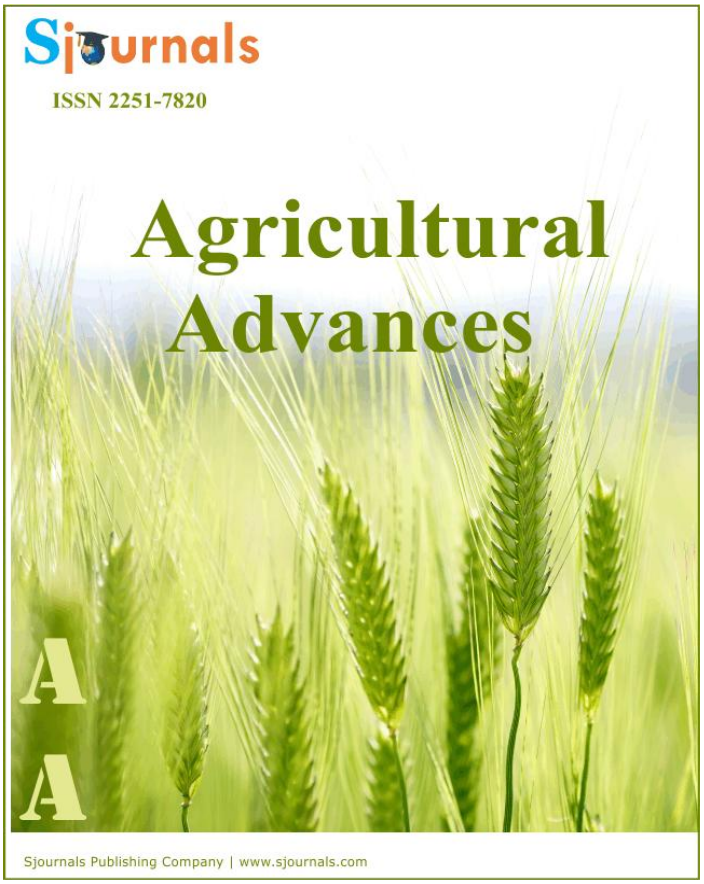
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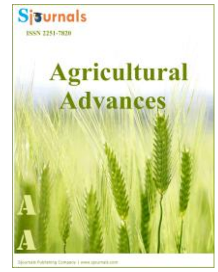

Original article

Examining grain and oil yields of different safflower cultivars affected by irrigation withholding treatment in two planting dates

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Safflower is a native plant to Iran, resistant to arid environment that will be used as an oil seed for future hopefully. The experiment was a split plot based on complete randomized block design with four replications. Main plot includes two spring and summer plantings and sub-plots include three irrigation withholdings (control, irrigation withholding at the start of flowering and irrigation withholding at the start of grain filling period) and ten safflower cultivars including Soffe, Goldasht, Sina, Faraman, Golmehr and Mexican cultivars, Mec117, Mec295, Mec184, Mec11, Mec7, were located in main plot as sub-plots. The results indicated that delaying in plantings reduced biologic yield, grain yield, harvest index and oil yield in Safflower cultivars, significantly. At the start of flowering, irrigation withholding reduced grain and oil yield significantly. Irrigation withholding treatments and safflower cultivars did not affect on oil percentage. However, Mexican cultivars had suitable yields in spring planting date, but it reduced during summer planting date, extremely; while, Iranian cultivars had higher grain and oil yields during both planting dates. Among the cultivars, Soffe and Goldasht had the highest grain and oil yield.

1. Introduction

Increasing population growth of the country and high dependence on vegetable oils make the development of planting and increasing oilseed yields necessary and inevitable, more than ever. The most part of edible oils needed in the country are provided from foreign sources. While oilseeds have high values in the world, especially in industrial countries, but producing oilseeds does not exceed 35 years in Iran, because the most useful oil was animal oil until 1961. By changing the nutrition system and structure of people, they tended to use vegetable oils, in a way that the national requirement of the oil has been 1MT, last years; whereas more than 90% of the required oil is provided from other countries (Naseri, 1991).

Fortunately, climate variation makes it possible to plant oilseeds, qualitatively and economically, in Iran. Among the compatible oilseeds to the climate of Iran, safflower (*Carthamus tinctorius* L.) is resistant to salinity and drought stress (Yau, 2006). Safflower is a winter annual crop, from Asteraceae family (Vollman and Rajcan, 2010). This plant is compatible to areas with little winter-spring rain falls; and has long roots with high water uptake from deeper parts of the soil, but the oilseed is suffered from water scarcity (Yau, 2006). Safflower seeds contain 30-40% of oil and 80% of unsaturated fatty acids like linoleic and oleic acids with suitable quality to be eaten (Gonzales et al., 1994). Despite of log time background in planting the oil plant, safflower, its plantation was limited for years because of different reasons, in Iran. Decreasing the area under cultivation of safflower became limited for reduction of grain yield by factors like pests, diseases, weeds and unavailability of suitable cultivars and enough information about farming the plant. However, the problems like this made some lacks of development for planting safflower in other parts of the world. Lastly, authors attempted to clear the limitations of producing this crop plant like focusing on some pests, diseases and late maturing cultivars; and producing new and suitable cultivars were the conclusion of these attempts. So that some countries such as United States pay much more attention to cultivate, safflower and their farmers plant it more than before (Zeinali, 2009).

