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Yield and Morphological Traits of Safflower as affected by Weeds Interference and Variety

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ABSTRACT: To evaluate the effect of weed interference and variety on seed yield and morphological traits of safflower, an experiment was conducted in Agriculture and Natural Resources Research Center of Southern Khorasan, Iran in 2013-2014 as a factorial experiment based on a Randomized Complete Block Design with three replications. The experimental treatments included a combination of weeds interference period at six levels (control or complete management of weeds until the end of growing season, weeds interference until: stem elongation initiation, auxiliary branch initiation, flower initiation, seeds filling termination, and no weeds management) and safflower cultivars at three levels (Padideh, Goldasht and Golsefid). Means comparison revealed that Padideh variety had the highest seed yield (274.1 g m^{-2}) among the varieties. Also, results showed that plant height, height of the first auxiliary branch to the ground, head number per auxiliary branch and seed yield reduced 10.36, 22.28, 25.21 and 33.9%, respectively as comparison with treatment of whole-growing season interference. In general, it can be recommended treatments of Padideh or Golsefid varieties and weeds free in the whole growth season or interference until stem elongation stage full control of weeds or their control at most until the initiation of stem elongation for cultivation of safflower in Birjand, Iran.

Keyword: Safflower, weed interference, variety, yield, morphological traits.

INTRODUCTION

As one of the main foods in human diet, oilseeds roughly supply 20% of daily calorie requirement of people through consuming oils (Seyed Sharifi, 2009). Therefore, given the growing population and daily consumption of oils the cultivation area of oilseeds and their yields need to be increased in order to reduce the dependency over other countries (Forouzan, 2008; Kafi & Rostami, 2007). Among oilseeds that are adapted to the conditions in Iran, safflower (*Carthamus tinctorius* L.) has a promising future as a salinity and drought resistant crop (Bassil & Kaffka, 2002) that has both spring and autumn types (Paseba, 2001).

Protecting the crops against weeds is regarded as a strategy to increase their production. The interference of weeds can reduce the availability of common resources to crops through which it affects their growth and yield (Lindquist *et al.,* 2007). In this sense, they are known as a limiting factor of crop production (Karimmojeni *et al.,* 2010).

Crop cultivar and the duration of weeds interference are two major parameters influencing the competitiveness of weeds against crops and so, one important method to control weeds is to use highly competitive cultivars and varieties (Horak & Loughin, 2000). In a study on sunflowers, Asghari *et al.,* (2011) found that the highest and lowest seed yield (3544 and 21 kg ha^{-1}) was obtained under the treatments of no weeds (control) and whole-season interference of the weeds, respectively. Kavurmaci *et al.* (2010) reported that the plant height of faba beans was significantly decreased due to longer competition with weeds as compared to no-weeds treatment, while a study on the competition between soybean and amaranth revealed that the density of latter plant had no effect on soybean height (Sama'ee *et al.,* 2006).

Firouzi *et al.,* (2011) reported that the effect of weeds interference was significant on plant height and seed yield of canola and that the highest seed yield was obtained under 55% interference of weeds as compared to control. In a study on soybeans, Shafagh Kalvangh *et al.* (2009) found that the interference of weeds decreased seed yield by 48.42% as compared to weeds-free (control) treatment. In a study on the effect of different weeds management times on yield and harvest index of three autumn canola genotypes Mirshekari *et al.,* (2011) concluded that the management of weeds at rosette, flower initiation and 50% flowering stages resulted in 32, 44 and 50% lower seed yield as compared to weeds-free (control) treatment, respectively. Zaraghani *et al.* (2012) concluded that longer weeds interference period resulted in significantly ($P<0.01$) lower yield and yield components of sesame and that sesame genotypes exhibited significant ($P<0.05$) differences in the number of capsules per plant.

Therefore, given the fact that the recognition and determination of sensitive stages of crop growth to the competition with weeds can help the better understanding of the influence of weed populations on crops (Bukun, 2004; Kavurmaci, 2010), the present study was carried out to evaluate the yield response of three safflower cultivars to different periods of weeds interference and to determine the best time of weeds management for these cultivars in Birjand region, Iran.

