Caspian moderate climates (tropic and moderate regions of earth specially) that simultaneously occurs with spring rain in mountain moderate and Mediterranean climates. Generally, weather and soil conditions of clammy regions that relatively have continual rain during spring and summer are appropriate for cultivation [4]. This plant is capable to grow and blossom on altitude of 1500-2000 meters [7-9].

The flowers and leaves of ox-tongue with warm temperament traditionally have effects of hilarity, general nutrient and can cause face to be more cheerful. The extract of ox-tongue has anti-inflammatory and anti-depression feature [11, 12]. In Iranian traditional medicine; the flowers of ox-tongue are also used by people so as to abate the symptoms of sniffle and common cold, multiplier of blood pressure, calmative and diaphoretic. Accordingly, this plant shall be considered as an Iranian purebred medicinal plant [5, 7-10, 13]. In general accomplished researches were mainly related to the seed components and petals and seed medicinal effects and no considerable study has been performed in order to determine suitable cultivation

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methods in Iran yet. The ox-tongue plant is a row crop [4] so assigning suitable row spaces and planting pattern can influence the increase of yield. Choosing a desirable plant density as for the continental conditions of region cause better gemmule establishment, more effective use of light, nutrients and environmental factors, better competition against weeds and finally more yield increase [14].

Anten *et al.* [15] reported that Flexing effects on stem characteristics were independent of stand density. Growth, reproduction and survival of solitary plants were not affected by flexing, while in the monostand growth was slightly reduced. But in the mixed stand, flexed plants were readily shaded by controls and had considerably lower growth, survival and reproduction rates. These results suggest that wind shielding indeed plays a role in the plastic increase in stem elongation of plants in dense vegetation and that this response can have important consequences for competitive ability and lifetime seed production. Also, Majnoun Hosseini *et al.* [16] indicated that total biomass and crop growth rate were the major elements explaining the reduced yield compensation factors at higher plant population density. Plotting the fitted seed yield values against the number of dominant alleles showed the effect of the maturity genes on the response of seed yield to plant density. Torabi Jafroudi *et al.* [17] showed that effects of row spacing and plant spacing on biological and grain yield were significant at 1% level. With increasing of row and plant spacing grain and biological yield, also increased. Statistical analysis showed that there were significant differences among cultivars for grain and biological yield and Naz cultivar produced higher biological and grain yield than Derakhshan cultivar. In vegetative traits, row spacing effect on the number of sub branches and it increased with increasing row spacing. By increasing plant spacing, number of sub branches, the length and the number of nodes per sub branches increased. Investigation of growth indices showed that by decreasing plant spacing, CGR was increased. Taheri Asghari *et al.* [18] showed that planting density had significant effect on lateral stem number, leaf number and pod number and biological yield and plant height had not significantly affected due to planting density. Means compression showed that highest biological yield and plant height were achieved under 15 plant/m^2 and highest lateral stem number, pod number and leaf number were achieved under 6 plant/m^2. The results of this experiment showed that drought stress and planting density are important effective factors on quantity and morphological characteristics of plants that they can affect on quantity yield of chicory sorely. Also, Shakarami and Rafiee [19] showed that there were significant differences in grains per row, grains per year, grain yield and light interception due to different planting pattern × density interactions. Higher LAI caused more light interception in twin-rows patterns than single –row pattern, with increasing in corn density. The highest grain yield was obtained for twin-rows planting from 10 plant mG_2 as a function of more grains per row. Single-row pattern in 13 plant mG_2 produced the lowest grain yield. In this matter, this study was accomplished for assessing the effects of planting pattern and plant density on physiological characteristics of Iranian ox-tongue in Latmahalleh village, North of Iran.

