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The economically important traits of safflower (*Carthamus tinctorius* L.) cultivars and lines cultivated in Tekirdag, Turkey

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Abstract
The aim of the study was to determine effect of winter sowing on yield and plant traits of safflower (*Carthamus tinctorius* L.) cultivars under Tekirdağ conditions. The research was conducted using a randomized complete blocks design with three replicates. This research was conducted at Applying Research Field, Faculty of Agriculture University of Namık Kemal in 2004-2005, 2005-2006 and 2006-2007. Forty safflower variety and lines were used in this study.

Winter sowing time significantly affected some agronomic characters of the genotypes used in this study. There was interaction between genotypes and years. According to the results of this research; Yenice has showed the tallest values 153.7 cm for plant height, PI 250187 has showed the smallest values 111.3 cm for plant height. PI 250599 line has showed the highest values 48.2 gr. for 1000 seed weight, Montola 2000 has showed the lowest values 38.6 gr for 1000 seed weight. GW 9003 has showed the highest values in winter sowing 270.5 kg/da for yield, PI 592391 line has showed the lowest values 104.6 kg/da for yield. Montola 2000 has showed the highest values % 37.9 for oil content, PI 210834 line has showed the lowest values % 25.0 for oil content.

Key words: Safflower - seed yield - 1000 seed weight - oil ratio - winter sowing

Introduction

Safflower (*Carthamus tinctorius* L.) is an annual, broadleaf oilseed crop of the family Compositae adapted chiefly to dryland or irrigated cropping systems (Rohini and Sankara, 2000). It is believed to have originated in southern Asia and is known to have been cultivated in China, India, Persia and Egypt almost from prehistoric times. During Middle Ages it was cultivated in Italy, France and Spain and soon after discovery of America, the Spanish took it to Mexico and then to Venezuela and Colombia (Elias et al., 2002). Safflower was originally grown for the flowers that were used in making red and yellow dyes for clothing and food preparation (Cho and Tae, 2000). It is an important cash crop throughout different production areas of the world. Planted area has reached 916,443 ha and resulted in 717,778 ton production in worldwide during 2006 (Anonymous, 2006). Today this crop supplies oil, meal, birdseed and foots (residue from oil processing) for the food and industrial products markets, although this crop is now primarily grown for the oil (Landau et al., 2004).

Safflower (*Carthamus tinctorius* L.) is an important oilseed crop with 35-40 % oil. It has been used as a source of edible oil and dying since ancient time (Kolsarıcı et al., 2005). In many areas worldwide, winter hardy safflower would provide important management alternatives for farmers (Yazdi-Samadi and zali, 1979; Ghanavati and Knowles, 1977; Carapetian, 2001). With earlier maturity, crop development of winter safflower would occur when temperatures are lower and moissture more plentiful than spring sown safflower (Yazdi-Samadi and Zali, 1979).

Safflower seeds contain 92-93 % unsaturated fat and as such is counted as high quality edible oil. This helps in reduction of blood cholestrol. Due to high linoleic acid the safflower oil is also being used in various types of industry (Eren et al., 2005).

This study was carried out to obtain high yielding safflower seeeds and develop appropriate cultivation method which could be suitable for the farmers Tekirdag the aim of developing winter varieties with increased yield, yield components, oil content, oil yield and the factors affecting these.

Materials and Methods

This research was conducted at Applying Research Field, Faculty of Agriculture University of Namik Kemal in 2004-2005, 2005-2006 and 2006-2007. The place where the trial was established reflected the typical characteristics of the climatic conditions of Tekirdag. 2004-2005, 2005-2006 and 2006-2007 years average temperature and relative humidity being closer to the data for a long past. The soil of the trial area was clay and loam, pH value 8.4, organic matter was 1.3 %, clay was 34.9 %, sand was 43.8 % and silt was 21.3 %.