MATERIALS AND METHODS

The present study was conducted in research farm of Agriculture and Natural Resources Research Center of Southern Khorasan (Long. 58°59' E., Lat. 32°52' N., Alt. 1381 m.) in 2013-2014. The total annual precipitation was 150 mm and the soil texture was loam-clay (pH = 8.18). The study was a factorial experiment on the basis of a Randomized Complete Block Design with three replications and 54 experimental plots.

The experimental treatments included a combination of weeds interference period at six levels (control – complete management of weeds until the end of growing season, weeds interference until stem elongation initiation, auxiliary branch initiation, flower initiation, seeds filling termination, and no weeds management) and safflower cultivars at three levels (Padideh, Goldasht and Golsefid).

After soil analysis, the plots were prepared for sowing. According to the results of soil analysis, the field was fertilized with 150 kg ha-1 superphosphate triple, 200 kg ha^{-1} potassium sulfate, and 150 kg ha^{-1} urea (one-third during sowing, one-third during the exit from rosette stage, and one-third before flower initiation).

The blocks were composed of 18 plots with the dimensions of 3m × 2.4 m. The adjacent plots and rows were spaced by 60 cm and the blocks were spaced by 15 cm. Each plot included four sowing rows with the within-plant spacing of 10 cm on each row. After disinfection with Benomyl (2:1000), the seeds were manually sown on ridges at the depth of 2-3 cm on October 14, 2014. The weeds were managed according to the different levels of interference period. To measure morphological traits, 10 plants were randomly selected from each plot considering the margin effect. Final harvest was carried out at the end of growing season from an area of 2 m^2 from the two middle rows and the chlorophyll index was read by SPAD.

The data were analyzed by SAS statistical software package, the means were compared by Duncan Multiple Range Test at 5% probability level and the graphs were drawn by MS-Excel software package.

RESULTS AND DISCUSSION

A. Plant height

Safflower cultivars showed significant differences in terms of plant height ($P < 0.01$) (Table 1). The highest plant height of 99.81 cm was observed in Padideh which was 12.21 and 30.30% higher than that of Golsefid and Goldasht, respectively (Table 2). Rashed Mohasel and Behdadi (1994) and Mahmoudieh (2003) reported significant differences in plant height of safflower cultivars, too.

The effect of weeds interference treatments was not significant on safflower plant height (Table 1). However, means comparison revealed that plant height of safflower cultivars was decreased by 10.36% as the duration of interference was increased from that until stem elongation initiation (90.91 cm) to that until the end of growing season (81.49 cm) (Table 3). In their study on the competition between soybean and amaranth, Sama'ee *et al.,* (2006) found that the densities of amaranth had no significant impact on soybean plant height. The effect of weeds competition on plant height varies with the weeds density as it is reported that weeds competition at lower rates results in taller plants for better light absorption (Zimdahl, 2007). In these conditions, the competition between crop and weeds is lower over water and nutrients and so, the crop can acquire enough energy for increasing its height for winning in the competition for light. In addition, Hucl (1998) stated that higher plant height is a superior trait in competition with weeds. The increase in infrared: red ratio due to the shading by weeds has been mentioned as a reason for higher plant height caused by the competition (Rohrig & Stutzel, 2001).

Table 1: Analysis of variance of traits in safflower as affected by varieties and weed interference periods.

Sources of variation	df	MS					
		Plant height (cm)	Height of the first auxiliary branch to the ground (cm)	Number of head per auxiliary branch	Seed yield ($g.m^{-2}$)	Seed harvest index per plant (%)	Chlorophyll index
Replication	2	35.13	14.90ns	0.051ns	1710.38ns	10.55ns	78.83ns
Variety (A)	2	4167.9**	4853.90**	0.927**	13327.45**	180.78**	1.91 ns
Interference (B)	5	118.61ns	105.11*	0.389*	13872.10**	4.86 ns	38.59 ns
A×B	10	28.81 ns	12.25 ns	0.107 ns	1230.97 ns	13.37 ns	44.85 ns
Erorr	34	72.74	33.77	0.145	926.40	19.01	34.49
CV (%)	-	9.95	13.51	18.20	7.44	13.29	8.29

ns, * and ** are non-significant and significant at 5 and 1% probability levels, respectively

Significant difference was observed in plant height between the treatment of interference until stem elongation initiation and control treatment in the present study, too.