MATERIALS AND METHODS

This study was accomplished in Latmahalleh village of Eshkevarat region located in the northern part of Iran, in the point of 36°50′ N latitude and 50°10′ E longitude in an area in scale of 300 Km^2 and in 2009-2010 agricultural years. Average annual precipitation is 662-1202 mm; altitude is 1500 m, minimal temperature is -5°C and maximum temperature is 35°C. The results of soil experiment indicated that the soil texture is a kind of Sandy-Clay t exture (39% Clay, 50% Sand & 11% Silt). The parameters such as pH, EC and amounts of Nitrogen, Potassium and Phosphorus were experimented and the results are shown in Table 1.

This study was implemented in the form of two-factor factorial exam and via the base design of complete random block with three replications. The first factor was planting pattern in two levels (square and rectangular) and the second factor was plant density in four levels (2, 4, 6 and 8 plant per m^2). Thus, four treatments with square shape planting pattern in 35.5x35.5, 41x41, 50x50 and 70x70 centimeters and four treatments with rectangular shape planting pattern in 25x50, 27.5x60, 35x70 and 60x80 centimeters were created. So the plant density was equated in both square shape pattern and rectangular shape pattern.

Table 1: Soil test

pH	6.3
EC (dS/m)	0.17
Percentage of N	0.08
Absorbable Potassium (mg/kg)	332.00
Absorbable Phosphorus (mg/kg)	13.00

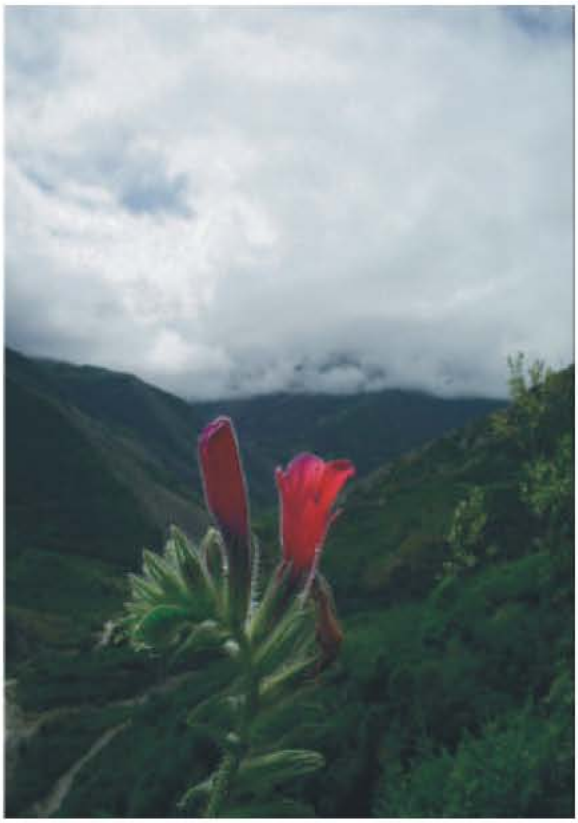

Fig. 1: Medicinal plant of *Echium amoenum* in Eshkevarat region (Picture by: Dariush Ashoori Latmahalleh)

Farm preparation accomplished in the end of March 2009 then it was created some plots in 3x4 meters so as to perform design plan. It was specified 70 centimeters distance between the plots and one meter between the blocks. It was utilized a kind of furrow irrigation system for planting ox-tongue. The planting process started on 5th May of 2009. Used seed was type of native subspecies and it was planted in the depth of 2-3 centimeters of soil level. As for the soil analysis results, the farm was fertilized by amount of 4.5 Kg of 46% triple super phosphate and 4.5 Kg of 50% 2-potassium sulfate used in the form of stripes between planting rows (in 300 m^2). It was also added 3 Kg of 46% urea manure on the planting time and 3 Kg of urea manure in the form of slippage after the first weeding (in 300 m^2). Weed control process was implemented in the mechanical way with the aid of hands on 6th June and 6th August of 2009. The herbs located in coastal rows and also ones that were in the outset and end of the plots were not identified in order to apply the sampling process properly and deletion of marginal effects.