In this research, twenty-four of the safflower line (PI 306924, PI 248624, PI 537683, PI 253564, PI 307112, PI 199888, PI 304462, PI 250195, PI 250187, PI 251984, PI 250838, PI 250839, PI 250840, PI 250599, PI 597684, PI 210834, PI 307014, PI 603207, PI 560177, PI 592391, PI 590162, PI 572433, PI 572415, PI 572421) and sixteen safflower variety (Dinçer, Yenice, Remzibey, Syrian, Montola 2000, Centennial, Kazakhstan Population, Finch, GW 9003, GW 9005, GW 9023, GW 9305, Cybregon, Saffire, Rancho and Gifford) were used material.

The experiment was carried out using a randomized complete block, split plot design with three replicates. Sowing dates on September 19 2004, on November 7 2005 and on September 20 2006. In the sowing, the row width was 100 cm. Intra-row spacing was stabilized as 10 cm by thinning. All treatments were fertilized with 10 kg nitrogen and 10 kg phosphorus per decare. Weed control was obtained by mechanical rotary tillage in the inter-row and by manual weeding in the row. Sowing was performed on nonirrigated.

For the oil analysis, three replicated samples were separated and their crude oil analysis was done in NMR. Statistical analysis was subjected to Analysis of Variance using MSTAT software program. The DUNCAN test was applied to the results using the same program.

Results and Discussion

Plant height

The significant effects of cultivars ($P < 0.01$) were observed on plant height. The differences between the means were compared by Duncan's multiple range tests and are shown in Table 1.

The results (Table 1) show that the plant height of 153.7- 111.3 cm between was observed in cultivars. Yenice has showed the tallest values 153.7 cm for plant height, PI 250187 has showed the smallest values 111.3 cm for plant height. Abo-Hegazi ve Shabaly (1992) found that plant height value varied from 89-169 cm respectively. These results also support our findings. Ekiz ve Bayraktar (1986), Esendal (1990), Bayraktar (1991), Günel et al. (1994), Sergek (2001) found that plant height value varied from 69.6-77.6 cm; 64.4-104.7 cm; 105.0-112.5 cm; 41.5-47.4 cm; 73.9-107.6 cm respectively. This result also does not support our findings.

Thousand seed weight

The significant effects of cultivars and cultivar x years ($P < 0.01$) were observed on thousand seed weight. The differences between the means were compared by Duncan's multiple range tests and are shown in Table 1.

Table 1. A comparison of the effects of sowing time on plant height (cm), on thousand seed weight (g), on seed yield (kg da^{-1}) and oil content (%) Duncan's Multiple Range Test*

