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Full Length Research Paper

Yield and yield components of six canola (*Brassica napus* L.) cultivars affected by planting date and water deficit stress

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In order to study the effect of planting dates and different irrigation regimes on yield and yield components of six canola cultivars, an experiment was conducted in two growing seasons; 2008 to 2009 and 2009 to 2010. Six canola cultivars (Zarfam, GKH1103, GKH1605, GKH2005, GKH305 and GKH3705) were cultivated in two different dates (October 7th and November 6th) with two levels of irrigation regimes (irrigation after 60 mm evaporation from Class A evaporation pan and irrigation interrupting at flowering stage). The experiments were conducted in randomized complete block design arrangement in split factorial with four replications. The results demonstrated that late planting date and interrupting of irrigation at flowering stage significantly decreased growth, yield and yield components the of canola cultivars. In addition, oil yield was affected by late planting and water stress and it was dramatically decreased. Also, there was no significant difference among the cultivars with respect to oil percentage. The highest seed yield (5930.4 kg. ha^{-1}) was obtained from GKH1103 cultivars planted on October 7th under the conditions of full irrigation. Seed yield and oil yield in the second year was more than that of the first year; this increase was related to the increase in seed weight and pod number per plant but not to number of seed per pod. In general, canola cultivation on November 6th considerably decreased seed and oil yield and it is an important point to achieve desirable yield to seed sowing not done later than October 7th. Additionally, complementary irrigation was very important to gain high yield in canola under the conditions of this study.

Key words: Canola, planting date, water stress, yield and yield components.

INTRODUCTION

Canola is an important oil crop growing in many part of the world. Canola in Iran is mostly cultivated as a winter annual for oil production and rarely livestock feed. If planted in spring, they can be grown as summer crop but the seed yield would be decreased due to short growing season and lack of enough water at the end of growing season, thus, winter cropping is preferred. The canola cultivars are slow growing especially in winter and most of them will complete their life cycle in 210 to 270 days. Canola cultivars appear to be best adapted to the conditions of Iran, however, some cultivars are less tolerant to environmental conditions. These crops are located in areas that receive reliable rainfall or have access to irrigation during summer as well as experience cool-mild temperatures at flowering. In Iran winter, grown canola crops often are harvested in late spring. The commercial cultivars proved to be ecologically well adapted to the Iran a noticeable occurrence of freezing days and lower winter temperatures. There are wide variations among the cultivated canola cultivars with

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respect to seed and oil yields per unit area at different planting dates as well as irrigation regimes. The seed yield and maturity of canola is greatly influenced by fertility management, seeding rate and seeding date (Bailey and Grant, 1993; Scott et al., 1973). Zahedi et al. (2009) reported that yield and yield components were strongly affected by drought stress. Planting dates obviously affect canola yield and yield components. In this regard, it has been reported that at the early planting date, seed yield and straw yields were greater than late planting (Daly and Martin, 1988). A number of studies have shown yield decline in canola with delay in sowing (Hocking and Stapper, 2001; Mendham et al., 1981). In addition, canola oil content has been found to decline with later sowing (Hocking and Stapper, 2001). Also, Hocking and Stapper (2001) concluded that oil concentration reduced by 3% per month of sowing delay. They concluded that the reduction was due to increased temperature and water stress during grain filling. Under harsh winter condition, most of the canola cultivars faced frost damage and displayed little growth in winter. Thus, planting date play an important role in canola production and access to desirable yield.

In addition, the most widespread limited factor in agricultural production is drought stress. The effect of soil moisture on canola oil is also significant, while increased soil water, including irrigation, increases oil concentration (Johnston et al., 2002); water stress (that is, drought and water lodging) reduces it (Pritchard et al., 2000). They also stated that water stress increased the ratio of oleic to linoleic acid. Some researchers have reported that there is a correlation between the oleic acid content and water consumption at the vegetative period. Water stress at the grain filling stage of standard cultivars and genotypes with high level of oleic acid increased the ratio of oleic to linoleic acid (Sainz et al., 1999). According to these points and importance of canola as an oil seed in Iran, this research was undertaken to provide basic information on the response of six canola cultivars to planting date and different irrigation regimes. In addition, our specific objectives were to evaluate the effect of these treatments on canola yield and yield components.