In this study, the studied features consist of: Number of flower in shrub, number of stem, altitude of shrub, abscissa of flower and abscissa of inflorescence. The flower harvest process was accomplished on May (2010) in five terms, on 13rd, 16th, 19th, 22nd and 25th. Row of five plants selected by the middle of the plots is to determine the variable test was used. To obtain the number of flower in shrub and number of stem per plot in current agricultural season and the results were five plants together. Mean Analogy by Duncan Test and variance analysis were used for data analysis by SPSS (16) software.

RESULTS AND DISCUSSION

Number of Flower in Shrub: In this study, results of variance analysis in Table 2 showed that there was no significant difference ($p>0.05$) between different treatments regarding the planting pattern effect on number of flower in shrub of ox-tongue. The effect of plant density on number of flower in shrub of ox-tongue is shown in Table 2 indicated that there was a significant difference ($p<0.01$) between different treatments. This result is in agreement with those obtained by Omidbeygi and Hasani Malayeri [20]. Mean analogy by Duncan test in Table 3 indicated that maximum average of number of flower in shrub was in 2 bushes per meter square density (about 1165 flowers) and the minimum average was in density of 8 bushes per meter square (about 530 flowers). In other words, number of flowers / shrub was increased with decreasing the plant density. Decrease of competition among the bushes and increase of the space allocated to each bush was seemed to be its reason. Nevertheless, results of variance analysis of interactions between planting pattern and plant density indicated that there was no significant difference between different treatments regarding number of flower in shrub of ox-tongue (Table 2).

Number of Stems: Results of variance analysis presented in Table 2 showed that there was no significant difference between different treatments regarding the planting pattern effect on number of stem of ox-tongue ($p>0.05$). The effect of plant density on number of stem of ox-tongue in Table 2 indicated that there was a significant difference between different treatments ($p<0.01$). Mean analogy by Duncan test in Table 3 indicated that the maximum average of number of stem was in 2 bushes per meter square density (about 125) and the minimum average obtained in density of

Table 2: Variance Analysis for Effect of Plant Density and Plant Pattern on Yield of *Echium amoenum*

		Mean squares				
Source of variation	df	Number of flower in shrub	Number of stem	Altitude of shrub (cm)	Abscissa of flower (cm)	Abscissa of inflorescence (cm)
Block	2	3332.16^{ns}	234.29^{ns}	4.51^{ns}	0.05*	32.00^{ns}
Plant Pattern	1	715.04^{ns}	1.50^{ns}	6.61^{ns}	0.00^{ns}	30.37^{ns}
Plant Density	3	462545.37**	1552.61**	141.83*	0.18**	27.53^{ns}
Reciprocal Effect	3	8387.15^{ns}	235.27^{ns}	39.95^{ns}	0.04*	38.21^{ns}
Error	14	23185.92	302.57	34.23	0.01	20.34
C.V (%)		18.85	16.11	7.47	2.20	28.83

^{ns}Non significant, *significant at P<0.05 and **significant at P<0.01

Table 3: Mean Analogy by Duncan Test

Source		Number of flowers per shrub	Number of stems	Altitude of shrub (cm)	Abscissa of flower (cm)	Abscissa of inflorescence (cm)
Plant Pattern	Square	813.00^{a}	107.66^{a}	78.80^{a}	4.53^{a}	33.28^{a}
	Oblong	802.08^{a}	108.16^{a}	77.75^{a}	4.53^{a}	35.53^{a}
Plant Density	2	1165.2^{c}	125.67^{c}	84.43^{b}	4.78^{b}	37.32^{a}
	4	875.17^{b}	115.00^{bc}	79.16^{ab}	4.50^{a}	34.90^{a}
	6	659.67^{a}	102.67^{ab}	72.83^{a}	4.38^{a}	32.60^{a}
	8	530.17^{a}	83.33^{a}	76.66^{a}	4.46^{a}	32.90^{a}
Reciprocal Effect						
Square Pattern- Density 2		1213.00^{d}	123.00^{b}	89.06^{c}	4.86^{d}	37.20^{a}
Oblong Pattern- Density 2		1117.30^{cd}	128.33^{b}	82.80^{bc}	4.70^{cd}	37.26^{a}
Square Pattern- Density 4		877.00^{bc}	119.66^{b}	80.86^{abc}	4.56^{bc}	36.76^{a}
Oblong Pattern- Density 4		873.33^{bc}	110.33^{ab}	77.46^{abc}	4.43^{ab}	33.00^{a}
Square Pattern- Density 6		674.33^{ab}	107.66^{ab}	74.93^{ab}	4.30^{a}	29.80^{a}
Oblong Pattern- Density 6		645.00^{ab}	97.66^{ab}	70.73^{a}	4.46^{abc}	35.40^{a}
Square Pattern- Density 8		487.67^{a}	80.33^{a}	73.33^{ab}	4.40^{ab}	29.33^{a}
Oblong Pattern- Density 8		572.67^{a}	96.33^{ab}	80.00^{abc}	4.53^{abc}	36.46^{a}