	Plant Height (cm)		Thousand seed Weight (g)		Seed Yield (kg da^{-1})		Oil Content (%)	
Montola 2000	133.7	c-h	38.6	r	115.0	ı-l	37.9	a
PI 248624	134.7	b-g	41.5	pq	123.6	h-l	32.3	hı
PI 537683	138.0	b-e	41.9	m-q	127.7	g-l	31.2	kl
PI 253564	131.5	d-ı	45.2	cd	127.7	g-l	29.6	pq
PI 307112	131.0	d-ı	41.9	m-q	128.8	g-k	30.4	no
PI 199888	133.2	c-h	42.0	m-q	219.6	de	31.5	jk
PI 304462	133.5	c-h	43.8	f-ı	118.1	ı-l	29.0	rs
PI 250195	113.2	l-n	41.6	opq	130.4	g-k	31.0	lmn
PI 250187	111.3	n	46.3	bc	119.2	h-l	32.2	hı
PI 251984	123.7	h-l	42.2	l-q	130.8	g-k	30.9	lmn
PI 250838	132.9	c-h	43.0	g-m	130.8	g-k	29.9	p
PI 250839	130.2	d-i	44.4	def	244.9	bcd	27.3	u
PI 250840	127.8	e-j	47.3	ab	122.4	h-l	28.5	st
PI 250599	132.9	c-h	48.2	a	115.3	ı-l	30.1	op
Remzibey	123.6	h-l	42.5	k-q	146.1	fgh	29.6	pq
PI 597684	125.1	g-k	44.3	def	274.0	a	30.7	mn
Syrian	121.1	ı-m	42.7	h-n	248.2	abc	32.3	hı
Centennial	116.3	k-n	42.9	g-m	201.4	e	35.0	c
PI 306924	118.4	j-n	45.1	cde	197.5	e	31.9	ıj
PI 210834	123.3	h-l	42.7	l-o	124.1	h-l	25.3	w
PI 307014	138.0	b-e	43.8	fgh	117.2	ı-l	28.1	t
Cyrbregon	126.3	f-k	41.9	m-q	112.7	j-l	27.2	u
Kazak Population	136.0	b-g	43.9	fgh	131.7	g-j	28.6	st
Yenice	153.7	a	43.9	efg	202.9	e	25.0	w
PI 603207	146.6	ab	44.3	def	119.9	h-l	27.0	u
PI 560177	137.9	b-e	43.6	f-k	117.5	ı-l	26.0	v
PI 592391	121.4	ı-m	44.1	d-g	104.1	kl	28.1	t
PI 560162	119.3	i-n	41.3	q	101.3	l	28.3	t
PI 572433	140.1	a-d	42.6	j-p	115.5	ı-l	29.9	P
PI 572415	132.4	c-h	41.6	n-q	112.0	jkl	34.8	c
PI GW 9023	140.4	a-d	42.1	m-q	168.7	f	32.7	gh
GW 9005	142.9	abc	43.6	f-j	197.7	e	34.0	d
GW 9003	137.0	b-f	42.4	l-q	270.5	ab	34.0	de
Gifford	132.5	c-h	41.4	q	209.4	e	29.1	qr
GW 9305	133.6	c-h	41.6	n-q	151.6	fg	33.2	ef
Finch	138.9	b-e	41.9	m-q	130.4	g-k	33.0	fg
Dinçer	141.3	a-d	44.0	efg	224.3	cde	29.3	qr
PI 572421	134.7	b-g	43.3	f-l	165.8	f	31.0	klm
Saffire	134.0	c-h	42.0	m-q	141.9	f-ı	30.5	no
Rancho	128.4	e-j	42.0	n-q	146.3	fgh	35.9	b
CV	8.3		16.4		14.7		9.3	
LSD			1.2		27.5		0.8	

* P <0.01

The Table 1 shows that minimum thousand seed weight 38.6 gr was observed in cultivars Montola 2000. The highest thousand seed weight of 48.2 gr. was obtained in cultivars PI 250599. Mundel et al. (1985) Ekiz ve Bayraktar (1986), Esendal (1990), Bayraktar (1991) found that thousand seed weight value varied from 36.7 g.; 31.5-36.7 g.; 43.7 g.; 36.4-49.9 g. respectively. Thousand seed weight value ranged between 38.6-48.2 g. in this study.

Seed yield

The significant effects of cultivars and cultivar x years (P <0.01) were observed on seed yield. The differences between the means were compared by Duncan's multiple range tests and are shown in Table 1.

The Table 1 shows that minimum seed yield 104.6 kg/da was observed in cultivars PI 592391. The highest seed yield of 270.5 kg/da was obtained in cultivars GW 9003. Esendal ve Tosun (1972) found seed yield per decare varied from; 69.8-208.5 kg/da, Bayraktar (1991) 167-240 kg/da, Samancı et al., (2001) 120-200 kg/da respectively. These results also support our findings.

Oil Content

The significant effects of cultivars and cultivar x years ($P < 0.01$) were observed on oil content. The differences between the means were compared by Duncan's multiple range tests and are shown in Table 1.

The Table 1 shows that minimum oil content 25.0 % was observed in cultivars PI 210834. The highest oil content 37.9 % was obtained in cultivars Montola 2000GW 9003. Öztürk (1994) found oil content varied from; 26.1-35.3 %, Bayraktar (1991) 28.2-33.3 % respectively.

The significant differences in the economically important traits of Safflower cultivars and lines are found; this might be due to different genotypes and ecologic conditions under which the experiments were carried out.

Conclusion

The studies clearly show that in winter safflower will be sown under tekirdag conditions. In the light of such data obtained, it can be concluded that safflower cultivation under Tekirdag conditions winter sowing gave better results for oil content in Montola 2000 and for seed yield GW 9003 and PI 597684 safflower varieties/line.

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