Finding the best time to plant every crops, according to the climatic conditions, is a prerequisite for crop management. If safflower is not cultivated during its suitable time, in warm areas, or if its cultivation is delayed, flowering and grain filling periods will encounter inhibitory temperatures (average daily more than 30°C and maximum more than 37°C) that results in grain yield and oil reduction (Emam et al., 2011). Unsuitable planting date results in happening vegetative and reproductive growth phases with unsuitable environmental conditions. Decrease of growth duration or encountering the sensitive growth phases to unfavorable temperature conditions reduce the vegetative growth and yield components or even lead to plant death (Abel, 1976). Increasing in temperature reduces vegetative phase duration; because heat accumulation, required by the plant to complete the life, is provided in shorter time. In addition to, thermal stress heat stress, directly or through water stress, affects on plant hormonal balance and makes the plant grow fast (Khajehpur, 2004). On the other hand, safflower is cultivated in summers in some provinces. So that, some stages of safflower growth encounter cooler temperatures at the end of this season and the yield is increased. Delaying the summer planting and choosing unsuitable cultivar may make the plant growth states to face seed filling and ripening to the low temperature, at the start of fall. As the duration of developmental stages is a function of two main factors, temperature and daytime, planting date can be changed in a way that different growth phases adapt the temperature and daytime of that season suitably and have ideal vegetative and reproductive growths. According to last droughts and water scarcity in most parts of Iran, cultivating this plant has been suggested as the summer planting after wheat and barley, replacing crops with high water requirement like maize.

2. Materials and methods

This experiment examined the effect of irrigation withholding on safflower cultivars grain, oil yields in spring, and summer plantings. It is experimented in Kabutarabad agricultural research center, located in latitude N 32° 30′ and longitude E 51° 49′. The station is 1541m above sea level and has hot and dry climate with hot summers and semi-cold winters, according to Köppen climate classification. The annual rainfall and temperature are 121mm and 16°C, respectively. The experiment was a split plot based on complete randomized block design with four replications. Main plot includes three irrigation withholdings: 1- Control treatment, adequate irrigation in total growth period based on irrigation cycle and with no water stress. 2- Irrigation withholding at the start of flowering, with no water stress and irrigation withholding until the end of the season. 3- Irrigation withholding at the start of grain filling period without water stress and irrigation withholding till the end of season. The sub-plots include two spring and summer plantings and ten safflower cultivars including Soffe, Goldasht, Sina, Faraman, Golmehr and Mexican cultivars, Mec117, Mec295, Mec184, Mec11, Mec7, were located in main plot as sub-plots. The experiment was conducted after choosing the farm in 2015, and then the soil was sampled and plowed. Fertilizer distribution was done based on chemical analysis of soil, before planting. Cultivations were on April 19, 2015 and July 16, 2015. Planting was in rows, five-row plots with 40cm distance and 5m length, and then the plots were irrigated. At 3-4 leaf stage, the lines were thinned and 5 cm distances were regulated among shrubs while the density became 50 shrub/m^2. After first planting and irrigation for shrubs growing and establishment, irrigation was conducted based on cycling after 70mm evaporation from Evaporation Pan Class A; and irrigation in plots was done according to growth phases of the plant and irrigation withholding treatments. Weeds management occurred after planting and in necessary situations. A Parshall Flumes was set and measured the amount of used water in irrigations, in water arrival to the place of experiment. In ripening stage, two lines were harvested from each plot, observing 3-meter margin, and then biologic and grain yields and harvest index were measured. Samples were dried in oven and weighed by a precise laboratory scale. For measuring the oil in each treatment, 10 g seeds were chosen and grinded; then the samples were put in oven for 24hrs in 75°C. The oil was extracted by Soxhlet method and hexane solvent based on the instructions of American Oil Chemistry Society (AOAC, 1990). The oil percentage and oil yield were calculated. The data were analyzed in Minitab 16; the means were compared in 5% probability by LSD test.

Table 1
Soil analysis results in the place of experiment.

