The growth and yield of the plant Azivash (Corchorus Olitorious L.) in various densities and irrigation regimes

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Abstract: The Azivash plant was cultivated at densities of 20, 27, 40 and 80 m-2 and three irrigation intervals of 6, 12 and 18 days with three replications using a randomized complete block design. Cultivation was considered in a row and row spacing of 25 cm was used. Plant spacing on the row was respectively 5, 10, 15 and 20 cm. At harvesting time when the plant height was about 50 cm, the components of plant height (cm), number of leaves per plant (number), new plant amount of yield (kg ha-1), number of branches per plant (number), leaf area index (leaf area), fresh weight of leaves and stems (kg ha-1), dry weight of leaves and stems, and total dry matter per hectare (kg ha-1) were determined. The results showed that both components of the irrigation and plant density have a significant impact on the level of yield and yield components both in the new harvest and after drying. And to achieve maximum performance, it should be used a density of 80 m-2 and irrigation period of 6 days.

Keywords: Azivash, yield, plant growth, plant density, irrigation regime

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1 Introduction

Azivash (*Wild okra*) (*Corchorus olitorius l.*) belongs to *Tiliaceae* family (Porta, 2011). Grubben and Denton (2004) reported that Azivash now is widely distributed throughout the tropics and in nearly all the countries of Africa. Also the plant as a vegetable is growing in Caribbean, Brazil, India, Bangladesh, China, Japan and the Middle East. Velempini et al. (2003) reported that the plant is used vastly as a vegetable among rural regions in most of Africa country. This plant also is cultivated in western Africa, especially in Nigeria and its usage is common in all classed of people (Oyedele et al.， 2006). This plant is grown in India, Bangladesh and China for fiber, but in Africa it is grown as a non-fiber plant, although it is sometimes possible to use domestic production as a fiber plant. It is consumed fresh, dried or frozen (Oomen, 1978). This yearling stands splits and with no cracks, had high altitude, which may reach 4.2 m. Plant can be without branches or have small amount lateral branches. The leaves are alternate, simple, lanceolate, with serrated margin, which is about 5-13 cm in length. (Duke, 1983).

Antia et al. (2006) reported that native plants play an essential role in the diets of humans and this plant in addition to providing energy, protein, minerals and herbs, provides specifically vitamins and hormones for the body. Tests showed that Azivash can be harvested about 30 days after planting at this stage, and however, the edible leave`s performance is very low. On the other hand, performance and efficiency can be further cultivated (density) increases (Palada and Chin 2003； Ghorbani et al., 2013).

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According to the findings of Zakaria et al. (2006), this plant has been used in traditional medicine for treating gonorrhea, dysuria, and chronic inflammation of the bladder, fever and tumors. Its leaves are also smoothing toothache (Hillocks, 1998). Azivash is used as an appetizer and ergogenic stuff (Duke, 1983). The seeds of the plant are cathartic the extract of the plant improves significantly heart failure (Chopra et al., 1986). Because this plant has not cumulative effect, then it is used as strophanthin in treating heart failure. Azivash contains large amounts of iron and folic acid and is useful to prevent anemia (Innami et al., 2005; Oyedele et al., 2006). Its seeds have vast antibacterial properties (Pall et al., 2006).

About the effect of cultivation date on growth and performance, Wahba et al. (2003) believe that cultivation timely of different types of vegetables leads to improve more economic performance without additional costs and contributes genotypes to reach their total potential performance. In another research, Abd-Allah and Nasr (2005) estimated that the best date of cultivation for Azivash is likely at the end of April month in terms of seed performance and green leaf in Alexandria region in Egypt. Abd-Allah et al. (2010) reported that most genotypes of Corchorusolitorius show better reaction to potential performance at the end of March month in some areas of Egypt.