B. Height of the first auxiliary branch to the ground

Cultivar and weeds had significant influence on the height of the first auxiliary branch to the ground at $P < 0.01$ and $P < 0.05$ levels, respectively (Table 1). Means comparison revealed that the highest height (55.89 cm, on average) was related to cv. Padideh which was 13.04 and 56.14% higher than that of Golsefid and Goldasht, respectively (Table 2).

The treatments of weeds interference until stem elongation initiation and that at whole growing season had the highest and lowest height of the first auxiliary branch to the ground (48.38 and 37.60 cm), respectively and the increase in the duration of weeds competition resulted in 22.28% loss of this height (Table 3). The increase in the height of the first auxiliary branch to the ground with the increase in the duration of weeds-free period can be related to the lower negative impact of weeds interference and the resulting increase in the availability of nutrients and space for the development of the plants.

Table 2: Means comparison of simple effect of traits in safflower as affected by varieties.

Variety	Plant height (cm)	Height of the first auxiliary branch to the ground (cm)	Number of head per auxiliary branch	Seed Yield ($g.m^{-2}$)	Seed harvest index per plant (%)	Chlorophyll index
Goldasht	69.57 c	24.51 c	1.98 b	224.69 b	34.51 a	70.63 a
Padideh	99.81 a	55.89 a	2.35 a	274.08 a	29.16 b	71.22 a
Golsefid	87.62 b	48.60 b	1.95 b	269.18 a	34.77 a	70.68 a

*Means with same letters for each column have not significantly different at 5% probability level based on Duncan's Multiple Range

Table 3: Means comparison of simple effect of traits in safflower as affected by weed interference period.

Interference	Plant height (cm)	Height of the first auxiliary branch to the ground (cm)	Number of head per auxiliary branch	Seed Yield ($g.m^{-2}$)	Seed harvest index per plant (%)	Chlorophyll index
1**	88.02ab	45.29ab	2.05ab	296.37 a	33.80 a	71.46 a
2	90.91 a	47.38 a	2.26 a	296.27 a	32.39 a	71.00 a
3	86.18ab	43.67ab	2.38 a	268.02ab	32.94 a	74.39 a
4	85.62ab	43.16abc	1.78 b	248.52bc	32.81 a	69.74 a
5	81.78 b	40.91bc	2.07ab	230.96c	33.28 a	70.24 a
6	81.49 b	37.60 c	2.03ab	195.77d	31.66 a	68.22 a

*Means with same letters for each column have not significantly different at 5% probability level based on Duncan's Multiple Range

**1- weeds free in the whole growth season, 2-Interfrence until stem elongation stage, 3- Until lateral stem emergence stage, 4- Until beginning of flowering stage, 5- Until end of seed filling stage and 6- Until whole drowth season

C. Number of head per auxiliary branch

Number of head per auxiliary branch of different safflower cultivars showed significant differences at 1% level (Table 1). The highest number of head per auxiliary branch (2.35, on average) was related to cv. Padideh which was 15.74 and 17.02% higher than that of Goldasht and Golsefid. The difference in this trait between Goldasht and Golsefid was not statistically significant (Table 2). The difference in this trait between safflower cultivars can be associated with their genetic differences as well as the difference in the length of auxiliary branches and the number of their branches. The effect of weeds interference was significant on the number of head per auxiliary branch at 5% level. The increase in the duration of weeds interference decreased the number of head per auxiliary branch. The treatments of the weeds interference until auxiliary branch elongation initiation and their interference until flower initiation had the highest and lowest number of head per auxiliary branch, respectively, while the interference of weeds at whole growing season resulted in 25.21% loss of the number of head per auxiliary branch as compared to control (Table 3). Yaghoubi *et al.,* (2011), also, reported that the highest number of pods per auxiliary and main branch was obtained under the weeds interference until 2, 4 and 6-leaf stage of canola and that the lowest ones were obtained under the interference until mid-flowering and pod-bearing stage.

The interaction between cultivar and weeds interference was not significant for the number of head per auxiliary branch.

Under the competition between the crop and weeds although total leaf area of plant society per unit area increases, leaf area index of single plant decreases in the fields infected by weeds owing to the loss of single plant leaf area caused by the interference and intra-species competition (Ahmadi *et al.*, 2007). Consequently, as competition period extends, the amount of resources allocated to reproductive parts is reduced resulting in the loss of auxiliary branch number and length, number of branches per auxiliary branch and finally, number of head per auxiliary branch.

