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Cultivar, Weed and Row Spacing Effects on Some Agronomic Characters of Safflower (*Carthamus tinctorius* L.) in Spring Planting

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Abstract: Safflower (*Carthamus tinctorius* L.) can be a potential oilseed crop for the low-rainfall areas of Central Anatolia, Turkey. The purpose of this study was to determine response of safflower cultivars to weed and the row spacing. The experimental design was used a split-split plot arrangement in a completely randomized block with 3 replications. Main plots were cultivars (5-118 and 5-154), sub plots were weed treatment (weed not removed and weed removed manually) and sub-sub plots were row spacing (20, 40 and 60 cm).

The hand weeding decreased the weed density by 75.3%, conversely increased the safflower yield by 36.3%. The highest seed yield (128.9 kg da $^{-1}$) was obtained for cv. 5-118 at 20 cm. However, for cv. 5-154 the highest yield (72.0 kg da $^{-1}$) was obtained at 20 or 40 cm row spacings. Plant height, number of branches plant $^{-1}$, number of heads plant $^{-1}$ and head diameter were always more closely associated with high yields of each cultivar than seed weight. Planting of the cv. 5-118 was recommended at 20 cm row spacing because of better competetion with weeds and it's higher yield than cv. 5-154. This cultivar is also more suitable to hand harvesting due to it's spinelessness.

Yazlık Ekimde Aspirin (*Carthamus tinctorius* L.) Bazı Tarımsal Özellikleri Üzerine Çeşit, Yabancı Ot ve Sıra Arasının Etkileri

Özet: Aspir (*Carthamus tinctorius* L.) orta Anadolu'nun az yağış düşen alanları için potansiyel bir yağ bitkisi olabilir. Bu çalışmanın amacı; aspir çeşitlerinin yabancı ot ve sıra arasına risponsunu belirlemektir. Tesadüf bloklarında, bölünen bölünmüş parseller deseninde 3 tekerrürlü kurulmuş olan denemede, ana parsellere çeşit (5-118 ve 5-154), alt parsellere ot işlemi (otlu ve otsuz) ve alt alt parsellere ise sıra arası (20, 40 ve 60 cm) yerleştirilmiştir.

El ile çapalama sonucu ot yoğunluğu %75.3 oranında azalırken, verim %36.3 artış göstermiştir. En yüksek tohum verimleri 5-118 çeşiti için 20 cm'den (128.9 kg da^{-1}) ve 5-154 çeşiti için 20 ve 40 cm'den (72.0 kg da^{-1}) alınmıştır. Bitki boyu, bitkide dal sayısı, bitkide tabla sayısı ve tabla çapı, tohum ağırlığına göre yüksek verim ile daha yakın ilişkili bulunmuştur. 5-154 çeşitinden daha verimli ve ot ile rekabeti daha iyi olan 5-118 çeşitinin 20 cm sıra aralığında ekilmesi önerilmiştir. Bu çeşitin dikensiz olması, el ile hasatta bir avantaj da sağlamaktadır.

Introduction

The main oil seed crops of Turkey are sunflower, cotton and soybean. They cover about 95% of the total oil seed production of the country. Farmers in Turkey don't produce safflower (*Carthamus tinctorius* L.) in a large scale because it does not have any market guarantee and subvention of the goverment. It's total production was 1600 tones in 1976 which had decreased to 124 tons in 1990's. Declining production of safflower is being realized in the transition region between western and central Anatolia. Safflower oil is used by farmers locally (1). However, safflower can be a potential oilseed crop for low-rainfall areas of the central Anatolia (2).

In safflower production row spacing is important because it determines the yields. Seed yields increase with narrow row spacings. Hoag et al. (3) concluded that yields from 15 or 53 cm spaced rows were greater than the yields from 91 cm rows. The results of Qayyum et al., (4) showed that all the growth and yield properties increased with 20 cm row spacing. Esendal (5) found that seed yield of safflower decreased significantly ($P<0.05$), as the row distance was increased from 18 to 90 cm. The seed yields obstained from 18, 54 and 90 cm rows were 235.6, 199.8 and 184.1 kg ha^{-1}, respectively in Erzurum Valley. Gencer et al., (6) reported that the suitable plant spacing was 34 cm at the unirrigated area of Cukurova region in Turkey. Knowles and Miller (7) recommended

45-60 cm row spacing when the safflower is grown on dry land. They also implied that under irrigation, rows should not be more than 75 cm apart, and the highest yield will be obtained if they do not exceed 60 cm.