PH	EC	Sand	Silt	Clay	N	P	K	Fe
	dS/m	%	%	%	ppm			
7.3	1.12	58	32	10	0.082	3.23	96	½

3. Results and discussion

3.1. Biologic yield

The results indicated that there was a significant difference between spring planting, with 33% increase in biologic yield, and summer planting (Table 2). Irrigation withholding treatment at the start of flowering, with 688 g/m^2, had less biologic yield than the two other treatments; it made a significance deference between this treatment and the others. Control treatment, with 808 g/m^2, had the most biologic yield, but there was no significant difference between this treatment and irrigation withholding at the stage of grain filling (Table 2). It seems that, in irrigation withholding treatment at the stage of grain filling, water stress happens at the stage, in which the plant passed its vegetative growth and water stress has been effective just at the time of grain filling. The biologic yield is equal to total net product, physiologically. Therefore, the plants that use more productive factors and aggregate more photosynthetic materials in their bodies, will have more yields and net production (Fanaei et al., 2008). There were significant differences among the cultivars. The cultivars, Soffe, Goldasht, Sina, Faraman, had more biologic yields than other ones. Mec10, with 675 g/m^2, has the least biologic yield (Table 2). Ehsanzadeh (2003) stated that lasting vegetative period makes the plant to aggregate more dry matter in its bodies like stem and leaf, because of using light, temperature and other environmental factors appropriately; and finally it plays role as a powerful source for filling the grain.

The effect of planting date and irrigation withholding on biologic yield in safflower cultivars indicated that changing the planting date from April to July in all treatments, biologic yield decreased significantly. There are significant differences among these three irrigation withholding treatments in spring planting date, while the most biologic yield in spring planting date was observed in control samples and the least one was seen in irrigation withholding at the start of flowering. In summer planting, there were no significant differences among irrigation withholdings, though differences were observed in biologic yield. While, control and irrigation withholding at the start of grain filling had more biologic yield than irrigation withholding at the start of flowering. Dadashi and Khajehpur (2004) examined the safflower on forth (June 8) and fifth (June 12) planting dates; they found that the plant was released from heat and water stresses, especially in flowering period, and produced more photosynthetic materials far away from environmental stresses while the shrub dry weight increased.

Table 2
Comparing the measured features means of safflower cultivars affected by irrigating withholding in two planting dates.

	Treatment	Biologic yield (g/m^2)	Grain yield (g/m^2)	Harvest index (%)	Oil yield (g/m^2)	Oil percentage
Safflower cultivars	Mec10	675	210	29	65	30
	Mec11	706	190	26	55	29
	Mec23	748	179	23	54	30
	Mec26	777	190	23	57	30
	Mec117	734	208	27	62	30
	Golmehr	726	191	25	56	29
	Faraman	802	212	25	63	30
	Sina	789	237	29	67	28
	Goldasht	823	235	28	71	30
	Soffe	877	259	29	78	30
	LSD	141	31	3	11	2
Planting date	Spring planting	966	307	31	90	29
	Summer planting	644	115	18	34	30
	LSD	77	30	3	10	2
Irrigation withholding	Control	808	269	30	81	30
	At start of flowering	688	153	21	45	29
	At start of grain filling	778	211	26	63	29
	LSD	68	41	4	11	2

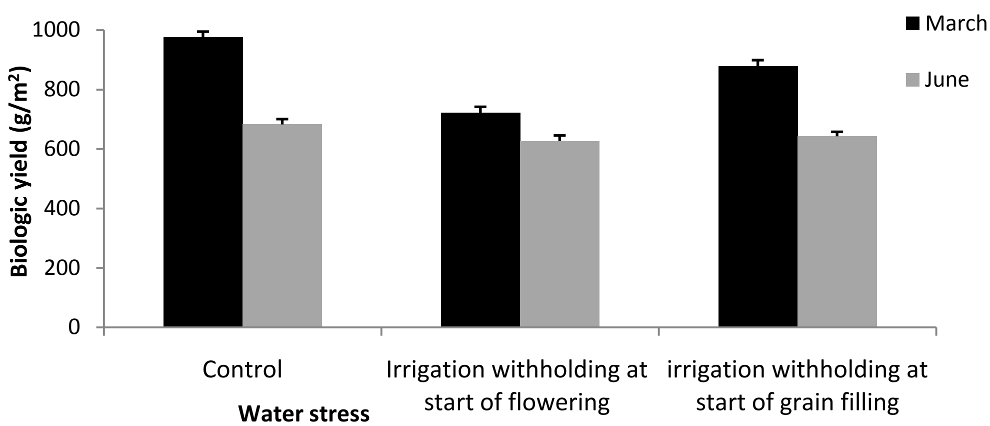

Fig. 1. Effect of planting date and irrigation withholding on biologic yield in safflower cultivars.

Table 3
Effect of planting date and cultivar type on biologic yield in safflower cultivars.

