



Fall cultivar of rapeseed (*Brassica napus*) for reduction of damage due to late season drought

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ABSTRACT

This study examined the possibility of cultivating the spring cultivars of rapeseed in the cold temperate regions during Fall season. The objective was to ensure early ripening, avoid drought and even reduce sun exposure during the final growing stages. This was with the Spring cultivation of the same cultivars. Experiment was carried out over two years. Planting season was the main factor which included two entities, namely “planting in Fall” (September 25) and “planting in Spring” (March 25). Plant cultivar was the sub factor which includes 24 cultivars of rapeseed. Effects of the planting season and cultivar, as well as the interaction of both on grain and oil yields, were significant ($P < 0.01$). In the Fall planting season, Hyola 401 hybrid had the highest grain yield and Hyola 330 hybrid had the highest oil yield. However, in the spring planting season, RG 405.03 cultivar had the highest grain and oil yields. The study indicated that it was possible to cultivate the spring cultivars of the plant in cool temperate regions during Fall season.

Key words: Cultivars, Drought, Grain, Oil, Rapeseed, Yield

Rapeseed is one of the most important oilseeds in the world and is considered as the third provider of edible oil after oil palm and soya. Cultivating this plant is important in agricultural programs because of its desirable crop rotation effects with grains, especially wheat and barley. The cultivation of rapeseed in spring is confronted by heat and water deficit in warm and temperate regions. At the final growth stages, namely flowering, pod formation and seed filling, rapeseed is highly sensitive to drought and heat, and these problems cause a sharp drop in yield (Shirani Rad *et al.* 2010). In many areas where rapeseed is cultivated, there is a sharp increase in temperature in late May, which coincides with pod formation and seed filling stages. In addition, during this period, cultivating rapeseed is usually confronted by water deficit and drought because of the limited water sources and allocation of existing water to spring and summer cultivations. One way to solve this problem is to cultivate certain cultivars of rapeseed that get ripe early, complete their growth period and are ready for

harvesting in spring in order not to face the problems of drought and heat. Numerous studies have been conducted on rapeseed cold regions. Bitarafan and Shirani Rad (2012) reported that the effect of water stress from flowering stage on yield and yield components of spring rapeseed cultivars in winter planting which helps us to choose the most appropriate and tolerant cultivars for cultivation in a region with cold temperate and semi arid region. Sinaki *et al.* (2007) and Faraji *et al.* (2009) reported that the number of seeds per pod is one of the influential and determining factors in rapeseed yield.

Every factor that increases the number of seeds also increases the grain yield. However, the increase in the number of seeds per pod is subject to some limitations, because the production capacity of this component of yield is often dependent on genetic factors. The studies by Robertson *et al.* (2004), Johnson *et al.* (1995) and Shirani Rad *et al.* (2012) show that a delay in planting reduces the grain yield significantly. Farre *et al.* (2002) studied the effect of planting date on grain yield and other agronomic traits of several cultivars of rapeseed in two areas with ample and little precipitation in the west of Australia and concluded that a delay in planting significantly reduces the grain yield.

In respect of the above mentioned points and to identify the spring cultivars of rapeseed that can be substituted for the fall cultivars with the purpose of early ripening and avoiding drought at the final growth stages, the study was conducted using 24 cultivars.

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MATERIALS AND METHODS

A study was conducted in Karaj (Iran), in a split plot design based on RCBD with four replications over two years (2008 and 2009 cropping seasons). The test site was at 35°48'N, 50°75'E, and altitude of 1 321 meters above sea level. The average annual precipitation in the test region based on 30-year average data of Karaj Meteorological Office is 243 mm. The planting season was the main factor, precisely "planting in Fall" (September 25) and "planting in Spring" (March 25). Plant cultivar was the sub factor including 24 cultivars of rapeseed, i.e. RGS 003, Amica, Sarigol, Option 500, Hyola 401, Hyola 42, Hyola 60, Hyola 420, Hyola 330, Hyola 308, Kimberly, RGS 006, 19-H, Syn-3, PR-401.16, PP-401.15E, PP-308.8, PP-308.3, ORS 3150-3006, ORS 3150-3008, RG 4403, RG 405.03, RGAS 0324 and RG 405.02. Each experimental plot included four 4-m lines with 30 cm space between the lines. The space between the plants along the line was 5 cm and 2 lateral lines were considered as margins. Two middle lines were used for determining all phenological stages and different characteristics of the plant, such as number of pod/plant, number of grains/pod, grain yield, grain oil percentage, oil yield. At the end of each year, simple variance analysis of the desired traits and a comparison of the averages were performed. After the second year of the experiment, analysis of the combined variance was performed for the mentioned traits. In order to prepare the ground, the desired land was irrigated before the experiment and then plowed using a moldboard plow. For softening the clods and flattening the soil, a disk and trowel were used on the land. Then, samples