MATERIALS AND METHODS

Study site and experimental design

The experiments were carried out at Qazvin, Iran, (36°15′ N latitude, 49°55′ W longitude and an altitude of 1300 m) in 2008 to 2009 and 2009 to 2010. The experimental design was a randomized complete blocks design arranged in factorial split plot with four replications. Briefly, the two irrigation regimes, including irrigation after 60 mm evaporation from class A evaporation pan (control) and irrigation interrupting at flowering stage and two planting dates including October 7th and November 6th were as factorial allocated to main plots and six canola cultivars including Zarfam, GKH1103, GKH1605, GKH2005, GKH305 and GKH3705 were randomized to sub-plots.

Seed sowing and irrigation treatments

In fall, land was prepared by semi deep plow to a 25 cm depth. All plots in both years were fertilized with 200 kg ha^{-1} of urea as starter and then were mixed with soil by surface disk. 150 kg ha^{-1} of urea was used at the stem elongation stage in spring. Plot size was 5 by 1.8 m with 6 rows in each plot. The plots were 1.5 m apart each other to prevent lateral water movement between plots. Seeds were planted at a 5 cm distance on the rows at 3 cm depth. After seed sowing, the plots were irrigated immediately. Plants were thinned at the six-leaf stage to reach optimal plant density (100 plants per square meter). During the growing season, irrigation was performed after 60 mm evaporation from class A evaporation pan in non stress plots, while in stress plots irrigation was interrupted at flowering stage until physiological maturity stage. Weeds were controlled by labors. A systemic insecticide (Metasystox) was used at the flowering stage of canola to protect them against aphids.

Data collection

At physiological maturity stage, the crops were harvested when 40 to 50% of the seeds in the main pods and primary branches turned brown. In order to evaluate biological yield, samples were oven-dried at 70°C for 72 h. In addition, height of plants in each plot was measured. Furthermore, pod number per plant, seed number per pod, 1000 seed weight and final seed yield were determined. Oil percentage and oil yield were calculated too. Oil percentage was measured by Inframatic 8620 Percor. Oil yield was obtained by multiplying seed yield in percentage oil.

Data analysis

Data were analyzed using the general linear model (GLM) procedure of the statistical analysis system, SAS. When analysis of variance showed significant treatment effects, Duncan's multiple range test was applied to compare the means at $P < 0.05$.

RESULTS AND DISCUSSION

Analysis of variance on data showed that effect of year was significant on all agronomic traits except biological yield and seed number per pod (Table 1). In addition, different planting date, irrigation regimes and canola cultivars significantly affected these traits (Table 1). Oil percentage was not affected by canola cultivars and there was no significant effect. Also, interaction of treatments was significant on the studied traits but not on oil percentage (Table 2). Comparisons between first year and second year showed that plant height, 100 seed weight, pod number per plant, seed yield, oil percentage and oil yield were considerably increased in the second year, while there was no significant difference between the first year and second year on the biological yield and seed number per pod (Table 2). Increase of the earlier mentioned attributes in the second year could be due to improvement of the agronomic practices and especially more suitable weather parameters such as temperature and precipitation. It was observed that seed yield was increased in the second year when compared with the first year (Table 2); this enhancement was because of the

Table 1. Analysis of variance on some agronomic traits affected by different planting date and irrigation interruption.

S.O.V	Biological yield	Plant height	1000 seed weigh	Seed number per pod	Pod number per plant	Seed yield	Oil percentage	Oil yield
Year	ns	**	**	ns	**	**	**	**
Rep (year)	ns	**	**	ns	**	ns	ns	ns
D	**	**	**	**	**	**	**	**
Year*D	ns	**	ns	ns	**	**	**	**
Rep*D*I(year)	**	**	**	ns	ns	ns	ns	*
I	**	**	**	**	**	**	**	**
Year*I	**	**	ns	ns	**	**	ns	**
V	**	**	**	**	**	**	ns	**
Year*V	**	**	**	*	**	**	**	**
D*I	ns	*	ns	ns	**	**	ns	**
Year*D*I	*	**	ns	ns	ns	**	ns	**
D*V	ns	**	ns	**	**	**	ns	**
Year*D*V	ns	ns	ns	*	**	**	ns	**
I*V	ns	**	ns	*	**	**	ns	ns
Year*I*V	ns	ns	ns	**	**	**	ns	**
D*I*V	**	**	*	**	**	**	ns	**
Year*D*I*V	ns	**	ns	ns	**	**	ns	**
C.V (%)	12.00	5.56	4.31	9.68	3.77	10.14	6.42	11.05

