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Comparison of the canola (*Brassica napus* L.) cultivars for yield, yield components and grain filling rate under different sowing times

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ABSTRACT: Canola has industrial applications as well as edible usage. In regard to 15.8 kg oil per capita usage and vast oil importing, cultivation development of oil seeds is a major issue. In order to investigate the effect of sowing time on seed yield and its components as well as determine the best winter canola cultivars to sow in Isfahan province, this experiment was conducted during 2011-2012 farming season. A split plot design in the layout randomized complete block design with three replications was used for this research. Four planting dates 15 October, 22 October, 29 October and 5 November were considered as main factor levels in the main plot. Also, ten canola cultivars were used as sub factor levels and were arranged randomly in the sub plots. Analysis of variance showed the significant effect of sowing time on all measured traits. Also, the cultivar effect was significant on all traits except biological yield. Interaction effects between sowing time and cultivar was significant for 1000-seed weight, harvest index and grain filling rate at 5% probability level while for grain filling duration at 1% . In conclusion, cultivar KR4 and Karaj3 are recommended as the best cultivar to sow in 15 October (normal sowing time) and 22 October (late sowing time), respectively. All to gether, KR4 is the best and superior cultivar to sow in Isfahan province.

***Keywords*:** Sowing time, late sowing, winter rapeseed, split plot design, agronomic attributes

INTRODUCTION

Canola grain yield is dependent to on the capacity of variety yielding, climate conditions, the type of soil and agronomic management. Also genetic and agronomic factors determine growth of the plant and grain yield (Mirmousavi et al., 2004). On the other hand, *Brassica napus* L. is the important oilseed crop throughout the world which rank third among the oilseed crops after soybean and oil palm in production of vegetable oils, while fifth in the production of oilseed proteins.

Canola is also important oilseed crop of Iran. Winter oilseed rape (*Brassica napus* L.), the most important species of oilseeds, must compete economically with cereal crops and to meet this challenge, the yield of rapeseed crops must increase significantly. In this regard, it has been reported that at the early planting date, seed yield and straw yields were greater than late planting (Daly et al., 1988). Sowing time is one of the most important factors for maximizing canola yield especially in those areas where temperature, day length, rainfall and humidity vary throughout the year. Taylor and Smith (1992) reported that yields of seed and oil declined when sowing was delayed beyond May (the optimum period of canola sowing in Australia).

A number of studies have shown yield decline in canola with delay in sowing (Hocking et al.,2001). Sowing time is an important factor that determines the length of growing season and hence yields. If planted in spring, it 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. Early spring sowing of oil canola delayed flowering and reduced reflection of radiation during flowering which were important factors leading to the highest yields achieved by late sowing (Jenkins and Leitch, 1986). Degenhardt and Kondra (1981) also suggested

that delayed seeding resulted in a significant decrease in seed yield, harvest index, racemes per plant and racemes per unit area. To date, management practices required for optimal yield of oilseed rape have been described for neither Isfahan in Iran.

Because of that, this study was achieved to compare the canola cultivars for seed production ability as well as yield components and grain filling rate under different sowing times in Isfahan province.

MATERIALS AND METHODS

This research was done at the agricultural farm station of Kaboutar-Abad, Isfahan, Iran, during 2011-2012 farming season. The experimental field was a piece of well drained high land with moderately even topography. The soil is neutral in nature with pH 7.8. There were four dates of planting viz. 15 October, 22 October, 29 October and 5 November as main factor levels that arranged in the main plots. Ten canola cultivars (Opera, Karaj3, KR4**,**GA096 x Zarfam ,Okapi x GA096 (2)(5),Orient x Modena (2)(4), Orient x Modena (5)(4) Okapix GA096)GA096 x Zarfam (1) (2), Okapi x GA096 (2) (5), Orient x Modena (2) (4), Orient x Modena (5) (4) Okapi x GA096,GA096 xZarfam, GA096 x Zarfam (5) (1)**,**Okapi x GA096,Okapi x GA096) were considered as the sub factor levels that randomly arranged in the sub plots.

The treatments were arranged in a split plot design in the layout randomized complete block design (RCBD) with three replications having plot size 4m x 1.2m. All other fertilizers and ½ amount of the urea were applied during final land preparation; and the rest ½ of urea were applied at 15 days after seedling emergence. Weeding cum thinning, irrigation, and insect and disease control measures were done as per requirement. At maturity, 10 randomly selected plants were uprooted for data collection. Data were collected on traits such as number of silique per plant, seed per silique, 1000-seed weight, seed yield, biological yield, harvest index, grain filling duration and grain filling rate.

Analysis of variance was conducted to assess the significant difference among sowing times, canola cultivars and interaction effects between times and cultivars. Also, Duncan's Multiple Range Test (DMRT) was performed to clarify the highest and lowest amount of the traits as well as significant difference among the sowing times, cultivars and interaction levels. SAS and SPSS statistical softwares were used to analysis the data.

RESULTS AND DISCUSSION

Analysis of variance showed the significant difference of sowing times for all the traits at 1% probability level except. Increasingly, effect of cultivars was significant on all the traits except biological yield. This revealed genetic variability among canola cultivars for these attributes. On the other hand, interaction effect between sowing time and cultivar was significant only for traits 1000-seed weight, harvest index, grain filling rate and grain filling duration. Mean comparison for sowing times showed that highest no. silique per plant (83.8) belongs to first and the lowest (69.1) to last sowing time (Table 1). The maximum seed yield (3170 Kg/ha) was produced in the first sowing time, while the minimum in the last (1410 Kg/ha). Over all, the highest and lowest amount of the traits were observed in the first and last sowing times, respectively (Table 1).