were taken from the soil at depths of 0-30 and 30-60 cm (Table 1). Based on the soil analysis and fertilizer recommendations, fertilizer (nitrogen, phosphorus and potash fertilizer) was applied and 2.5 l/ha of Treflan herbicide was distributed uniformly across the field. The fertilizer and herbicide were mixed with the soil using a light disk. For optimal use of nitrogen, the rest of the required nitrogen fertilizer was consumed at the beginning of the stem elongation and appearance of the first flower buds. After performing the experiment according to the cultivation plan and emergence of the seedlings, storage operation including pest control, particularly of waxy aphids, was performed using pesticides namely Metasystox (1.5 l/ha) and Ocatin (1 l/ha). To determine the traits such as number of pod/plant, 10 plants were randomly selected from each experimental plot and these traits were measured accordingly. To determine the number of seeds/pod, 30 pods were randomly selected from 10 desired plants and this trait was calculated accordingly. After removing the grains from the pod, the grain yield was determined. After determining the oil content of each experimental plot, the oil yield is calculated through multiplication of oil content with grain yield.

RESULTS AND DISCUSSION

The simple effects of planting season and cultivar, as well as the interaction of both on the grain yield (Table 2) were significant at $P < 0.01$. Fall planting was significantly superior with an average yield of 3 766.8 kg/ha, compared to spring planting which showed an average yield of

Table 1 Physical and chemical properties of soil collected from site study

Texture	K(ppm)	P (ppm)	N (%)	Saturated percentage (%)	Organic carbon (%)	pH	EC (ds/m)	Depth (cm)	TNV (%)
Clay loam	172	4.9	0.15	32.58	0.56	7.8	1.38	0-30	7.95
	129	3.2	0.09	30.64	0.35	7.7	1.76	30-60	10.59
Clay loam	205	3.1	0.06	36.06	0.51	7.8	1.46	0-30	9.81
	150	2	0.06	36.12	0.4	7.9	1.34	30-60	10.55

Table 2 Combined Analysis of variance for plant characteristic

SOV	df	MS				
		Biological yield	Biological yield	Oil content	Oil yield	HI
Year (Y)	1	659671121/102**	6076075/397**	3574/64**	402201/591**	599/742**
E _a	6	2156315/722	50832/334	10/854	57047/72	2/776
Date(d)	1	10314179727/671**	536380995/682**	8716/941**	140004862/213**	964/597**
(Y × d)	1	149992499/178**	3509/705 ns	46/028 ns	612014/498**	534/06**
E _b	6	3334080/843	173500/211	46/284	131501/582	4/683
Variety (V)	23	16158593/258**	1413118/444**	8/572**	260664/629**	33/398**
(Y × V)	23	9950515/908**	411381/352**	4/843**	43621/408**	13/384**
(d × V)	23	15630940/117 **	1292110/337**	1/468ns	244610/434**	20/312**
(Y × d × V)	23	7600433/264**	414323/711**	2/881**	56219/036**	13/059**
E	276	730654/052	39562/236	1/42	8776/362	2/637
CV (%)		6/19	7/69	2/93	8/49	8/9

ns: Non-significant , * and ** Significant at 5% and 1% probability levels, respectively