*, ** significant at the 0.05 and 0.01 probability levels, respectively; ns, not significant.

Table 2. Effect of year on some agronomic traits in canola.

Year	Biological yield	Plant height	1000 seed weigh	Seed number per pod	Pod number per plant	Seed yield	Oil percentage	Oil yield
2008-2009	12477.7a	109.44b	4.00b	19.92a	102.71b	3115.61b	38.21b	1189.07b
2009-2010	13227.7a	118.50a	4.36a	20.05a	121.91a	3748.18a	40.86a	1556.31a

Means with similar letter were not significant at the 5% probability level.

increase in the number of pod in plant and seed weight, furthermore, plant height was increased in the second year. Obviously, increase in plant height leads to increase in pod number in plant, like the obtained results in this study (Table 2). In other word, increases of seed yield may be due to increases of vegetative growth and dry matter accumulation. Comparison of means indicated that planting dates significantly affected plant height and biological yield. The results revealed that late planting of canola on November 6th dramatically decreased plant height and biological yield (Table 3). Moreover, plant height and biological yield decreased due to water stress whether in the early planting date or late planting date (Table 3). The highest plant height and biological yield were obtained from GKH group cultivars when they were cultivated on October 7th and irrigated until physiological maturity stage (Table 3). On the other hand, the lowest biological yield and the shortest plants were observed from Zarfam cultivar, cultivated on November 6th and water stressed at the flowering stage. It could be stated that planting canola on October 7th was the most suitable sowing date for canola, because late sowing on November 6th reduced the growth period as well as reduced the vegetative growth such as number of branches per plant that reflected increases in seed yield. Halvorson et al. (2001) found that the number of branches per plant was closely correlated with soil moisture regime during growing season. These results are similar to the results of Saini and Sidhu (1997).

The obtained results demonstrated that one month delay in seed sowing can decrease seed yield from about 10 to 50% in different canola cultivars (Table 3). Also, interruption of irrigation since flowering stage until seed maturity, drastically decrease seed yield. Abiotic stress at the later stages of reproductive growth can result in source limitation for seed yield by inducing leaves shedding and hastening maturity (Gan et al., 2004). The increase in seed yield as a result of early planting date may be attributed to more light, water and mineral absorption by plant canopies thus, increasing photosynthetic capacity. These results are in accordance with those of Chauhan et al. (1993). On the other hand, late planting date not only decreases crop growing season, but also causes weak pollination and seed filling at the end of season due to hot and dried days. Previous studies on canola indicated that canola production is mainly affected

Table 3. Interaction among different planting date, irrigation regimes and canola cultivars on some agronomic traits.