	Mec10	Mec11	Mec23	Mec26	Mec117	Golmehr	Faraman	Sina	Goldasht	Soffe
Spring planting (March)	733	802	816	928	896	848	943	868	962	875
Summer planting (June)	604	588	654	619	573	583	655	667	685	760
LSD	183									

The effect of planting date and safflower cultivars indicated that spring planting had more biologic yield in all cultivars than the summer planting. In spring planting, only Mec10, with 733 g/m^2, had the least biologic yield while there was a significant difference between Mec10 and Goldasht cultivars. It is worth to say that high biologic yield in Soffe cultivar was observed in summer planting. This cultivar has more biologic yield than other cultivars in summer planting and there is a significant difference between this cultivar and the Mexican cultivars (Table 3). Bagheri et al. (2006) found that delaying in planting from April 20 to April 24, decreased the shrub dry weight during flowering phase, in Isfahan. He stated this condition as the result of growth acceleration by high temperature. Dadashi and Khajehpur (2004) concluded that second (April 12) and third (May 10) planting, comparing to the first (March 11) planting, encountered higher temperatures, heat and water stresses; because of this condition, aggregation of dry matter decreased in the plant.

3.2. Grain yield

The results of main effects indicated that there is a significant difference between spring and summer planting dates for grain yield (Table 2). Planting in April, with 307 g/m^2, increased to 62% comparing to July planting. There were significant differences among the irrigation withholding treatments. The most grain yields were observed in control treatment (without irrigation withholding), irrigation withholding during grain filing and irrigation withholding during flowering phase, respectively. Irrigation withholding during grain filling and flowering phases decreased 21% and 54% comparing to control treatment, respectively (Table 2). The average of grain yield in safflower is going to be increased through breeding and high yielding cultivars while the yields like 4400 kg/ha have been reported too (Arnone, 1972). Shahsavari et al. (2011), in their experiment about choosing higher lines of native masses of summer planting in Isfahan, stated that two cultivars including Isfahan-8 and Isfahan-6 had the most and the least yields, as 5714 kg/ha and 1547 kg/ha, in 1999, respectively. Among the cultivars, Soffe, Goldasht and Sina had the most grain yield, which was significantly different from other ones. Mec23, 179 g/m^2, had the least grain yield (Table 2).

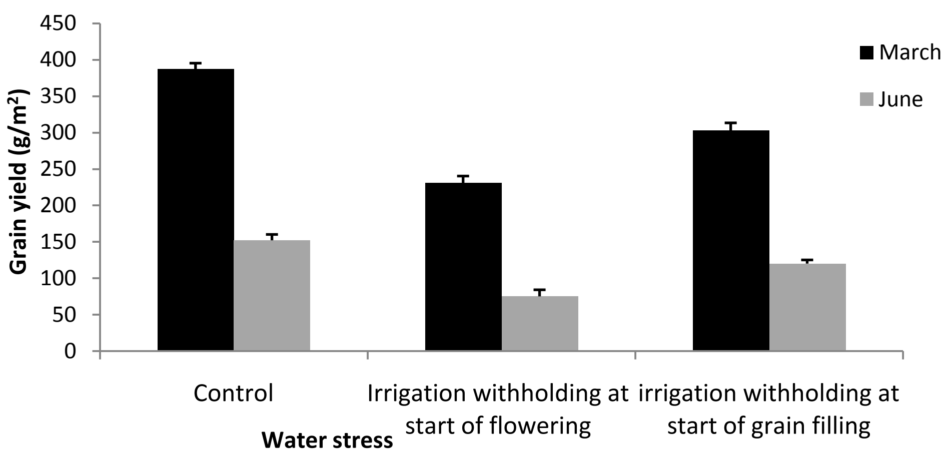

Fig. 2. Effect of planting date and irrigation withholding on grain yield in safflower cultivars.

The effect of planting date and irrigation withholding indicated that there are significant differences among the treatments (Fig. 2). Summer planting decreased more than 50% in grain yield for every three irrigation treatments comparing to spring planting. Irrigation withholding during flowering phase in spring and summer planting dates had the least gain yield, while the gain yield in irrigation withholding during flowering phase in summer planting became 75 g/m^2 (Fig. 2). Other researchers investigated the decreasing effect of delayed plating on grain yield (Emam et al., 2011; Jajarmi et al., 2009; Ozel, 2004). Luebs et al. (1965) indicated that in irrigated conditions, every 4-6 week delay, to the first planting date, decreased grain yield between 170-340 kg/ha. Bagheri et al. (2006) found that summer planting date (June 21) in Isfahan had the most grain yield. They attributed this increase in yield to the planting date simultaneity to grain filling in dry climate of September; because it results in production and transition of photosynthetic materials stored in grain and finally increases grain yield.

Table 4
Effect of planting date and cultivars on safflower grain yield.