D. Seed yield

It was found that seed yield was influenced by cultivar and weeds interference period (Table 1). Cv. Padideh had the highest seed yield among the cultivars (Table 2). As weeds interference period was extended, seed yield was significantly decreased. The highest seed yield (296.37 $g\ m^{-2}$) was obtained under no weeds treatment which was decreased by 33.9% with the increase in the duration of weeds interference until the level of whole-growing season interference (Table 2).

The loss of yield due to the increase in the interference duration was caused by the loss of availability of environmental resources like light, water, nutrients and space to the plants. Nonetheless, seed yield was not significantly affected under the treatment of weeds interference until the stem elongation initiation (Table 2). In fact, the interference between the crop and the weeds is not intense enough at the beginning of the growing season due to the presence of adequate environmental resources and the smaller size of the plants and consequently, the crop is less affected (Mohammadi, 2004). This finding is in agreement with Ebrahimi *et al.* (2012), Zaraghani *et al.* (2012), Miri and Ghadiri (2006), Ebtali *et al.* (2009) and Jannink *et al.* (2000). They, also, reported that longer period of weeds interference decreased seed yield as compared to control.

E. Seed harvest index per plant

Harvest index is a measure of the efficiency of assimilate mobilization to the seeds. Among the studied treatments, only the influence of cultivar was significant on seed harvest index per plant at 1% level (Table 1). Whereas cv. Padideh had the highest seed and biomass yield, it had lower harvest index that the other two cultivars. Cultivars Golsefid and Goldasht had the highest harvest indices of 34.77 and 34.51%, respectively. However, their difference was not significant. Cv. Padideh had the lowest harvest index (29.16%, on average) (Table 2). It implies that Golsefid and Goldasht allocated greater part of their assimilate to economical yield, i.e. seeds.

F. Chlorophyll index

The effect of the experimental treatments including cultivar, interference duration and their interaction was not significant on chlorophyll index (Table 1). However, means comparison revealed the effect of interference durations so that as it was extended until the initiation of auxiliary branch production, chlorophyll index was increased but further extension of interference period resulted in the loss of this index. In the end, the interference until the end of growing season resulted in the lowest index of 68.22 (Table 2).

CONCLUSION

It was found that the presence of weeds until the end of growing season decreased the yield of safflower cultivars by 33.9% as compared to control. Therefore, as the results showed, the highest seed yield of safflower in the studied region can be produced by variety Padideh under full control of weeds or their control at most until the initiation of stem elongation.

REFERENCES

Ahmadi, A.R., Baghestani, M.A., Mousavi, K. & Rastgoo, M. (2007). Evaluation of the competitiveness of two beans cultivars in a weeds interference critical period experiment. *Journal of Research in Agronomy.* **76**(2): 64-70.

Asghari, J., Vahedi, A. & Khoshghol, H.R. (2011). Critical period of weeds management in sunflower fields of Wester Gilan Province. *Plants Protection Journal.* **25**(2): 116-126.

Bassil, B.S. & Kaffka, S.R. (2002). Response of safflower (*Carthamus tinctorius* L.) to saline soils and irrigation. II Crop response to salinity. *Journal Agriculture Water Management.* **54**(1): 67-80.

Bukun, B. (2004). Critical periods for weed control in cotton in Turkey. *Weed Research.* **44**(5): 404-412.

Ebrahimi, M., Pouryousef, M., Rastgo, M. & Saba, J. (2012). Effect of planting date, plant density and weeds on soybean growth indices. *Journal of Plant Protection (Agricultural Sciences and Technology).* **26**(2): 190-178.

Ebtali, Y., Baghestani, M.A. & Ebtali, M. (2009). Competitive effect of wild mustard (*Sinapis arvensis* L.) on yield and growth Indices of canola (*Brassica napus* L.) cultivars. *Journal of weeds.* **1**(2): 73-63.

Firouzi, H., Mirshekari, B. & Bagher Khorshidi, M. (2011). Study on the interference of different growth stages of amaranth and lamb's-quarters on yield and yield components of autumn canola cultivars. *Plants and Weeds Ecophysiological Journal.* **5**(8): 1-10.

