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The effect of planting row interval and plant density on the phonological traits of safflower (*Carthamus tinctorius* L.) dryland conditions

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Abstract

Planting arrangement through the plant's phonological traits affect on plant yield. In order to the experiment was done in factorial randomized complete block design with three replicates in 2010 in Kermanshah Mahidasht. In this experiment the three row intervals of 25, 35 and 45 cm plant intervals and three rows 10, 15 and 20 cm were compared. The results showed that the effect of row interval and plant interval on the row on the number of days to heading, the number of days to flowering, the number of days to maturation and the number of days to economic yield was significant. By reducing the row intervals, plant interval on the row, the number of days to flowering decreased,. The grain yield decreased by increasing the planting row interval from 25 cm to 45 cm. The row intervals and plant intervals on fewer rows by the reason of homogeneous plant distribution; vegetation has been completed faster and used of maximum sunlight and environmental factors. The maximum grain yield in per unit area was of 30 cm row interval and 10 cm plant interval on row, respectively. The increasing grain yield relates to the shortening days to maturate, does not encounter the plant with water stress and better use of environmental factors.

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Introduction

Safflower is one of the oldest agronomy plants and as oil seed can be used in oily seeds cultivation (Mc Pherson *et al.* 2004). Safflower has 25-40% oil that more than 90 percent of its oil is from unsaturated fatty acids type and 12-25% protein (Jamshi-Moghadam and Pordad, 2006). Be aware of the different stages of growth period involves the emergence, shooting, button, flowering and maturation makes to evaluate the required conditions in each stage and it is close to the plant optimal conditions to increase the crop yield (Koocheki and Sarmadnia, 2000). Different investigation among safflower genotypes as terms of the phonological duration and time of phonological stages had difference because of genetic characteristics and environmental factors (Behdani *et al.*, 2008). Increasing the plant density due to reducing the light absorption inside the plant canopy and creating competition among plants, caused to increase the plant height and early flowering (Dadashi, 2001). Hans *et al.*, (1992) the planting period to shoot in Canada announced 5-7 weeks and flowering stage lasts 2-3 weeks, the difference in the length of the flowering stage related to a different plant density, soil humidity, and genotype features of cultivars. With the increasing of planting row interval, due to more light absorption into the plant canopy, the number of sub branches increased (Azari, 2001). Different experiments results on safflower (Zareian, 2001: Azari, 2001), Soybean (Khadem Hamzeh, 1995), Chickpea (Gen *et al.*, 2003) represents the reducing, sub branches is influencing of increasing plant density. Number of head in per plant is one of the main components of seed yield in safflower which high vegetative growth and plant ramifications are the reasons of the increasing yield (Omid Tabrizi *et al.*, 2002). High seed yield in productive genotypes relates to number of heads in per plant, number of seeds in per head and 1000-grain weight (Pourdad, 1999). The long growth period and facing with drought stress in the seed filling stage makes to reduce the average head diameter from 26.3 mm to 24 mm, and the number of seeds in per head also reduce from 53 to 38 (Farokhinia *et al.*, 2010). Bagheri *et al.*, (2001) by evaluating 121 safflower genotypes were reported a plant yield with the number of days until the start of the first flower, the number of sub branches, the number of days to head, the number of heads in per plant, diameter head, number of seeds in per head, and 1000-seed weigh had the meaningful correlation. Dealing the flowering phase, with high temperature environment caused the significant reduction of head number in per plant (Tavakolee Zanialee, 2002). Increasing the heed in plant, seed number in head, and seed weight are as a result of planting row interval reducing and density increasing, seed yield was increased by planting row interval reducing (Azari, 2001; Azeri dward, 2004; Mandel *et al.*, 2004). Because of plants in narrow planting row distance had better distribution and less competition with together (Morrison *et al.*, 1990). The objectives of the study are to identifying the phonological stages of the safflower and effect of row interval and plant density on the number of days to planting, the number of days to heading, the number of days to flowering, the number of days to maturate, seed yield and choosing the best planting date of safflower 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. Then to determine the physical and chemical properties of the soil sample the soil in 0-30 cm depth (Table 1).

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 safflower 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

The number of days to sprouting

The effect of row interval and plant distance on row and their reciprocal effects on plant emergence was in a same level and did not show significant differences (Table 2). 45 cm row distance and 20 cm plant distance with a little difference compared to other treatments had the greater number of days to emergence (Table 3).

Table 1. Results of soil Physical and chemical properties of experimental location .