	Mec10	Mec11	Mec23	Mec26	Mec117	Golmehr	Faraman	Sina	Goldasht	Soffe
Spring planting (March)	304	270	314	312	320	315	281	289	326	343
Summer planting (June)	117	111	45	69	98	67	144	185	145	175
LSD	51									

The effect of planting date and safflower cultivars indicated that Soffe, Goldasht and Mec117 had the most grain yield in spring planting, but in summer planting, Soffe, Goldasht, Sina and Faraman cultivars had more grain yield than other cultivars, significantly (Table 4). Mexican cultivars had good yields in spring planting, but the yields decreased significantly in summer planting. Among Iranian cultivars, Golmehr had a high yield in spring planting (315 g/m^2). But in summer planting, this cultivar decreased to 67 g/m^2, that is 80% (Table 4). According to the authors, long term growth with rosette period is related to yield increase directly. In addition to, encountering sensitive growth phases, like flowering and pollination, to undesirable environmental conditions like high temperature, results in decreasing grain yield (Emam et al., 2011; Jajarmi et al., 2009). Probably, the yield decrease in planting date of July results from shortening the vegetative growth period in which the plant was affected by environmental conditions, especially temperature and it entered the reproductive phase passing having enough vegetative growth while it could not produce suitable components comparing to the first planting so its yield has been decreased significantly.

Table 5
Effect of irrigation withholding treatment and safflower cultivars on grain yield.

	Mec10	Mec11	Mec23	Mec26	Mec117	Golmehr	Faraman	Sina	Goldasht	Soffe
Control	**299**	**238**	**196**	**250**	**249**	**247**	**251**	**326**	**320**	**321**
Irrigation withholding at start of flowering	133	142	148	123	169	136	146	179	173	182
Irrigation withholding at start of grain filling	199	192	194	199	209	191	241	206	213	275
LSD	61									

The results indicated that in control treatment (without irrigation withholding), Iranian cultivars including Soffe, Sina and Goldasht had the most grain yield. Among Mexican cultivars, Mec10 had the most grain yield in control treatment. In treatment of irrigation withholding at the start of grain filling, Iranian cultivars including Soffe, Sina, Goldasht and Mec11 had the most grain yield. Treatment of irrigation withholding at the start of flowering had less grain yield than control and irrigation withholding at the start of grain filling in all cultivars. In treatment of irrigation withholding at the start of flowering, Soffe, Sina, Goldasht had the most grain yield. While, there was no significant differences in irrigation withholding at the start of flowering among the cultivars (Table 5).

Cultivars ability in transiting and aggregating photosynthetic material, especially from boll to seed is one of the most important factors to increase safflower yield. The pattern of sap accumulation and transmission depends on flow photosynthesis and is determined by power and closeness of various destinations (Tezar, 1994). Edalatian (2007) reported that the critical water-requiring phase in plants is flowering; and in condition of soil water deficit during this phase, dry matter and yield increase. He stated that drought stress in vegetative and reproductive stages decreases relative growth rate in both phases.

3.3. Harvest index

Harvest index expresses the percentage of transiting photosynthetic materials from vegetative organs (source) to seeds (destination). The results indicated that harvest index in spring planting increased 42% comparing to summer planting, which is from 18% to 31%. Among irrigation withholding treatments, harvest index was significantly different. The most harvest index was observed in control treatment and then in irrigation withholding at the start of grain filling and after than in irrigation withholding at the start of flowering with 18% index. Among Iranian cultivars, Soffe, Goldasht and Sina had the highest harvest index and Mec10 had the most indexes among Mexican cultivars. This cultivar had the least biologic yield so it had the highest harvest index (Table 2). Delaying in planting date affects on dividing plant dry matter by shrub economic sink and results in inefficiency of transiting photosynthetic materials to seeds and so decreases the harvest index (Fanaei et al., 2008). Usually, most part of high efficiency species growth happened at the beginning of vegetation season to develop leaf area. Therefore, solar radiation is used with more efficiency. This feature increases photosynthesis and so enhances economical and biologic yield (Sarmadnia and Kuchaki, 1989). Singh and Stoscope (1971) reported that there is a positive correlation between grain yield and harvest index, but this correlation is negative between grain yield and vegetative growth.

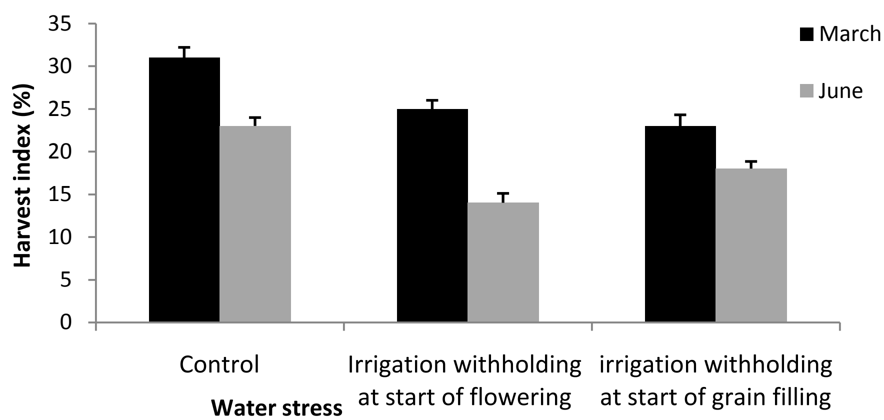

Fig. 3. Effect of planting date and irrigation withholding on harvest index of safflower cultivars.