It is believed that the density per unit area can affect the behavior of vegetative and reproductive growth of plants (Yaluk, 1980). Mikend *et al.* (2009) reported that increasing plant density per unit area has negative influence on all measured traits of Azivash per plant except plant height. They believe that the increase in height with increasing density, due to competition for factors such as light is essential for plant`s life. They in total order to use the density of 10 to 25 m^{-2} (100,000 to 250,000 plants per hectare) to achieve optimal performance of Azivash per unit area. Palda and Krasmon (1998) recommended the density of 100,000 m^{-2}. Ghorbani *et al.* (2013) for cultivation of this plant in Gorgan used density of 33 m^{-2} (330,000 plants per hectare).

Since this plant is a crop used in the form of fresh vegetables, salad, and in variety of foods as well as a very useful medicinal plant, and considering that this plant is unknown in Iran and scientific work has not been done on the effect of various plant densities and irrigation regimes on the plant growth and yield of Azivash, therefore, the aim of this study was to evaluate the effects of density on growth, performance and irrigation regime in weather conditions of Gorgan, Iran.

2 Materials and methods

2. 1 Plant cultivation

This plant has been cultivated in Farm number one in Gorgan University of Agricultural Sciences and Natural Resources with Annual rainfall 607 mm, average annual temperature 13 ℃, longitude 54 ℃East, latitude 27 ℃North, height above sea level 13 m and silty clay loam soil. The plant was cultivated at densities of 20, 27, 40 and 80 m^{-2} and three irrigation intervals of 6, 12 and 18 days with three replications using a randomized complete block design. Cultivation was considered in a row and row spacing of 25 cm was used. Plant spacing on the row was respectively 5, 10, 15 and 20 cm.

2. 2 Fertilization and protection

Planting was carried out in the context of the preparation and use of fertilizers, nitrogen, phosphorus and potassium values of 100, 100 and 50 kg ha^{-1} and mixture of it with soil. Seeds due to their small size were cultivated at a depth of 0.5 cm. Amount of seed at planting to ensure they reach the target density was at least considered tripled. And after germination at a stage that its height reached 5 cm, an additional plant sparse was conducted. Seeding was done in wet until plants grow irrigation was done every three to four days (twice watering after planting the seeds until the germination) and subsequently continued to be applied to irrigation treatments.

2. 3 Harvesting time

At harvesting time when the plant height was about 50 cm, the components of plant height (cm), Number of leaves per plant (number), New plant amount of yield (kg ha-1), Number of branches per plant (number), Leaf area index (leaf area), Fresh weight of leaves and stems (kg ha-1), Dry weight of leaves and stems, and total dry matter per hectare (kg ha-1) was determined. The obtained data was analyzed and evaluated by SAS software program and LSD test in the level of five percent.

3 Results and discussion

Table 1 shows analysis of density variance, irrigation regime and their interaction on the number of branches, number of leaves per branch, number of leaves, plant height, leaf area branches, stem, leaf area, plant weight, stem and main leaf weight, stem`s fresh weight, Dry weight leaves, Stem`s dry weight, Main stem and leaf`s dry weight, Main stem dry weight, Leaf dry weight of branches And the dry weight of branches. As is clear from the table, the interaction between density and irrigation regime on all components except plant height was significant at the 1% level. To evaluate the interactions between different levels of compression factors and irrigation regime on the desired components, mean comparison LSD test level was used at 5% significance. This means that the mean density at each level of irrigation regime and mean comparison of different levels of irrigation regime on each level of density conducted separately and the results are presented in Tables 2 and 3.

Table 1 Analysis of density variance, irrigation regime and their interaction on the plant growth and yield of Azivash (*Corchorus Olitorious L.)* plant.