Means for groups in homogeneous subsets are displayed

8 bushes per meter square (about 83). In other words, number of stem discovered increases with the plant density decreases that this result was similar with Omidbeygi and Hasani Malayeri [20]. Decrease of competition among the bushes and increase of the space allocated to each bush was seemed to be its reason. The interactions between planting pattern and plant density on number of stem of ox-tongue indicated that there was no significant difference between different treatments (Table 2).

Altitude of Shrub: Results of variance analysis presented in Table 2 showed that there was no significant difference between different treatments regarding the planting pattern effect on altitude of shrub of ox-tongue (p>0.05). Similar result was reported by Biyabani [21]. While, this result was different with the findings of Khalil zadeh Gogani *et al.* [22]. The effect of plant density on altitude of shrub of ox-tongue (Table 2) indicated that there was a significant difference between different treatments (p<0.05). Mean analogy by Duncan test in Table 3 indicated that the maximum average was in density of 2 bushes per meter square (84.43 cm) and the minimum average obtained in 6 bushes per meter square density (72.83 cm). Similar result was reported by Hosani Malayeri *et al.* [23], while, this result did not correspond with Pasari *et al.* [24], Mohammadi Miril *et al.* [25], Bredmose & Nielsen [26] and Francescangeli *et al.* [27]. Nevertheless, results of variance analysis of interactions between planting pattern and plant density indicated that there was no significant difference between different treatments regarding altitude of shrub of ox-tongue (Table 2), that was similar with the results of Gholinejhad *et al.* [28].

Abscissa of Flower: Results of variance analysis presented in Table 2 showed that there was no significant difference ($p>0.05$) between different treatments regarding the planting pattern effect on abscissa of flower of ox-tongue. The effect of plant density on abscissa of flower of ox-tongue (Table 2) indicated that there was a significant difference ($p<0.01$) between different treatments. Data in Table 3 also indicated that the maximum average was in density of 2 bushes per meter square (4.78 cm) and the minimum average obtained in 6 bushes per meter square density (4.38 cm). In other words, abscissa of flower discovered increases with the plant density decreases. Decrease of competition and overcast among the bushes was seemed to be its reason. This result is consistent with Bredmose and Nielsen [26], Hemmatzadeh *et al.* [29] and Saghatol Eslami & Moosavi [30]. Furthermore, the results of variance analysis of interactions between planting pattern and plant density indicated that there was a significant difference ($p<0.05$) between different treatments regarding abscissa of flower of ox-tongue. Data in Table 3 indicated that the maximum average was in Square Pattern + Density 2 (4.86 cm) and the minimum average obtained in Square Pattern- Density 6 (4.30 cm).

Abscissa of Inflorescence: Results of variance analysis presented in Table 2 showed that there was no significant difference between different treatments regarding the planting pattern effect on abscissa of inflorescence of ox-tongue ($p>0.05$). The effect of plant density on abscissa of inflorescence of ox-tongue (Table 2) indicated that there was a significant difference between different treatments ($p>0.05$). The interactions between planting pattern and plant density indicated that there was no significant difference between different treatments regarding abscissa of inflorescence of ox-tongue (Table 2).

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