The effect of planting date and irrigation withholding indicated that delaying in planting decreased harvest index in all treatments. This reduction was 50% in treatment of irrigation withholding at the start of flowering. In spring planting date, control treatment had the most harvest index and it was significant different from two other irrigation withholdings. In this planting date, irrigation withholding at the start of flowering had more harvest index than irrigation withholding at the start of grain filling phase but it they were not significantly different. In treatment of irrigation withholding at the start of flowering, biologic and grain yields decreased that this resulted higher harvest index, though this reduction was more in biologic yield; therefore harvest index increased comparing to the treatment of irrigation withholding at the start of grain filling phase. In summer planting, there were significant differences among the three irrigation-withholding treatments. The harvest index increased in irrigation withholding at the start of flowering and at the start of grain filling to 14% and 18%, respectively (Fig. 3). In spring planting and during irrigation withholding at the start of grain filling, the plant was more able to produce vegetative organs because of desirable vegetative growth conditions. Therefore, harvest index became less in this treatment than irrigation withholding at the start of flowering.

3.4. Oil percentage

The results indicated that among the treatments of plantings date and irrigation withholding and cultivars, planting date was significantly different for oil percentage. Spring planting date increased 2% more than summer planting in oil percentage. There were no significant differences between levels among irrigation withholding treatment, while control treatments increased little.

There were no significant differences among safflower cultivars, but little diversities (Table 2). The seed oil is a feature with high heredity, affected by environmental conditions. Among environmental factors, effective on oil rate, temperature is the most important element whose increase reduces seed oil percentage significantly. This reducer effect of temperature on oil percentage is more obvious in delayed planting dates (Fanaei et al., 2008). Researches indicated those safflower cultivars are different in vegetation period duration. In addition, various oil percentages among different safflower genotypes were reported (Omidi and Sharif Moghadas, 2010; Nikabadi et al., 2008). Ozer (2003) found that delayed planting results in reducing oil percentage of canola seed. He stated that suitable environmental conditions for increasing grain yield is different from suitable environmental conditions for enhancing seed oil percentage. When temperature increases during seed production, the fatty acids of the seeds change and affect on the quality and quantity of the seeds oil, negatively (Alhasan et al., 2005). It was reported that delaying in planting autumn canola didn't affect on seed oil percentage (Jenkins and Litche, 1986). In this experiment, there was no difference between oil percentages of safflower cultivars and irrigation withholding treatment; it seems that seed oil percentage is affected less by agronomic factors and more by genetic elements.

3.5. Oil yield

The results indicated that oil yield deceased to 60% in summer planting comparing to spring planting; this difference was significant too. In addition to, there were significant differences among all irrigation withholding treatments. So that control treatment, with 81 g/m^2, had the most and irrigation withholding at the start of flowering, with 45 g/m^2, had the least oil yield. Among safflower cultivars, Soffe and Goldasht had the most oil yield, as their oil yield was more than 70 g/m^2. Mec23 had the least oil yield (Table 2).

Oil yield is equal to multiply grain yield and seed oil percentage. According to Rabertson et al. (2004), every centigrade increase in temperature during flowering and grain filling equals to 1.7 % decrease in seed oil. While Mendham et al. (1981) believe that oil percentage of different varieties is constant and planting date affects on it some. Some reported that delaying in plating date reduces oil percentage inconsiderably, but oil yield decreases (Mocorasi, 1975). Uzel et al. (2003) stated that delaying in plating date decreases safflower oil percentage and yield.

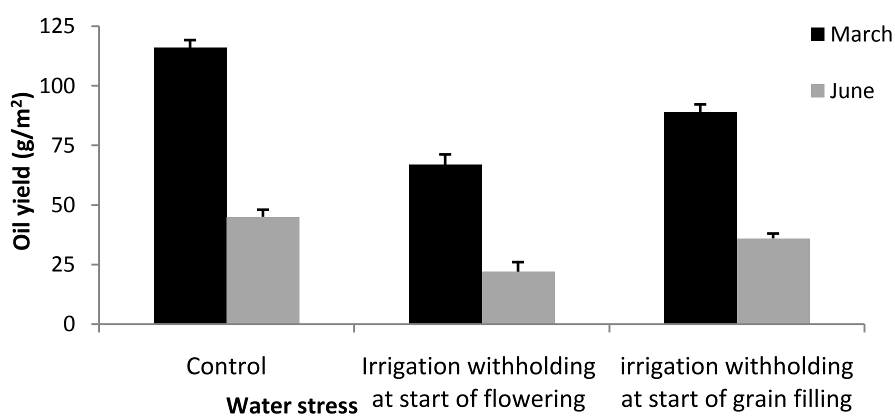

Fig. 4. Effect of planting date and irrigation withholding on oil yield of safflower cultivars.