	F value			Mean		
	Irrigation×Density	Irrigation	Density	Irrigation×Density	Irrigation	Density
1	6.40**	27.04**	10.60**	4.44	18.78	7.36
2	493.15**	615.68**	2717.26**	224575.81	280375.36	1237409.22
3	106.30**	56.49**	4878.84**	24722.66	13138.58	1134736.63
4	1.27^{ns}	150**	189.74**	3.04	358.33	453.26
5	1630.10**	2145.42**	11317.7**	0.55	0.73	3.84
6	3048.48**	7154.07**	25944.8**	0.57	1.33	4.83
7	854.57**	4717.15**	14838.5**	29479940	162726356	511882012
8	1108.32**	2544.47**	16618.7**	1822515.38	4184090.86	27327554.99
9	1883.28**	7580.64**	25734.4**	15486448.1	62336667	211617550.9
10	124.90**	887.76**	3272.03**	111277.67	790940.78	2915194.44
11	192.93**	3287.54**	683.12**	203427.66	3466340.58	720278.85
12	963.08**	1087.88**	20365.7**	50267.56	56781.44	1062976.78
13	1391.22**	4369.66**	25277.8**	246863.63	775372.11	4485408.96
14	29.82**	227.13**	2290.26**	1207.03	9192.58	92691.78
15	71.30**	446.44**	1233.43**	1974.54	34159.03	12363.88

Note: ** Significant difference at 1% level ($p < 0.01$) and ns not significant

1-Number of sub branches 2-Number of leaves per branch 3- Number of leaves 4- Plant height 5- Leaf area branches in the m^2 6- Leaf area main stem, in the m^2 7- Plant weight 8- Fresh weight of leaves the main stem 9- Main stem weight 10- Fresh weight of leaves branches 11- Branch fresh weight 12- Stem`s dry weight 13-Stem`s dry weight 14- Leaf dry weight of branches 15-Dry weight of branches

Table 2 Effect of density (per square meter) and irrigation regime on the plant growth.

For, numbers of sub branches, number of leaves per branch and number of leaves.

Density	Number of sub branches			Number of leaves per branch			Number of leaves		
	Irrigation, days			Irrigation, days				Irrigation, days	
	18	12	6	18	12	6	18	12	6
20	$12^{.00\ Ab}$	14.00^{ABab}	17.00^{Aa}	363.67^{Db}	244.33^{Cc}	416.00^{Ca}	155.67^{Db}	264.00^{Ca}	131.00^{Dc}
27	12.33^{Ab}	15.67^{Aa}	14.33^{Ba}	438.33^{Cc}	502.33^{Bb}	$625/00^{Ba}$	278.00^{Cb}	$277^{.00Cb}$	399.33^{Ca}
40	12.33^{Aa}	$14^{.00Aba}$	13.67^{Bca}	592.33^{Ba}	518.00^{Bb}	457.67^{Cc}	546.33^{Ba}	$429^{.00Bb}$	457.67^{Bb}
80	11.67^{Aa}	13.33^{Ba}	$12^{.00Ca}$	658.00^{Ac}	1147.33^{Ab}	1745.67^{Aa}	942.67^{Ab}	$905^{.00Ab}$	1136.33^{Aa}

For, leaf area and leaf branches in the m^2

Density	Leaf area branches in the m^2			Leaf area main stem, in the m^2		
	Irrigation, days			Irrigation, days		
	18	12	6	18	12	6
20	0.53^{Cb}	0.49^{Db}	0.90^{Ca}	0.33^{Dc}	0.47^{Da}	0.36^{Db}
27	0.87^{Bb}	1.05^{Ba}	1.06^{Ba}	0.50^{Cc}	0.63^{Cb}	0.80^{Ca}
40	0.88^{Ba}	0.88^{Ca}	0.77^{Db}	0.87^{Bb}	0.85^{Bb}	1.27^{Ba}
80	1.16^{Ac}	2.83^{Aa}	2.30^{Ab}	1.36^{Ac}	1.64^{Ab}	3.15^{Aa}

For, the main stem weight, fresh weight and dry weight of leaves, branches and leaves of the main stem.

