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An investigation of cultivation arrangement on growth physiological indexes and safflower yield in dryland condition

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Abstract

Planting arrangement through the impact of growth physiological indexes effect on grain yield. In order to survey these influences in fall cultivation of safflower, Zhilla cultiver was tested in 2011. This experiment was done in Mahidasht farm in Kermanshah as factorial randomized complete block design with three replications. Planting row interval treatments consists of 25, 35 and 45 cm and plant interval treatments on planting row consists of 10, 15 and 20 cm. In this experiment the physiological growth indexes consists of leaf area index, plant dry weight, product growth rate, relative growth rate, net assimilation rate and grain yield were evaluated. The results showed that the effects of planting row interval and plant interval on row on the mentioned physiological indexes were significant. By reducing the planting row interval (25 cm to 45 cm) and reducing the plant interval on row (20 cm to 10 cm) due to uniform distribution of plants, Plant vegetation was completed faster and the plant uses well of sunlight and environmental factors, and enhances the dry matter accumulation, leaf area index, crop growth rate, relative growth rate, net assimilation rate and seed yield (70%-35%) .

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Introduction

Safflower was known as oil plant and compatible to regions that have the less winter and spring falling and dry climate in flowering period, filling and maturating grain (Yao, 2006).

Weinberg *et al.*, (2005) knew that the main cause of this related to high tolerance of safflower to water scarcity due to having the roots with high water absorption. Distribution and plant density methods in the field effected on absorption and using the environmental factors that affecting on growth and by changing on the growth plant of indexes, seed yield in per surface unit will be determined. The rate of closing canopy cover, the dry matter accumulation, the leaf area index, crop growth rate, net assimilation rate and relative growth rate, such as indicators that are often used to evaluate the plant yield (Johnson and Hanson, 2003). Johnson and Hanson, (2003) If the stability of the plant density, combined with the reducing of the row cultivation, distribution of plants in per unit area were become more uniform and were used well of environmental factors and the vegetation were closed earlier and the leaf area index for the full absorption of solar radiation was be higher, as a result of this more dry matter accumulation finds (Azari and Khajehpour, 2005). Increasing of plant density due to the less infiltration light inside the plant canopy cover and create competition among plants, was caused to increase the plant height and early flowering of the plant (Dadashi , 2001). Ganjali *et al.*, (2000) showed that leaf area index is the most important factor on the grain yield and if the plant in less time to reach optimal leaf area index, the maximum yield is achieved. Ganjali *et al.*, (2000) showed the slow development of leaf area in the low densities was caused the weak development of vegetation and less absorption of radiation. Labaschi *et al.*, (2009) also early flowering and achieve the maximum dry matter accumulation in high density of safflower attributed, to the more number of plants in per unit area. These increases were caused to the competition among plants for catching water and nutrients and acceleration of growth. Ganjali *et al.*, (2000) showed at 10 cm plant interval due to the competition which comes the number of leaves in per surface unit in creased, and this leads to increasing the leaf area index in the early and mid period of growth. The crop growth rate has the direct relationship with plant photosynthesis level, In the optimal density, distribution of the plant and leaf area in per unit area have been more uniform and plants find the good location for absorbing the radiation and photosynthesis and thus the amount of crop growth rate will increase (Ozoni Davaji *et al.*, 2008). At the beginning and end of the growing season due to the lack of complete vegetation and low level of radiation received by the leaves, less dry matter produced and the amount of crop growth rate in more planting row interval, reduced (Hossein-Zadeh *et al.*, 2008). Pourhadian and khajehpour, (2008) The reason of reducing of net absorption in planting row intervals less than related to become closer of plants together, increasing the competitiveness of the plant and the leaves canopy. The role of physical features in improving the agronomy plants yield were not hidden for anyone and a lot of researches on safflower are not done. The aim of this study was to evaluate the grain yield potential and its relationship to the growth indexes in different densities in dry land conditions.

Materials and methods

Site description and soil analysis

This experiment was conducted at Mahidasht field in Kermanshah. With 34° 16` latitude, 48° 46` longititude, and 1365 m height above sea level in 2009-2010. The highest rainfall with 115.3 mm in October and the lowest with 0 mm in June, July, August, September and October happened. The desired area with 16.4°C annual temperature average and having 150 days dry, was concluded hot and dry Mediterranean climate zones and with having wet and cold winter and hot and dry summer, was concluded semi-arid temperate regions (Table 1). Then to determine the physical and chemical properties of the soil sample the soil in 0-30 cm depth.