The effect of planting date and irrigation withholding on oil yield indicated that there are significant relationships among all treatments in various planting dates. Control treatment had the most oil yield in both planting dates. On the other hand, irrigation withholding at the start of flowering in both planting dates had the least oil yield. Dallying in planting decreased oil yield in every irrigation withholding more than 50% (Fig. 4).

Adamsen and Cofelt (2005) stated that desirable planting date, with high grain yield and oil percentage, had the most oil yield in a hectare. While delaying in plating decreased oil yield comparing to other planting dates because of reducing the growth of plant, encountering to heat during grain filling at the end of season, increasing respiration and decreasing photosynthetic materials production, decreasing oil yield and oil percentage.

Table 6
Effect of planting date and cultivars on oil yield in safflower.

	Mec10	Mec11	Mec23	Mec26	Mec117	Golmehr	Faraman	Sina	Goldasht	Soffe
Spring planting (March)	94	76	94	94	96	91	84	82	97	101
Summer planting (June)	35	33	14	21	27	21	43	52	43	56
LSD	17									

The effect of planting date and cultivars indicated that most oil yield were observed in Iranian cultivars, Goldasht and Soffe, during spring planting date. Except Mec11 that had the least oil yield, other Mexican cultivars had the same yields that were not significantly different. Among Iranian cultivars, Faraman and Sina had the least oil yields in spring planting. But Soffe, Sina, Goldasht and Faraman and more oil yields than other cultivars in summer plantings. Golmehr and Mec23 had the least oil yield in summer planting among Iranian and Mexican cultivars. Moet oil yield was observed in Mec10 as 35 g/m^2. It seems that Mexican cultivars had good capabilities in producing more oil yield in spring planting; but delaying in plating decreased their yield. Iranian cultivars gad good oil yield in both planting dates. Soffe and Goldasht had high yields in both planting dates.

Nejad Shamlu (1996) found that there are positive and significant correlations among oil percentage, oil yields and proteins. However, this correlation is not significant to protein percentage. He stated that cultivars with more biologic yields during the growth, transmit more nutrients during grain filling and have more grain yield and oil yield, affecting by more boll and shrub harvest index and higher bolls. Oil yield is equal to multiply grain yield and seed oil percentage, therefore it can be observed that though cultivars are not significant different in seed oil percentage but are considerably different in seed yield. Finally, multiplying them is oil yield that is significantly different among the cultivars. As the changes in oil percentage are scarce in various treatments, oil yield changes are similar to grain yield changes and correlated to each other.

It seems that first planting date in this experiment could make relatively high grain yield comparing to the second planting date, because of suitable environmental conditions; so that more oil yields were related to second and thirds planting dates. In addition to, there is a direct relationship between oil yield and oil percentage and grain yield that is high oil yield relates high grain yield.

4. Conclusion

Generally, the results indicated that delaying in cultivation decreases biologic yield, grain yield, harvest index and oil yield in safflower cultivars, significantly. Irrigation withholding at the start of flowering caused decreasing oil and grain yields significantly, but there were no significant differences among harvest index and biologic yield and irrigation withholding at the start of grain filling, in this treatment and in summer planting. Oil percentage was not affected by irrigation withholding treatments and safflower cultivars. Though Mexican cultivars had desirable yield in spring planting, they decreased in summer planting extremely. Iranian cultivars had more grain and oil yields in both planting dates. Soffe and Goldasht had the most yields in this experiment.

References

Abel, G.H., 1976. Effect of irrigation regimes, planting dates, nitrogen levels and row spacing on safflower cultivars. Agron. J., 68, 448-451.

Adamsen, F.J., Coffelt, T.A., 2005. Planting date effects on flowering, seed yield and oil content of rape and crambe cultivars. Ind. Crop. Prod., 21, 293-307.

AOAC, 1990. Official methods of analysis. Association of Official Analytic Chemists. Washington, D.C.

Arnon, I., 1972. Crop production in dry regions. Background and principles. Leonard Hill. London. 1, 372-380.

Bagheri, H., Saeedi, G., Ehsanzade, P., 2006. Evaluation of agronomic traits of selected genotypes from native accessions of safflower in spring and summer sowing dates. J. Sci. Technol. Agr. Nat. Res., 10, 375-390.

Dadashi, N., Khajepour, M.R., 2004. Effects of sowing date on yield and yield components of safflower in Esfahan. J. Sci. Technol. Agr. Nat. Res., 8, 95-111.

Edalatian, F., 2007. Effect of complementary irrigation on yield and components of four lentil cultivars through dry land farming in Shirvan. M.S. thesis. Islamic Azad University, Bojnourd Branch.

Ehsanzadeh, P., 2003. Yield, yield components and growth characteristics of two safflower genotypes under varying plant densities. J. Sci. Technol. Agr. Nat. Res., 7(1), 129-140.

Emam, T., Naseri, R., Falahi, H., Kazemi, E., 2011. Response of yield, yield component and oil content of safflower (CV Sina) to planting date and plant spacing on row in rainfed conditions of western Iran. Am. Eur. J. Agr. Environ. Sci., 10(10), 947-953.