Safflower seedlings grow slowly and compete poorly with weeds for the first 3 to 4 weeks after emergence. During that period, many weeds are taller than the crop, effectively shading it. Weeds can cause yield losses up to 75% depending on the species and numbers of weeds. However, narrow row plantings may help the safflower crop to compete better with the weeds and give a more uniform stand which matures earlier (8, 9).

This paper reports the response of agronomic properties of safflower to weed and row spacing. Also, the weed densities under weed treatments and row spacings were investigated.

Materials and Methods

The field experiment was conducted at the Nuclear Research and Training Center, Ankara in 1995. Two safflower cultivars; cv. 5-118 (which had been registrated as Dincer, is a tall, thick, stemmed and spineless type) and cv. 5-154 (is a short, spiny type and yields less than cv. 5-118).

The experimental design was used a split-split plot arrangement in a completely randomized block with 3 replications. Main plots were cultivars, sub plots were weed treatments; weed not removed (W) and weed removed manually (W_0) and sub-sub plots were row spacing (20, 40 and 60 cm). Each plot was consisted of 6 rows with 4 m long. Cultivars were hand planted on May 3 rd., at the rate of 30 seeds m^{-1}.

Soil was a heavy texture, slightly alkaline, low in organic matter and total nitrogen and also low in extractable phosphorous. Ammonium sulphate (80 kg N ha^{-1}) was used; it was broadcasted to the plots meanwhile, treble superphosphate (60 kg P_2O_5 ha^{-1}) was banded at seeding. The plants were thinned after complete emergence as keeping on row about 5-7 cm. Two weeks after emergence and five weeks after emergence weeds were removed manually. The mainly growing weeds in the experimental area were *Centaure diffusa* Lam., *Circium arvense* L., *Salsola koli, Ononis spinosa* L., *Convolvulus arvensis* L. and *Sinapsis arvensis* L. Safflowers were harvested on August 23 rd. Measured parameters at physiological maturity (20 days after full flowering) were plant height, branches $plant^{-1}$, heads $plant^{-1}$, head diameter and 100-seed weight. Plot seed yields and plot weed weights were obtained at maturity. Statistically analysis of the results was done with computer by using MSTAT programme. Means were compared using the least significant differences (LSD) at 0.05 and 0.01 levels of probability. Correlations between yield and some plant characters were calculated for each combination of weed control and row spacing.

Results and Discussion

Cultivar Effects

Cultivars effected head diameter, seed weight and seed yield significantly ($P<0.05$). Plants of cv. 5-118 were 8.2 cm longer than cv. 5-154. They produced larger head, heavier seed weight and higher seed yield in comparision cv. 5-154. Contrarily, the 5-154 cultivar showed an increase in the number of branches and number of heads. The cv. 5-118 competed with weeds better due to their tallness. Thus, there were less amount of weed in the cv. 5-118 plots. The weed weights $decar^{-1}$ were 67.8 kg and 104.3 kg for 5-118 and 5-154 cultivars, respectively. However, they were not statistically different (Table 1).

Weed Effects

The hand-weedings reduced the weed density by 75.3% which was significantly ($P<0.05$) different from unweeded treatment. A result of this; all plant characters were increased as expected significantly (either $P<0.05$ or $P<0.01$ levels) with weed control manually (Table 1). The increase in the seed yield was 36.3% (it increased from 69.4 to 94.6 kg da^{-1}). Plants in the "W" yielded low because they produced shorter plants, branches, smaller head and less seed weight than "W_0".

Row Spacing Effects

The wide row spacing (60 cm) increased the number of head, head diameter and seed weight, but decreased the plant height and number of branches $plant^{-1}$, However, these fluctuations were not statistically significant, except the number of head $plant^{-1}$ ($P<0.05$). The narrowest row spacing (20 cm) gave the maximum seed yield (100.4 kg da^{-1}) and the lowest weed density (35.7 kg da^{-1}) which were significantly ($P<0.01$) different than the other spacings. The decreases in the seed yields were 23.6 and 31.6% for 40 and 60 cm row spacings, respectively, in comparison to 20 cm spacing (Table 1).