Density	Plant weight (kg/h)			Fresh weight of leaves the main stem (Kg/h)			Main stem weight (kg/h)		
	Irrigation , days			Irrigation, days			Irrigation, days		
	18	12	6	18	12	6	18	12	6
20	5095^{Dc}	6469.3^{Cb}	8383^{Da}	738.67^{Db}	1061.67^{Da}	720.67^{Db}	1902^{Dc}	2297.33^{Db}	2807^{Da}
27	7407^{Cc}	9366.7^{Cb}	10713.3^{Ca}	991^{Cc}	1270^{Cb}	1487.67^{Ca}	2518.33^{Cc}	3685^{Cb}	4464.67^{Ca}
40	8503.7^{Bc}	11419^{Bb}	15222.3^{Ba}	1778^{Bc}	1967.67^{Bb}	2650.67^{Ba}	3615.67^{Bc}	6270^{Bb}	8043.67^{Ba}
80	14702.7^{Ac}	25633.7^{Ab}	30705^{Aa}	2767^{Ac}	5491.67^{Ab}	5905.67^{Aa}	7067.67^{Ac}	14735^{Ab}	17706.33^{Aa}

For, the main stem and leaf dry weight, weight, weight stems and leaves of branches

Density	Fresh weight of leaves branches, (kg/h)			Branch fresh weight, (kg/h)			Dry weight leaves, (kg/h)		
	Irrigation, days			Irrigation, days			Irrigation , days		
	18	12	6	18	12	6	18	12	6
20	1127.67^{Cc}	1356.33^{Db}	1793^{Ca}	1162.67^{Cc}	1516^{Cb}	2709.67^{Aa}	196.67^{Db}	214.67^{Da}	126^{Dc}
27	1748^{Bc}	1862.67^{Bb}	2039.33^{Ba}	1817.33^{Bc}	2202^{Ab}	2391.67^{Ba}	235^{Cc}	252.67^{Cb}	306.33^{Ca}
40	1700.67^{Bb}	1444.67^{Cc}	1780.67^{Ca}	1172.33^{Cc}	1325^{Db}	2237.33^{Ca}	413^{Bb}	384^{Bc}	496^{Ba}
80	2352.33^{Ac}	2589.67^{Ab}	3234.33^{Aa}	1911.33^{Ab}	1809^{Bc}	2779.67^{Aa}	659.33^{Ac}	1111.33^{Aa}	1068.33^{Ab}

For, the weight of the branches, leaf and stem

Density	Stem`s dry weight, (kg/h)			Leaf dry weight of branches, (kg/h)			Dry weight of branches, (kg/h)		
	Irrigation, days			Irrigation, days			Irrigation, days		
	18	12	6	18	12	6	18	12	6
20	351.33^{Db}	517.67^{Da}	370^{Db}	252.67^{Db}	247^{Db}	287.67^{Da}	174.67^{Bc}	278^{Cb}	311.33^{Ca}
27	424.33^{Cc}	591.67^{Cb}	743.33^{Ca}	339^{Cb}	303.67^{Cc}	370.33^{Ba}	282.33^{Ab}	338^{Aa}	354.33^{Aa}
40	721.33^{Bc}	801.67^{Bb}	1159.67^{Ba}	369.33^{Ba}	328^{Bc}	346^{Cb}	179.33^{Bc}	239^{Db}	330.33^{Ba}
80	1244.33^{Ac}	2288.33^{Ab}	2425^{Aa}	522.33^{Aa}	450.33^{Ab}	539.67^{Aa}	273^{Ac}	301^{Bb}	338.33^{Aba}