Table 1 . Comparison of sowing times for seed yield and yield components based on DMRT

Date of planting	No.silique/plant	No.seed/silique	1000-seed weight(gr)	Seed yield(Kg/ha)	Biological yield(Kg/ha)	Harvest index(%)	Grain filling duration	Grain filling rate(Kg/ha/day)
15 October	83.80^{a}	29.10^{a}	3.710^{a}	3170 ^{a}	19670^{a}	16.12^{a}	28.30^{a}	117.7^{a}
22 October	76.57^{b}	26.10^{b}	3.453^{a}	2465^{b}	14070 ^{c}	21.22^{a}	25.80^{a}	96.20^{a}
29 October	74.40^{c}	21.57^{c}	3.233^{a}	1882^{c}	18400^{b}	10.30^{a}	28.37^{a}	70.64^{a}
5 November	69.10^{d}	18.40^{d}	2.977^{a}	1410^{d}	6845^{d}	20.44^{a}	26.03^{a}	54.62^{a}

Means followed by the same letter(s) have non significant difference (P<0.05)

Mean comparison between canola cultivars revealed the maximum seed yield (3911 Kg/ha) in KR4, while the minimum (1487 Kg/ha) in Orient x Modena (2) (4). Also, the highest biological yield (17610 Kg/ha) was produced from Orient x Modena (5) (4). The lowest biological yield (10900 Kg/ha) was observed in Okapi x GA096 (2) (5) (Table 2).

Table 2. Comparison of canola cultivars for seed yield and yield components based on DMRT

Canola cultivars	Attribute							
	No.silique/ plant	No.seed/siliq ue	1000-seed weight(gr)	Seed yield(Kg/ha)	Biological yield(Kg/ha)	Harvest index(%)	Grain filling duration	Grain filling rate(Kg/ha/day)
Opera	67.75^{d}	29.33^{b}	3.683^{a}	2742^{b}	15490^{c}	18.59^{a}	25.25 ^{a}	108.2^{a}
Karaj3	66.58^{de}	31.58^{a}	4.008^{a}	3071^{a}	16730^{b}	18.92^{a}	28.92^{a}	114.6^{a}
KR4	75.92^{c}	27.58^{c}	4.067^{a}	3119^{a}	17330^{a}	18.46^{a}	27.58^{a}	113.2^{a}
GA096 x Zarfam (1) (2)	74.67^{c}	25.00^{d}	3.442^{a}	2391^{c}	14820^{d}	17.73^{a}	25.83 ^{a}	91.86^{a}
Okapi x GA096 (2) (5)	65.75^{e}	22.08^{e}	3.275 ^{a}	1827^{d}	13740 ^{f}	15.35^{a}	25.50 ^{a}	72.44 ^{a}
Orient x Modena (2) (4)	92.92^{a}	18.17^{fg}	2.342^{a}	1487^{e}	12540^{g}	14.96^{a}	28.00^{a}	53.11^{a}
Orient x Modena (5) (4)	94.00^{a}	19.33 ^{f}	2.592^{a}	1723de	17610 ^{a}	15.91^{a}	28.75^{a}	59.52^{a}
Okapi x GA096 (5) (2)	87.50^{b}	17.33^{g}	2.767^{a}	1530de	10900^{h}	16.20^{a}	31.67^{a}	54.19^{a}
GA096 x Zarfam (5) (1)	58.92^{f}	21.83^{e}	3.592^{a}	1711de	13830^{f}	14.53^{a}	26.00^{a}	65.82^{a}
Okapi x GA096 (2) (2)	75.67 ^{c}	25.67^{d}	3.667^{a}	2717^{b}	14470^{e}	19.54^{a}	23.75^{a}	115.00^{a}

Means followed by the same letter(s) have non significant difference (P<0.05).

KR4 in the first sowing time and Orient x Modena (2) (4) in the last time produced the highest and lowest seed yield, respectively. Hosseinian Maleki and Mir Shekari (2011) reported the significance effect of cultivars on seed yield and its components in canola. Norouzi et al (2008) also get the similar results.

Seed yield was reduced with the advancement of sowing date from 15 October to 5 November. Chakraborty et al. (1991), Ozer (2003) and Ghjobadi et al (2006) stated that early sowing produced 24% higher seed yield than that of later sowing. Tuteja et al. (1996) also reported the highest seed yield from October 2 sowing but it was decreased by delayed sowing to October 22. Normal sowing time (15 October) increased the seed yield drastically, which might be occurred due to higher number of silique per plant, seed per silique, 1000-seed weight as well as grain filling rate than other sowing times as the delayed sowing (Table 1). Brar et al. (1998) also reported increased seed and oil yield from early planting.

In conclusion, form results of present study revealed that KR4 cultivar has the excellent potential to produce the highest seed yield in the first sowing time (15 October). In the late sowing time (22 October), Karaj3 was the promising cultivar for seed yield production. Because of that, these cultivars are the best for recommendation to plant in the normal and late sowing times under Isfahan province condition.

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