Treatment		Cultivar	Biological yield	Plant height (cm)	1000 Seed weigh (g)	Seed number per pod	Pod number per plant	Seed yield (kg/ha)	Oil yield (kg/ha)
Planting date October 7th	Non stress	Zarfam	15293bc	132.25bcd	4.54abc	21.46bcde	132.93bcd	4369.3cd	1836.6c
		GKH1103	18983a	153.42a	4.54abc	23.23b	150.52a	5930.4a	2472.1a
		GKH1605	18216a	145.61a	4.51abcd	22.70bc	145.70ab	5355.1ab	2249.3ab
		GKH2005	17867a	143.22ab	4.54abc	21.9bcd	143.35abc	4932.2bc	2042.6bc
		GKH305	18461a	149.35a	4.83a	29.11a	151.71a	5615.8ab	2271.0ab
		GKH3705	18302a	148.15a	4.60ab	23.68b	148.01a	5757.6a	2327.8ab
	Stress	Zarfam	12470def	107.92fg	4.25bcdef	20.53cdef	107.58fgh	3073.1efg	1235.9de
		GKH1103	14125bcd	124.98cde	4.01efgh	19.87defg	123.60de	3654.7def	1460.1de
		GKH1605	15860b	130.97bcd	4.26bcdef	21.85bcd	128.67cd	3653.7def	1451.4de
		GKH2005	15602b	128.93cd	4.32bcde	21.26bcdef	128.92cd	3657.8def	1431.4de
		GKH305	13261cde	113.53ef	4.33bcde	21.74bcd	118.20def	2860.4gh	1126.0defg
		GKH3705	14637bcd	132.67bc	4.31bcde	22.59bc	130.95cd	3806.7de	1489.1d
Planting date November 6th	Non stress	Zarfam	9814gh	93.71hi	4.19cdefg	17.89ghi	94.07hi	2671.8ghi	1072.1efg
		GKH1103	10677fgh	107.76fg	3.97efgh	17.38hi	105.36fgh	3005.0fg	1215.9de
		GKH1605	13819bcde	122.83cde	4.17defg	20.59cdef	119.42def	3408.5efg	1263.5de
		GKH2005	13183cde	118.86def	4.15defg	20.40cdef	112.58efg	3408.5efg	1301.5de
		GKH305	11025fgh	96.98gh	4.02efgh	18.93fgh	97.47hi	2879.5fgh	1092.4defg
		GKH3705	11739efg	100.32gh	3.98efgh	19.13efgh	101.16ghi	2999.9fg	1187.9def
	Stress	Zarfam	6460j	73.43k	3.72h	14.37j	66.67k	1548.0j	599.4h
		GKH1103	7617ij	79.80jk	3.70h	14.77j	73.86jk	2012.2ij	784.2gh
		GKH1605	6684j	75.88jk	3.85gh	16.08ij	70.52k	1634.6j	640.4h
		GKH2005	7595ij	83.60ijk	3.83gh	15.981ij	78.00jk	1979.2ij	762.2gh
		GKH305	7500ij	83.46ijk	3.84gh	16.55ij	77.81jk	2105.6ij	818.9fgh
		GKH3705	9277hi	87.62hij	3.91fgh	17.54ghi	88.36ij	2201.2hij	813.0fgh

Means with similar letter were not significant at the 5% probability level.

by the heat and water stress at critical growth stage especially flowering stage. Thus, selecting early planting date allow canola emergence, growth and flower early to avoid heat and water stress.

Similar results were observed regarding 1000 seed weight, seed number per pod and pod number per plant so that these components were reduced by late planting date and interruption of irrigation at flowering stage. Clark and Simpson (1978) suggested that increased pods per plant in irrigation treatment were primarily due to lengthening of the flowering period. Planting date is an important factor that determines the length of growing season and hence, yields. Early planting of canola postpones flowering which is an important factors leading to the highest yields (Jenkins and Leitch, 1986). Jasinka et al. (1989) reported that seed and oil yields decreased with delay in sowing date. The differences between oilseed canola cultivars in seed yield might be attributed to their differences in growth traits such as number of branches that reflected differences in yield components such as number of pod per plant as well as 1000-seed weight and hence, increased seed yield per plant as well as per unit area. Shareif and Keshta (2000) obtained similar results.

Oil percentage was affected by planting date and water stress, but there was no significant effect on the interaction of them. In addition, the different canola cultivars were same with respect to oil percentage (Table 1). The increases in oil yield in October 7th sowing and full irrigation regime may be due to the increases in both oil percentage and seed yield. Sharief and Keshta (1999) reported similar conclusions.

In general, late canola cultivation (November 6th) had high risk and imperil seed and oil yield, thus, it suggests that canola cultivation should not be done later than October 7th. In addition, interruption of irrigation at flowering stage and after that, significantly decreased canola yield and it is necessary to irrigate until seed maturity stage.