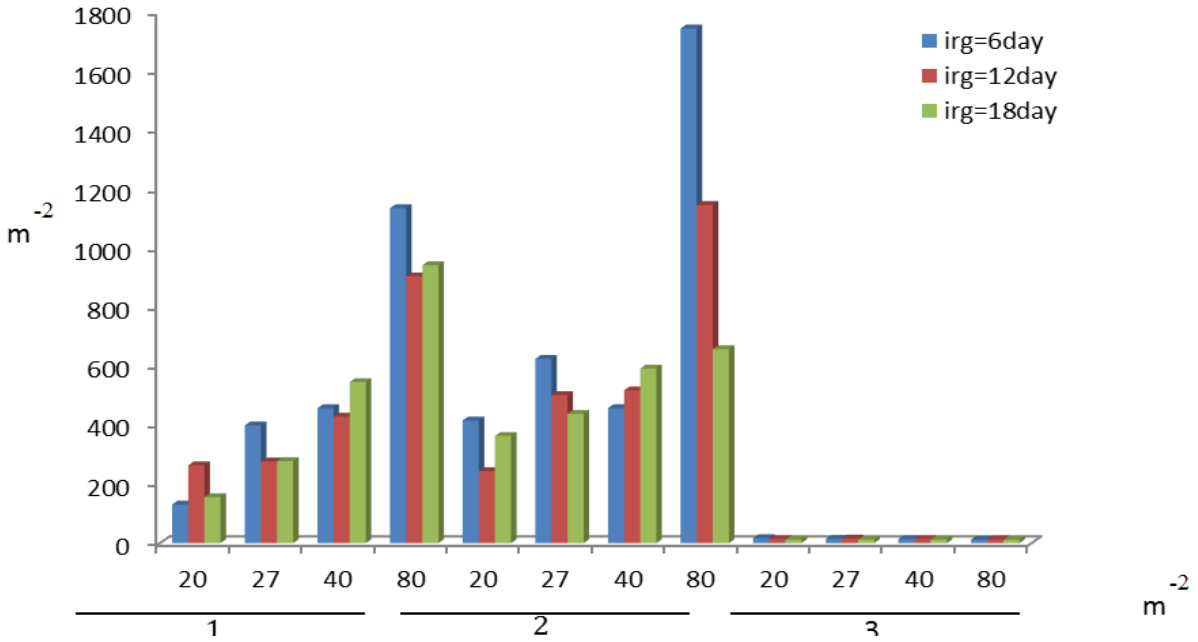
Note: Lowercase letters in each row, uppercase letters in each column represent no significant difference

Table 3 Effect of plant density and irrigation regime on the weight of the branches, leaf and stem

Density	Stem`s dry weight (kg/h)			Leaf dry weight of branches (kg/h)			Dry weight of branches (kg/h)		
	Irrigation, days			Irrigation, days			Irrigation, days		
	18	12	6	18	12	6	18	12	6
20	351.33^{Db}	517.67^{Da}	370^{Db}	252.67^{Db}	247^{Db}	287.67^{Da}	174.67^{Bc}	278^{Cb}	311.33^{Ca}
27	424.33^{Cc}	591.67^{Cb}	743.33^{Ca}	339^{Cb}	303.67^{Cc}	370.33^{Ba}	282.33^{Ab}	338^{Aa}	354.33^{Aa}
40	721.33^{Bc}	801.67^{Bb}	1159.67^{Ba}	369.33^{Ba}	328^{Bc}	346^{Cb}	179.33^{Bc}	239^{Db}	330.33^{Ba}
80	1244.33^{Ac}	2288.33^{Ab}	2425^{Aa}	522.33^{Aa}	450.33^{Ab}	539.67^{Aa}	273^{Ac}	301^{Bb}	338.33^{Aba}

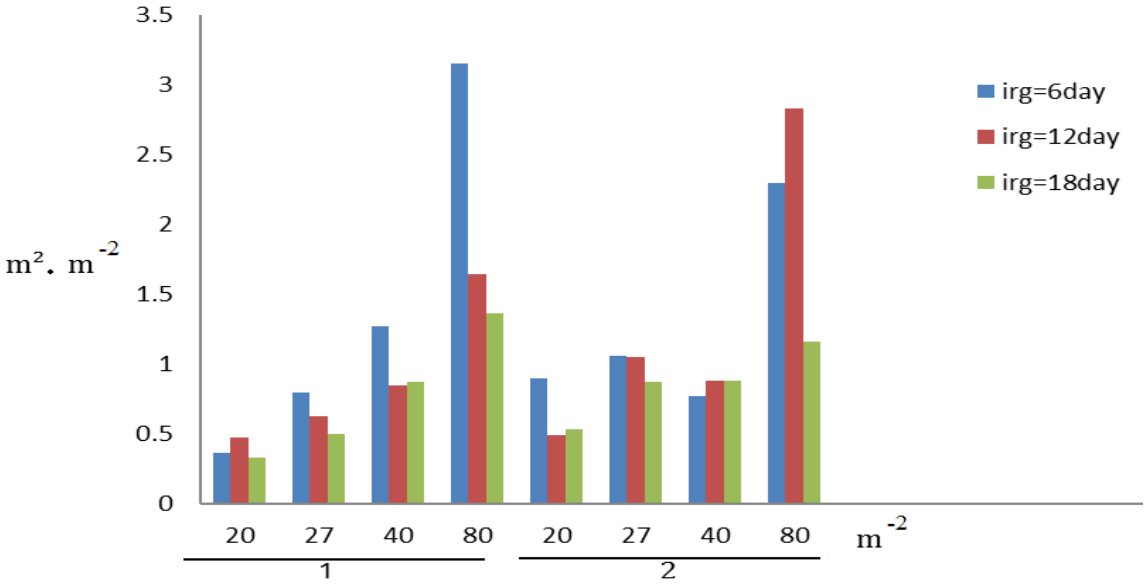
Note: Lowercase letters in each row, uppercase letters in each column represent no significant difference