Cultivar x Row Spacing Interactions

A significant interaction was not found between cultivar and weed (is not presented in the Table). Meanwhile, the effect of cultivar x row spacing interactions on the plant height, head number, seed weight and seed yield were significant. The plant height

Table 1. Effects of cultivar, weed control and row spacing on the plant characters and weed weights.

Treatments	Plant height (cm)	No. of branch (plant^{-1})	No. of head (plant^{-1})	Head diameter (mm)	100-seed weight (g)	Seed yield (kg da^{-1})	Weed weight (kg da^{-1})
Cultivar							
5-118	61.8	4.7	7.7	24.2	5.01	94.7	67.8
5-154	53.6	5.5	10.5	21.8	4.81	69.3	104.3
LSD (0.05)	NS	NS	NS	1.6	0.18	22.9	NS
(0.01)	NS	NS	NS	NS	NS	NS	NS
Weed treatment							
W	55.1	4.5	7.4	21.7	4.88	69.4	138.1
W_0	60.4	5.7	10.9	24.2	4.94	94.6	31.1*
LSD (0.05)	2.8	0.8	2.2	1.1	NS	14.0	87.7
(0.01)	4.6	NS	NS	1.8	NS	23.3	NS
Row spacing							
20	58.3	5.4	9.6	22.9	4.87	100.4	35.7
40	57.6	4.9	8.0	23.0	4.87	76.7	83.7
60	57.3	5.0	9.8	23.1	4.99	68.7	138.9
LSD (0.05)	NS	NS	1.5	NS	NS	12.0	43.9
(0.01)	NS	NS	NS	NS	NS	16.5	60.5
CV (%)	3.79	11.76	19.29	5.03	2.88	16.89	58.90

* Shows the means of weed weights grown between the last weeding and harvest time in the W_0 treatment.

and head number plant^{-1} decreased for cv. 5-118, but, they increased for cv. 5-154 at the wider row spacings. For both cultivars, heavier 100-seed weights were obtained at 60 cm row spacing in comparison to 20 and 40 cm. The highest seed yields were obtained for cv. 5-118 at 20 cm (128.9 kg da^{-1}) and for cv. 5-154 at 20 and 40 cm row spacings (72.0 kg da^{-1}). In spite of a very wide range (from 21.7 to 150.3 kg da^{-1}) of weed weights, they were not significantly different (Table 2).

Weed x Row Spacing Interactions

Significant weed x row spacing interactions were found for the plant height ($P<0.05$), head number ($P<0.05$), seed weight ($P<0.01$) and weed weight ($P<0.05$). The plant height and head number plant^{-1} decreased in the "W" treatment. However, they increased at 60 cm of the "W_0" when compaired to other row spacings. Higher 100-seed weights were obtained from 40 cm (4.96 g) and 60 cm (5.08 g) for "W" and "W_0" treatments, respectively. Weed weights showed a significant decrease at narrow row spacings. Seed yields were higher at 20 cm row spacings, and they were 95.6 kg da^{-1} and 105.3 kg da^{-1} for "W" and "W_0" treatments, respectively (Table 3).

Table 2. Effects of cultivar x row spacing interactions on the plant characters and weed weights.

Cultivar	Row spacing	Plant height (cm)	No. of branch (plant^{-1})	No. of head (plant^{-1})	Head diameter (mm)	100-seed weight (g)	Seed yield (kg da^{-1})	Weed weight (kg da^{-1})
5-118	20	63.8	5.5	9.5	24.6	5.06	128.9	21.7
	40	62.0	4.4	6.5	24.0	4.89	81.5	54.4
	60	59.6	4.3	7.2	24.0	5.08	73.6	127.5
5-154	20	52.9	5.4	9.6	21.1	4.69	72.0	49.7
	40	53.1	5.4	9.5	21.9	4.85	7.20	113.0
	60	55.0	5.7	12.6	22.2	4.91	63.9	150.3
LSD	(0.05)	2.67	NS	2.2	NS	0.2	16.9	NS
	(0.01)	3.68	NS	3.0	NS	NS	23.3	NS

In this study, plant height, number of branches plant^{-1}, number of heads plant^{-1} and head diameter were always more closely associated with high yields of each cultivar (Table 4). Result showed that above mentioned properties were important in determing the seed yield of safflower. Meanwhile relatively poor relationship was found between yield and seed weight for cv. 5-118 (r=0.49), which was not significant for cv. 5-154.