Conclusion

The results demonstrated that late planting date and interruption of irrigation at flowering stage significantly decreased growth, yield and yield components of the

canola cultivars. In addition, oil yield was affected by late planting and water stress and it was dramatically decreased.

REFERENCES

Bailey LD, Grant CA (1993). Fertility management in canola production. Can. J. Plant Sci. 8(2): 651-671.

Chauhan AK, Singh M, Dadhwal KS (1993). Effect of nitrogen level and row spacing on the performance of rape (*Brassica napus,* L). Ind. J. Agron. 37 (4): 851 - 853.

Clark JM, Simpson GM (1978). Influence of irrigation and seeding rate on yield and yield components of *Brassica napus* cv. Tower. Can. J. Plant Sci., 58: 731-737.

Daly MJ, Martin RJ (1988). Oilseed rape: The effect of rate, timing and form of nitrogen application on a depleted in more soil. Proc. Ann. Conf. Agron. Soc. New Zealand, 18: 97-102.

Gan Y, Angadi SV, Cutforth H, Mc Donald CL (2004). Canola and mustard response to short periods of temperature and water stress at different developmental stages. Can. J. Plant Sci., 84: 697-704.

Halvorson AD, Wienhold BJ, Black AL (2001). Tillage and nitrogen fertilization influence grain and soil nitrogen in annual cropping system. Agron. J. 93: 836-841.

Hocking PJ, Stapper M (2001). Effect of sowing time and nitrogen fertilizer on canola and wheat, and nitrogen fertilizer on Indian mustard. I. Dry matter production, grain yield, and yield components. Aust. J. Agric. Res. 52: 623-634.

Jansinka Z, Kotecki A, Malarz W, Horodyski A, Musnicka B, Musnicki C, Jodlowski M, Budzynski W, Majkowski K, Wrobel E, Sikora B (1989). Effect of sowing date and sowing rate on the development and seed yields of winter rape cultivars. Akl. Ros. 169: 111-119.

Jenkins PD, Leitch MH (1986). Effects of sowing date on the growth and yield of winter oil seed rape (*Brassica napus*, L). J. Agric. Sci. UK. 107(2): 405-420.

Johnston AM, Tanaka DL, Miller PR, Brandt SA, Nielsen DC, Lafond GP, Riveland NR (2002). Oilseed crops for semiarid cropping systems in the Northern Great Plains. Agron. J. 94: 231-240.

Mendham NJ, Shipway PA, Scott RK (1981). The effect of delayed sowing and weather on growth, development and yield of winter oil-seed rape (*Brassica napus*). J. Agric. Sci. 96: 389-416

Pritchard FM, Eagles HA, Norton RM, Salisbury SA, Nicolas M (2000). Environmental effects on seed composition of Victorian canola, Aust. J. Exp. Agric. 40: 679-685.

Saini KS, Sidhu JS (1997). Effect of different levels of nitrogen and row spacing on the yield performance of gobhi sarson (*Brassica napus*, L) sown on different dates. Ann. Agric. Bio-Res. 2(2): 125-127.

Sainz R, Echeverra HE, Studdert GA, Andrade FH (1999). No-tillage maize nitrogen uptake and yield: Effect of urease inhibitor and application time. Agron. J. 91: 950-955.

Scott RK, Ogunremi EA, Ivins JD, Mendhan NJ (1973). The effects of sowing date and season on growth and yield on oil seed rape (*Brassica napus*). J. Agric. Sci. Camb. 81: 227-285.

Sharief AE, Keshta MM (1999). Canola (*Brassica napus*, L) productivity in North Delta affected by sowing dates and plant population density. J. Agric. Sci. 24(2): 435-444.

Sharief AE, Keshta MM (2000). Response of some canola Cultivars (*Brassica napus*, L) to different sources and levels of nitrogen fertilizers in soil affecting by salinity. Zag. J. Agric. Res. 27(3): 603-616.

Zahedi H, Shirani Rad AH, Noormohammadi G, Habibi D, Boojar M (2009). The effects of zeolite soil applications and selenium foliar applications on growth yield and yield components of three canola cultivars under drought stress. World Appl. Sci. J. 7(2): 255-262.

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