Fanaei, H.R., Galavi, M., Ghanbari Bongar, A., Solouki, M., Naruoei-Rad, M.R., 2008. Effect of planting date and seeding rate on grain yield and yield components in two rapeseed (Brassica napus L.) cultivars under Sistan conditions. Iranian J. Crop Sci., 10(2), 15-30.

Gonzales, A.A., Schneiter, N.R., Riveland, Jonson, B., 1994. Response of hybrid and open pollinated safflower to plant population. Agron. J., 76, 1070-1079.

Jajarmi, V., Azizi, M., Shadlu, A., Omidi Tabrizi, A.H., 2009. The effect of density, variety and planting date on yield and yield components of safflower. In Knights, S.E., Potter (ed.) T.D., Proceedings of the 7th International Safflower Conference. 10-14 June, Wagga, Australia, 235-241.

Jenkins, P.D., Leitch, M.H., 1986. Effects of sowing date on the growth and yield of winter oil seed rape (B. napus). J. Agr. Sci. Camb., 105, 405-420.

Khajehpur, M., 2004. Industrial plants. Esfahan Ind. University's Jihad, Vol 2.

Luebs, R.E., Yermanos, D.M., Laag, A.E., Burge, W.D., 1965. Effect of planting date on seed yield, oil, content, and requirement of safflower. Agron. J., 57, 162-164.

Mendham, N.J., Shipway, P.A., Scott, K.K., 1981. The effects of seed size autumn nitrogen and plant population density (B. Napus). J. Agr. Sci. Camb., 96, 414-428.

Mukurasi, N.J., 1975. Research on rapeseed and fodder rape. Proc. 5th Int. Rapeseed Conf. Malmo, Sweden, 280-283.

Naseri, F., 1991. Oil seeds. Astan Quds Pub, Mashhad, Translation.

Nejad Shamlu, A.R., 1996. Investigating morphologic, physiologic features and yields of spring safflower cultivars in Isfahan. M.S. thesis in agronomy. Agriculture faculty. Islamic Azad University, Khorasgan University (Isfahan). 131p.

Nickabadi, S., Solemani, A., Dehdashti, S.M., Yazdanibakhsh, M., 2008. Effect of sowing dates on yield and yield components of spring safflower (Carthamus tinctorius L.) in Isfahan Region. Pakistan J. Biol. Sci., 11, 1953-1956.

Omidi, A.H., Sharifi Mogadas, M.R., 2010. Evaluation of Iranian safflower cultivars reaction to different sowing date and plant densities. World Appl. Sci. J., 8, 953-958.

Ozel, A., 2004. Effects of different sowing date and intra row spacing on yield and some agronomic traits of safflower (Carthamus tinctorius L) under Harran plain's arid conditions. Turk. J. Agr. Forest., 28(6), 413-419.

Ozer, H., 2003. Sowing date and nitrogen rate effects on growth, yield and yield components of two summer rapeseed cultivars. Eur. J. Agron., 19, 453-463.

Robertson, M.J., Holland, J.F., Bambach, R., 2004. Response of canola and Indian mustard to sowing date in the grain belt of north-eastern Australia. Aust. Expt. J. Agr., 44, 43-52.

Sarmadnia, G.H., Koucheki, A., 1989. Crop physiology. Mashhad Jahad-e-Daneshgahi Press. 400p.

Shahsavari, M., Omidi, A.H., Karimi, S., 2001. Final report on pure line selection in safflower of Isfahan. Plan No 100-12-78281. Seed and plant improvement institute. Isfahan.

Singh, I.D., Stoskopf, N.C., 1971. Harvest index in cereals. Agron. J., 63, 224-226.

Tezar, M.B., 1994. Principles of plants growth (Crop science association of America). Translated by Kuchaki, A., Reshed Mohasel, M.H., Nasiri, M., Sadr Abadi, A.R., Astan Quds Pub. Mashhad. 404p.

Ul-Hassan, F., Ali, H., Akhtar Cheema, M., Manaf, A., 2005. Effects of environmental variation on oil content and fatty acid composition of canola cultivars. J. Res. Sci., 16, 65-76.

Uzel, A., Demiribilek, T., Atilla Gur, M., Copur, O., 2003. Effects of different sowing date and intra row spacing on yield and some agronomic traits of safflower (Carthamus tinctorius L.) under Harran plains, arid conditions. Turk. J. Agr. For., 28, 413-419.

Vollman, J., Rajcan, I., 2010. Oil crops. Springer. London.

Yau, S.K., 2006. Winter versus spring sowing of rain-fed safflower in a semi-arid, high-elevation Mediterranean environment. Eur. J. Agron., 10, 1-8.

Zeinali, A., 1999. Safflower (recognition, production and application). Gorgan Agriculture and Natural Resource University.

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