Table 3. Effects of weed control x row spacing interactions on the plant characters and weed weight.

Weed treatment	Row spacing	Plant height (cm)	No. of branch (plant^{-1})	No. of head (plant^{-1})	Head diameter (mm)	100-seed weight (g)	Seed yield (kg da^{-1})	Weed weight (kg da^{-1})
W	20	56.3	5.0	8.3	21.5	4.78	95.6	59.2
	40	56.0	4.5	7.0	21.9	4.96	41.5	127.1
	60	52.9	4.1	6.9	21.8	4.91	50.3	227.9
W_0	20	60.3	5.9	10.9	24.2	4.97	105.3	12.2*
	40	59.1	5.3	9.1	24.0	4.79	91.2	40.3*
	60	61.7	5.9	12.8	24.4	5.08	87.2	49.8*
LSD	(0.05)	2.7	NS	2.2	NS	0.2	NS	62.1
	(0.01)	NS	NS	NS	NS	0.2	NS	NS

* Shows the means of weed weights grown between the last weeding and harvest time in the Wo treatment.

Table 4. Some correlation between plant characters and seed yield within each cultivar and over cultivars (n=18 for cultivars and n=36 for over cultivars)

Plant characters	5-118	5-154	Over cultivars
Plant height	0.75**	0.70**	0.76**
Branches plant-1	0.81**	0.71**	0.49**
Heads plant-1	0.80**	0.56*	0.34*
Head diameter	0.67**	0.66**	0.72**
100-seed weight	0.49*	NS	0.39

*, ** Significant at the 0.05 and 0.01 probabilty levels, respectively.

Conclusion

The two cultivars responded differently to weed density. The cv. 5-118 competed better with weeds because of it's taller height than cv. 5-154. Weed control done by two separate hand weedings increased the seed yields at all row spacings, which was expected. Narrowest row spacing (20 cm) was found favorable for the highest seed yield of each cultivar. However, farmers should prefered the 5-118 cultivar at the spring planting because of it's higher yield than 5-154. This cultivar is also more suitable to hand harvesting due to its spinelessness. More research is necessary at the several parts of the region in different years with these or different cultivars in order to obtain more date.

References

1. Esendal E., Kevseroğlu K., Uslu N., Aytaç S., Performance of late autumn and spring planted safflower under limited environment. Proceedings Thirt International Safflower Conference (14-18 June, 1993, Beijing, Chine). p. 421-428, 1993.
2. Er C., Endüstri bitkilerinin nadas alanlarına sokulabilme olanakları. Kuru Tarım Bölgelerinde Nadas Alanlarından Yararlanma Sempozyumu (28-30 Eylül, 1991, Ankara), p. 289-297, 1984.
3. Hoag B.K., Zubriski J.C., Geiszler G.N., Effect of fertilizer treatment and row spacing on yield, quality and physiological response of safflower. Agron. J., 60: 198-200, 1968.
4. Qayyum S.M., Rajput M.A., Sodhro T.M., Tunio K.D.L., Khan W.A., Effect of different row spacing on the growth and yield of safflower. Sesame and Safflower Newsletter, 2: 74-82, 1986.
5. Esendal E., The effect of phosphorus, nitrogen and row-spacing on the yield and some plant characters of the safflower. Sesame and Safflower Newsletter, 2: 96-98, 1986.
6. Gencer O., Sinan, M.S., Gulyasar F., A research on different row spacings of safflower which grown under unirrigated conditions of Cukurova region. J. of Cukurova Univ., Faculty of Agric., 2: (2) 54-68, 1987.
7. Knowles P.F., Miller M.D., Safflower. California Agricultural Experiment Station, Extension Service, Circular 532, p.51, 1965.
8. Mündel H.H., Morrison R.J., Blackshaw R.E., Roth B., Safflower Production on the Canadian Prairies. Graphcom Printers Ltd., Lethbridge, Alberta, p. 27, 1992.
9. Lyon D.J., Boltensperger D.D., Sall R., Kerr E., Growing safflower in Nebraska. http://ianrwww.unl.edu/ianr/pubs/nebfacts/nf 91-36.htm, 1996.