Also in Figures 1 to 5, the effects of plant density and irrigation regime on various factors have been shown. According to Figure 1 and Table 2, in each irrigation regime with increasing plant density per unit area, number of leaves on the main stem and branches in m^2 increased but the number of branches declined. Increased plant density per unit area could increase the total number of leaves on the main stem and the branches, but the number of leaves and branches per plant decreased with increasing density. Mickend et al. (2009) also believe that the increased density will reduce the number of leaves per plant, but due to the increased number of plants, number of leaves per unit area will increase.



1- Number of leaves 2-Number of leaves per branch 3- Number of sub branches

Figure 1 The effect of plant density and irrigation regime on the number of leaves, stem, branches and sub-branches



1- Leaf area main stem, in the m^2 2- Leaf area branches in the m^2

Figure 2 The effect of plant density and irrigation regimes on stem`s leaf area, and branches' leaves at one square meter.

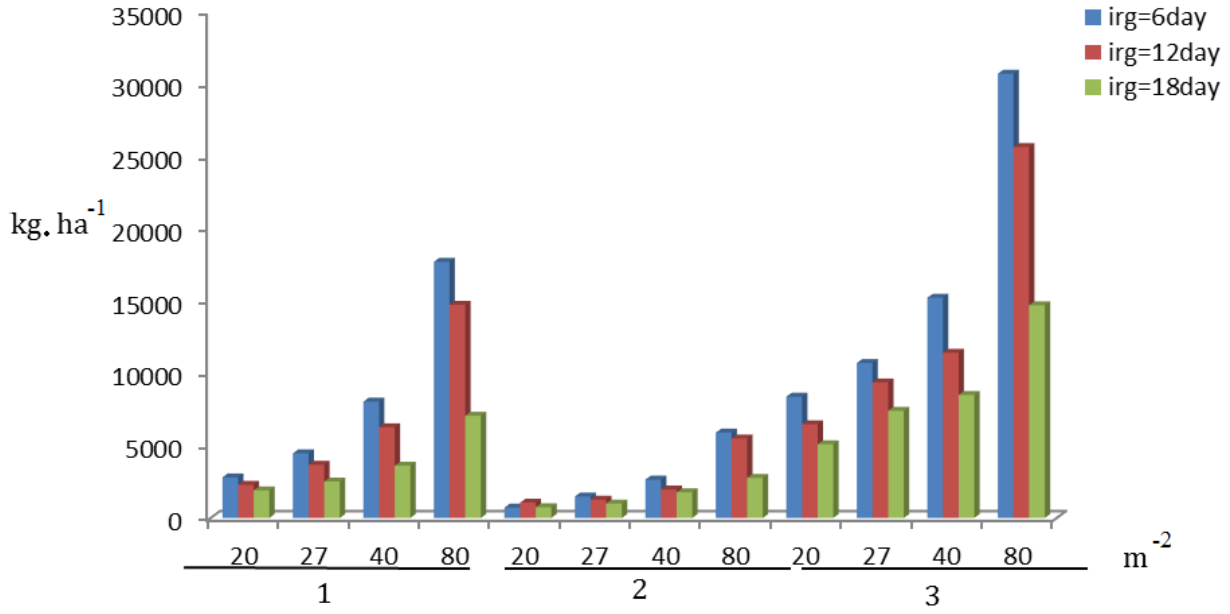
Also at each density by increasing the distance between the two irrigation and thereby increasing drought stress, number of leaves, stems, number of leaves per branch and number of branches has fallen indicating the negative effects of drought on the desired components.