Forouzan, K. (2008). Safflower. Oilseeds Development Company Press. 150 pp.

Horak, M.J. & T.M. Loughin (2000). Growth analysis of four *Amaranthus* species. *Weed Sci.* **48**: 534-340.

Hucl, P. (1998). Response to weed control by four spring rapeseed genotypes differing in competitive ability. *Candian Journal of Plant Sciences.* **78**(1): 171-173.

Jannink, J.L., Orf. J.H., Jordan. N.R. & Show, R.G. (2000). Index selection for weed suppressive ability in soybean. *Crop Science*. **40**: 1087-1094.

Kafi, M. & Rostami, M. (2007). Yield characteristics and oil content of three safflower (*Carthamus tinctorius*) cultivars under drought in reproductive stage and irrigation with saline water. *Iranian Journal of Field Crops Research.* **1**: 121-131.

Karimmojeni, H., Rahimian Mashhadi, H., Alizadeh, H.M., Beheshtian, R.D. & Mesgaran. M. (2010). Interefernce between maize and *Xanthum strumarium* or *Datura starmonium*. *Weed Res.* **50**: 253-261.

Kavurmaci, Z., Karadavut, U., Kokten, K. & Bakoglu, A. (2010). Determining critical period of weed-crop competition in faba bean (Vicia faba). *International Journal of Agriculture and Biology.* **12**: 318-320.

Lindquist, J.L., Barker, D.C., Knezevic, S.Z., Martin, A.R. & Walters, D.T. (2007). Comparative nitrogen uptake and distribution in corn and velvet leaf (Abutilon Theophrasti). *Weed Science.* **55**: 102- 110.

Mahmoudieh, R. (2003). Comparison of three safflower inflorescence and adjacent leaves on the formation and production of seeds in spring planting. M.Sc. Thesis, Department of Agriculture, Isfahan University of Technology, Isfahan, Iran.

Miri, H.R. & Ghadiri, H. (2006). Determination of the critical period of weed control in fall-grown safflower. *Weed Science*. **1**: 1-16.

Mirshekari, B. (2011). Study on the effects of different weeds control times on morphological traits, yield and harvest index of three autumn genotypes of canola. *Crop Production Electronic Journal.* **4**(4): 51-66.

Mohammadi, G.H.R. (2004). The effect of different periods of weed interference on some physiological and agronomic traits in chickpea. Agriculture doctoral dissertation. Tabriz University. 185 pp.

Paseban Islam, B. (2001). Safflower. *East Azarbayejan Jahade Keshavarzi.* **694**: 1-2.

Rashed Mohassel, M. & Behdani, M.A. (1994). Effect of plant density on yield and yield components of safflower. *Food Science and Agriculture.* **8**(2): 124-110.

Rohrig, M. & Stunzel, H. (2001). Canopy development of *Chenopodium album* in pure and mixed stands. *Weed Research.* **41**(2): 111-128.

Sama'ee, M.G., Akbari, R. & Zand, A. (2006). Study on effect of density and competition with *Amaranthus retroflexus* L. on morphological traits, yield and yield components of soybean (*Glycine max* L.) cultivars. *Journal of Agricultural Science*. **12**(1): 41-56.

Seyed Sharifi, R. (2009). Industrial crops (2nd Ed.). Amidi Press, Mohaghegh-e Ardabili University. 432 pp.

Shafagh Kalvangh, J., Zehtab Salmasi, S., Javanshir, A., Moghadam, M. & Dabagh Mohammadi Nasab, A. (2009). Effect of different N levels and weeds interference on yield, yield components and leaf chlorophyll of soybean. *Journal of Sustained Agriculture Knowledge*. **1**(1): 1-24.

Yaghoubi, S.R. & Agha Alikhani, M. (2011). Effect of weeds natural population interference and control periods on yield and yield components of autumn canola (*Brassica napus* L.). *Iranian Journal of Agricultural Research.* **9**(4): 659-669.

Zarghani, H., Nezami, A., Khajeh Hosseini, M. & Izadi Darbandi, A. (2012). Effect of weeding on yield and yield components of sesame (*Sesamum indicum*). *Journal of Agricultural Research.* **10**(4): 698-690.

Zimdahl, R.L. (2004). Weed-crop competition, a review. Oregon: International Plant Protection Center, Oregon State University, 196 pp.