Sampling depth	pH	Ec dsm^{-1}	Organic Matter (%)	Silt (%)	Clay (%)	Sand (%)	Total Nitrogen (%)	Available Phosphormgkg^{-1}	Available Potassium $mgkg^{-1}$	Available Zinc $mgkg^{-1}$	Soil Texture
0-30	7.1	0.78	2.1	46.3	40.8	12.9	0.13	9.4	531	0.78	Silt Clay

The number of days to heading

The effect of row interval and plant interval on the row showed a significant difference in 5% and 1% surface on the number of days to heading. But their reciprocal effects did not show significant differences (table 2). Comparing the average showed that 45 cm

row interval had more number of days to heading than 25 and 35 cm intervals (Table 3). The competition between plants on planting row increased by increasing row intervals and the plant will not be able to use well environmental factors, as a result of this; heading will delay (Porhadin and Khajehpour, 2007). 20 and 10 cm plant interval respectively have the highest and lowest number of days to heading. (Azari, 2001) Heat air and faster completion of the life cycle of the plant are the main factor reducing the period length the number of days to head the narrow row intervals than wide row intervals reported.

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

		MS				
	df	Planting to emergence	Planting to heading	Planting to flowering	Planting to maturity	Economic yield (Kg.h)
Replication	2	2.76	4.4	4.1	6.53	14453.4
Row spacing	2	13. 2 ^{ns}	30.6*	27.8**	39.6**	1877120.1 **
Plant spacing	2	9.3 ^{ns}	35.2**	29.8**	57.9**	461654.7**
Interaction	4	0.51 ^{ns}	89.5 ^{ns}	2.1 ^{ns}	13.1 ^{ns}	42541.9 ^{ns}
Error	26	0.68	3.6	0.143	6.12	27042.3
C.V (%)	-	7.6	10.1	11.5	11.2	12.97

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

The number of days to flowering

The effects of row intervals and plant interval treatments on the row with the number of days to flowering showed the significant difference at 1% probability level (Table 2). The number of days to flowering was increased by increasing the row interval. So that the 45 cm row interval had the maximum and 25 cm had the minimum number of days to flowering (Table 3). Unfavorable environmental conditions such as drought, stress high temperature reduce the number of days to plant flowering. Comparing the average showed that there weren't the significant difference between the number of days to flowering in 35 and 45 cm row intervals and the maximum number of days to flowering belonged to 45 cm row interval. Among the plant intervals on row, 20 cm had the maximum number of days to flowering. (Table 3).

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

	Planting to emergence	Planting to heading	Planting to flowering	Planting to maturity	Economic yield (Kg.h)
Row spacing (cm)					
25	10.4 ^{a}	187.1 ^{b}	204.1 ^{b}	236.5 ^{b}	1425 ^{a}
35	12.3 ^{a}	188.3 ^{ab}	208.3 ^{a}	234.9 ^{b}	1216 ^{a}
45	12.8 ^{a}	192.2 ^{a}	209.5 ^{a}	239.1 ^{a}	853 ^{c}
Plant spacing (cm)					
10	10.3 ^{a}	187.8 ^{b}	201.9 ^{b}	227.8 ^{b}	1265 ^{a}
15	^{a} 12.1	189.1 ^{b}	208.2 ^{a}	231.5 ^{ab}	1089 ^{b}
20	12.5 ^{a}	191.5 ^{a}	209.7 ^{a}	237.6 ^{a}	936 ^{b}

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

The number of days to maturation

The effects of row interval and plant interval on the number of days to maturation had the significant effect at 1% probability level (Table 2). Planting period length was increased by increasing row intervals. 45 cm (1/239 days) row interval causes a delay in the maturation and 25 cm (5.231 days) row interval causes the earliness plant (Table 3). (Naseri *et al*., 2010) reported similar results. 20 cm (6.237 days) plant interval had the highest number of days to maturation and 10 cm (8.227 days) plant interval had the minimum number of days to maturation (Table 3). Reducing the plant interval on the row causes to increase competition in and out of the plant and the plant uses less than environmental factors including food and sunlight therefore was made the fast maturation and head maturation uniformity (Azari and Khajehpour, 2003).

Economic yield

The effects of planting row interval and plant interval on grain yield in row 1% probability level was significant. Yield declined with increasing the planting row and plant interval on row (Table 2), with increasing, the planting row interval from 25 cm (265 kg) to 45 cm (853 kg/ha) yield decreased 70.6 percent. As well as 10 cm plant interval on the row (1270 kg) had the maximum and 20 cm (936 kg ha-1) interval had the lowest seed yield. Competition within a plant and outside the plant is reduced with reducing cultivation row interval and the plant can use well of environmental factors and photosynthesis efficiency is increased. Thus, the number of heads in per plant, the number of seeds in per head. Will increase also with shorten the growth period (shorten the number of days to maturation) can be caused plant was not encountered with high environ mental temperature and drought stress and yield will increase noticeably (Azari, 2001; Morrison *et al*,. 1990).

Conclusions

Some of the essential tips that the cultivation of safflower in dry land regions should be considered climate, high temperature and drought stress in the region. The cultivars, which have shorter growth cycle had the maximum seed yield. So 25 cm row intervals and plant interval on 10 cm row, because of having the fewer number of maturation day had the maximum yield.

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