Increased leaf area results increased leaf`s photosynthesis and thus the product will be greater. According to Figure 2 and Table 2, the density, reduced amount of irrigation or in other words increased distance between two irrigations, has led to a reduction in leaf area index. And at all levels of irrigation, increased density has led to an increase in leaf area index. Since this plant and its leaves are consumed fresh, thus, the increase in in leaf area index means increase in the crop yield the unit`s level.

As shown in Figure 3 In each level of density weight, stem, leaf, stem weight, total plant weight has raised by increasing the amount of irrigation and in each irrigation period with increasing density the weight of the stem, weight stem leaves and total plant weight has raised. The results of the interaction of plant density and irrigation regimes shows that to achieve maximum performance, irrigation should be done once every 6 days, and increasing irrigation interval will reduce the total product performance, this reflects the sensitivity of this plant to drought.

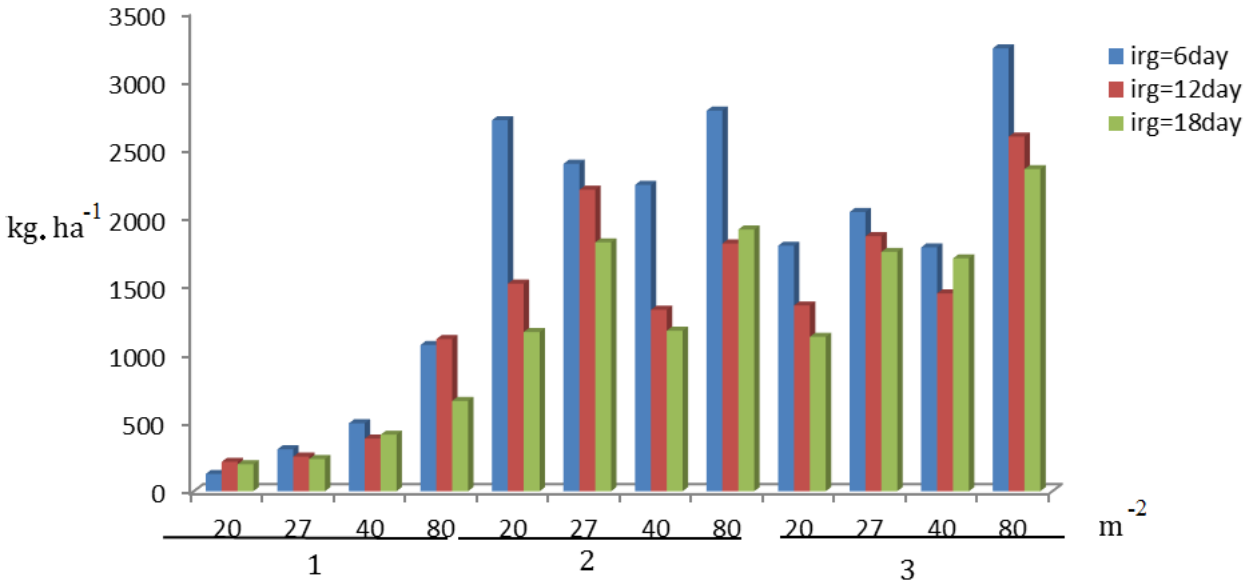
As shown in Figure 4 at each density level with increasing amounts of irrigation the main dry leaf weight, weight of branches and leaf weight of the branch increased. In each irrigating period with increasing density the dry weight of leaves, weight of branches and leaf weight has risen.