Treatments and experimental design

The experimental design was factorial based on Randomized complete Block design with three replicates. 25, 35, and 45 cm are three row intervals and 10, 15, and 20 cm plant interval on row were chosen as experimental treatments. In a year ago, was fallow. Beginning in the fall of the year, mentioned field order to maintain and store moisture was plow by using a pen plow in fall, in order to shatter a hunk and a uniform soil condition, the field be disked. Based on the results of soil analysis requirement fertilizer, nitrogen and phosphor plus 2.5 Lit/h Treflan herbicides (Trifluralin) along with the disc was given to earth style and mixed with the soil. Then the farm by faror (deep wide cultivation act) likes streamlet and hill. Each experimental plot contains 6 sowing lines that is 4 m^2 plant interval and lines on the rows based on the desired plant density was variable. Two lines in each side-plot (1 and 6 lines) were in the Commons as the margin of 4 middle lines to specify the phonological stages of the plant and evaluation of all the various traits were used. Zhila was the sunflower cultivar. Planting on 10 November to manually at the desired density by changing the distance between plants on the row is done. For enough seed germination and plant emergence confidence lay at any point were two seed that after germination decrease to a plant. At the time of planting paid attention carefully on that the seeds to be placed at a depth of 3-4 cm soil. In order to achieve the appropriate plant density in step 2 to 4-leaf stage, emprise to thin and also remove the weeds. Permanent or perennial weeds during the experiment weed but annual weed with once or twice weed were controlled.

Plant sampling and measuring

For determining growth indexes in growth season was used the rosette stage, the beginning of the shooting, heading, flowering, and physiological maturation. The samples and next samples is done once in 15 days interval of all plots as a demolition. Comply with the margins and in each sampling of lines 2 and 5, 5 plant numbers by Clipper cut from the surface of the soil to measure leaf area was transferred to the laboratory. After separating the leaves of the plant, was determined the leaf area with digital device Leaf area matter. The aerial part of the plant, for 48 hours at 80 °C oven was put to dry. After drying was weight with a milligram weighing scale. At the end of the growing season to determine yield and yield component selected randomly mentioned ten plants to each experimented plot to measure morphological traits. Harvest operation after you delete the margins of two rows in the middle of each plot (3 and 4 lines) and remove half a meter from the beginning and end of the lines of which is equal to 1.5 m^2. Samples of harvested laid on hemp bags after slamming the seeds were parted of pod and a weight of seeds with an accurate scale for weighing with an accuracy of one milligram and seed yield was calculated in kg/h.

Statistical analysis

The variance of the data, compared with a test average of Duncan and the calculation of the correlation coefficients was used with MSTAT-C software. Excel soft ware was used for drawing the charts.

Results and discussion

Plant dry weight

Effect of planting row interval on plant dry weight was signification at 1% probability level (Table 2). By increasing planting row interval from 25 to 45 cm, maximum plant dry weight was significantly reduced (Table 3). 25 and 45 cm planting row interval had the most and the least dry matter, receptively in the whole of growing season. 45 cm row interval was caused to more competition among plants to get food and water, and this would reduce the dry matter accumulation (Pourhadian and Khajehpour, 2008). The process of dry matter accumulation in per plant is same as sigmoedi and linear growth was started about 14 days after shooting and before flowering the amount of dry matter accumulation was been slow flowering and 14 days before physiological maturation stage due to defoliation, the amount of dry matter accumulation is reduced. Similar results have been reported by Lopez-Bellido *et al.*, (2000).

The effect of plant interval on planting row in plant dry weight at 1% probability level was significant (Table 2). The highest and the lowest plant dry weight acquired in 10 and 20 cm plant interval respectively (Table 3). At 20 cm, plant interval shrubs at the beginning of the growing season less used, from environmental factors such as sunlight, and thus causing the low covering development, reducing the photosynthesis and reducing of dry matter in per plant the same report Rosalind *et al.*, (2000) presented.

Table 1. Results of climatic properties of experimental location in 2012-2013.

Climate	Cold-temperate semi-arid
Latitude	34° 16'
Longitude	48° 46'
Height above sea level	1365
Annual absolute maximum temperature	40.7 (°C)
Annual temperature mean	15.3 (°C)
Annual absolute minimum temperature	-8.6 (°C)
Annual rainfall mean	365 (mm)
Annual evaporation rate	1771 (mm)
Sundial	2618.7
Number of rainy days	54
Number of frost days	68

Leaf area index

The effect of row interval on maximum leaf area index at the level of 5% was statistically significant (Table 2). By increasing the planting row interval, the maximum leaf area index was significantly reduced (Table 3). 25 and 45 cm planting row interval had the most and the least leaf area index respectively in whole of the growth season. Leaf area index represents plant photosynthesis capacity and depends on the number and size of the leaves and the most important influencing factor in seed yield (Azari and Khajehpour, 2003). At the beginning of the plant growth due to being low and small leaves, the amount of leaf area index is down but gradually with the plant growth and the leaves development, leaf area index increased and at the stage of flowering reaches to the Maximum 45 cm row internal due to leaves canopy yellowing and drying the plant lower leaves and soil moisture deficit reduced leaf area index.

Table 2. Analysis of variance for some of safflower physiological traits in row interval and plant on row.

		MS				
	df	TDM (gr.m²)	LAI %	CGR (gr.m².day⁻¹)	NAR (gr.m².day⁻¹)	Economic yield (Kg.h)
Replication	2	2.20	0.36	0.031	0.002	15453.4
Row spacing	2	424.7 **	0.10*	0.82**	0.003**	1977120.1 **
Plant spacing	2	489.9 **	0.26**	1.21**	0.005*	471654.7**
Interaction	4	36.3 ns	0.031 ns	0.046 ns	0.004ns	43841.9 ns
Error	26	2.43	0.026	0.031	0.0004	28042.3
C.V (%)	–	6.5	9.2	10.7	11	11.1

ns: Non-significant, *and **: Significant at α= 0.05 & α= 0.01, respectively.