As shown in Figure 5 at each level of density with increasing amounts of irrigation, weight of the branch, leaf and stem weight increased. In each level of irrigation, with increasing density the weight of the branches, leaves and stem increased.



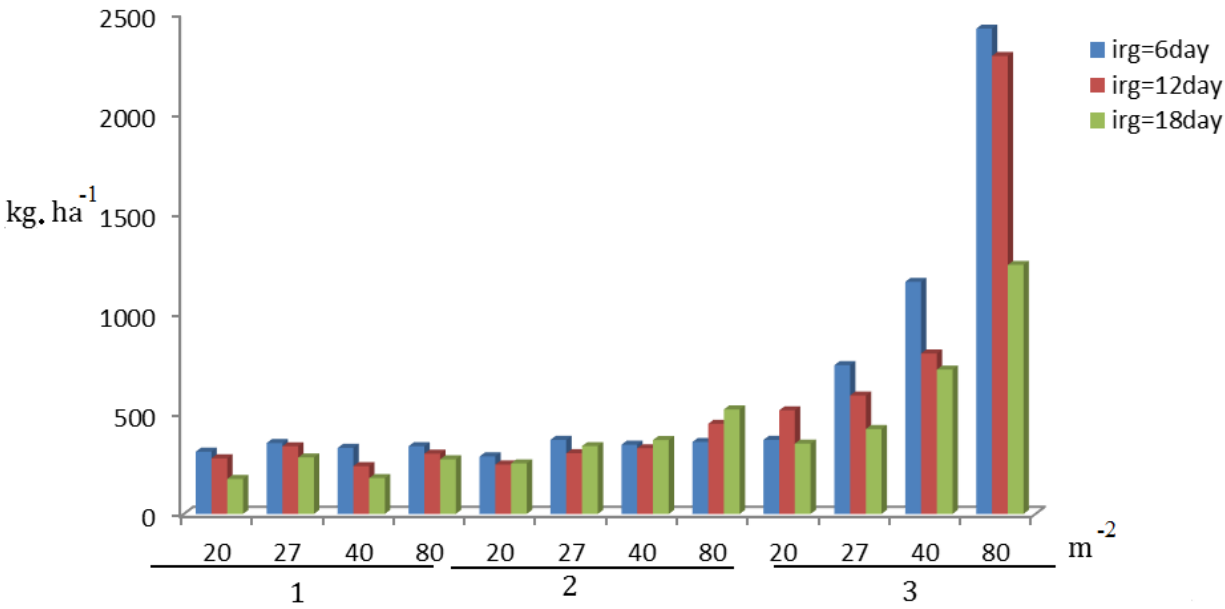
1- Main stem weight 2- Fresh weight of leaves the main stem 3- Plant weight

Figure 3 The effect of plant density and irrigation regime on the weight of the stem, and leaf weight and total plant weight



1- Dry weight leaves 2- Branch fresh weight 3- Fresh weight of leaves branches

Figure 4 The effect of plant density and irrigation regime on the dry weight of the leaves, branches' weight and branch`s leaf weight



1- Dry weight of branches 2- Leaf dry weight of branches 3- Stem`s dry weight

Figure 5- The effect of plant density and irrigation regime on the weight of the branch, leaf weight and stem weight

4 Conclusions

(1) Since the density of plants and irrigation regimes of crops are important factors that determines the amount of yield, therefore the influence of these factors on Azivash yield was evaluated.

(2) In total the results showed that both components of the irrigation and plant density have a significant impact on the level of yield and yield components both in the new harvest and also after drying.

(3) Increasing irrigation regimes will reduce the total product performance.

(4) Both fresh and dried Azivash plant is consumed and in both cases at each level of density with increasing amounts of irrigation, weight of the branch, leaf and stem weight increased and in each level of irrigation, with increasing density the weight of the branches, leaves and stem increased.

(5) To achieve maximum performance, should be used density of 80 m^{-2} and irrigation period of six days.

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