The effect of plant row interval on leaf area index at 1% probability level was significant (Table 2). The highest and the lowest leaf area index acquired in 10 and 20 cm plant interval respectively (Table 3). At 10 cm plant interval due to competition the number of leaves in per unit area increased but by passing the time and with senescing and defoliation leaf area index decreased noticeably (Ganjali *et al.*, 2000).

Crop growth rate

Row interval effect on maximum crop growth rate 1% probability level was significant (Table 2). By increasing the planting row interval from 25 to 45 cm maximum crop growth rate declined significantly (Table 3). 25 and 45 cm planting row interval had the most and the least amount of crop growth rate respectively in the whole growth season. Maximum crop growth rate is from starting to shoot to flowering and after flowering stage due to being low of photosynthetic rate and defoliation, senescing and crop growth rate had the amount of it will be negative(Lebaschi *et al.*, 2009; Pourhadian and Khajehpour, 2008). 25 cm plant row interval with better access to water, food and enough space increases the sub branch, raises the leaf area index and has maximum crop growth rate. The effect of plant interval on the row on crop growth rate at 1% probability level was significant (Table 2). The highest and lowest CGR in 10 and 20 cm plant interval respectively (Table 3). In the low density due to low leaf area index and less absorption of solar radiation by the plant crop growth rate reduced (Ganjali *et al.*, 2000).

Table 3. Means comparison of safflower physiological traits in row interval and plant on row.

	TDM ($gr.m^2$)	LAI %	CGR ($gr.m^2.day^{-1}$)	NAR ($gr.m^2.day^{-1}$)	Economic yield (Kg.h)
Row spacing (cm)					
25	429.2 ^{a}	2.0 ^{a}	2.0 ^{a}	0.199 ^{a}	1438 ^{a}
35	406.5 ^{a}	1.8 ^{ab}	1.8 ^{a}	0.181 ^{a}	1216 ^{a}
45	385.6 ^{a}	1.7 ^{b}	1.5 ^{b}	0.170 ^{b}	857 ^{c}
Plant spacing (cm)					
10	412.5 ^{a}	2.0 ^{a}	2.2 ^{a}	0.205 ^{a}	1265 ^{a}
15	^{b} 408.7	1.8 ^{ab}	1.9 ^{b}	0.187 ^{b}	1089 ^{b}
20	396.8 ^{c}	1.6 ^{b}	1.3 ^{c}	0.176 ^{c}	936 ^{b}

Similar letters in each column shows non- significant difference according to Duncan's Multiple Range Test in 0.05 level.

Net absorption speed

Effect of plant row interval on the maximum net assimilation rate at 1% probability level was significant (Table 2). By increasing the planting row, interval from of 25 to 45 cm NET assimilation rate significantly declined (table 3). 25 and 45 cm planting row interval respectively had the most and the least net absorption speed. In more planting row interval because of the approaching shrubs to each other, competition among the bushes was intensified and plants is ghosting, and the amount of net assimilation rate at the beginning of the growth of the plant will decrease (Pourhadian and Khajehpour, 2008). But in less planting row interval because of defoliation at the end of the growing season, the amount of net assimilation rate reduced severely (Morrison *et al.*, 1990). The effect of plant interval on the planting row on net assimilation rate 5% level was significant (table 2). The highest and lowest amount of net assimilation rate of respectively assessed10 and 20 cm plant interval (Table 3). The uniform distribution of the plants in the closest rows used to better light absorption in to covering and increase the photosynthesis is and net absorption speed (Hatami and Latifi, 2004).

Grain yield

The effect of planting row interval on grain yield in 1% probability level was significant and yield reduced with increasing the planting row interval (Table 2). The yield declined significantly by increasing planting row interval from 25 to 45. 45 cm planting row interval had 68% (587 kg/ha) grain yield less than 25 cm plant row interval (Table 3). By reducing the cultivation row interval, competition within and among plants, reduced and the plant used well from environmental factors such as light and food number of heads in per plant and number of grains in per head rises, thus it was caused to increase seed yield (Azari and Khajehpour., 2003). The effect of plant interval on grain yield planting row 1% probability level was significant (Table 2). The highest and lowest amount of grain yield respectively accessed from10 and 20 cm plant interval, so that 20 cm plant interval had 35% (329 kg/ha) less than another one (Table 3). Row interval and plant interval on fewer rows through plant uniform disturbution used the maximum sunlight and were caused to increase the leaf area index, crop growth rate, relative growth rate, and finally yield.

Conclusion

Some of the vital points in safflower cultivation in dry land regions should be pay attention, are climate conditions, high temperature, and drought stress in the region. The cultivars that have the shorter growth period have higher grain yield. So 25 cm row interval on 10 cm row due to having fewer maturation days had higher yield.

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