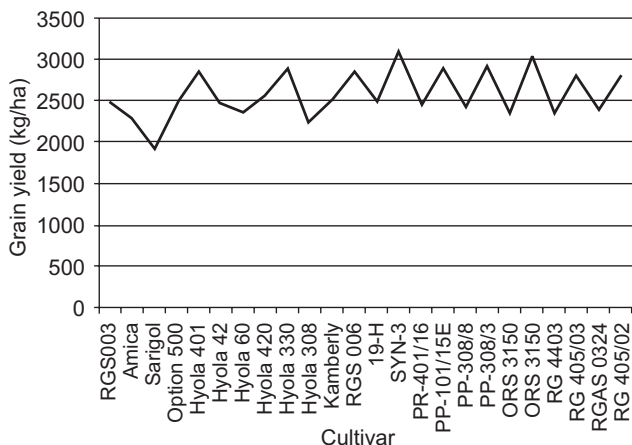


Fig 1 Mean comparison of simple effect of cultivar on grain yield

1 402.9 kg/ha. Syn-3 cultivar with an average of 3 114 kg/ha had the maximum grain yield while Sarigol cultivar with an average of 1 931 kg/ha had the minimum grain yield (Fig 1).

A comparison of the average interaction of planting season and cultivar showed that the tested cultivars at different planting seasons were placed in statistically different groups in terms of this trait (Table 3). While the highest yield (4 689 kg/ha) was observed in Hyola 401 hybrid cultivar that was planted during fall, Sarigol cultivar planted in spring yielded the grain quantity (920.9 kg/ha) (Fig 2).

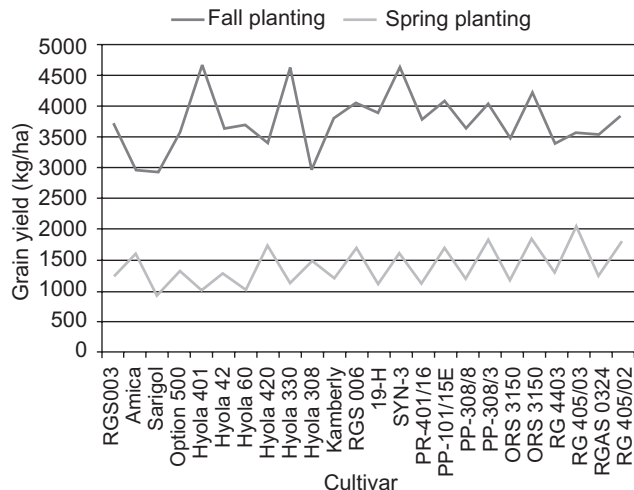


Fig 2 Mean comparison of the interaction effect of planting season by cultivar on grain yield

Both, Hyola 401 hybrid cultivar and RG 405.03 cultivar had the highest grain yield through planted in fall and spring respectively (Fig 2). Bitarafan and Shirani Rad (2012) compared the effect of different planting dates on rapeseed yield and concluded that a delay in planting reduced the grain yield. In examining the effect of planting date and the amount of seed on the grain yield of two cultivars of rapeseed, Fanaei *et al.* (2008) concluded that a delay in planting reduced the grain yield and the reduction rate was

Table 3 Mean comparison of plant characteristics

Variety	Grain yield (kg/h)		Oil yield (kg/h)		Oil content (%)	
	Fall	Spring	Fall	Spring	Fall	Spring
RGS003	3725 dh	1253 pq	1677 cde	463 mp	45.1 be	35.92 gl
Amica	2966 j	1615 mn	1339 h	568 jkl	45.23 be	36.01 gl
Sarigol	2941 j	920 s	1317 h	321 q	44.83 cde	34.98 jn
Option 500	3597 fi	1336 op	1695 cd	490 lo	47.28 a	37.5 f
Hyola 401	4689 a	1020 rs	2146 a	378 pq	45.87 bcd	36.62 fi
Hyola 42	3647 eh	1293 opq	1659 cf	438 nop	45.56 be	34.77 lmn
Hyola 60	3712 dh	1017 rs	1712 c	378 opq	46.19 abc	36.8 fgh
Hyola 420	3410 i	1755 lm	1555 fg	639 ijk	45.68 be	37.41 f
Hyola 330	4660 a	1130 ps	2165 a	420 opq	46.33 ab	37.03 fg
Hyola 308	2979 j	1493 no	1351 h	535 kn	45.42 be	36.14 fl
Kimberly	3821 def	1203 pqr	1698 cd	419 opq	44.5 de	34.84 kn
RGS 006	4054 bc	1691 lmn	1833 b	606 jk	45.36 be	36.35 fj
19H	3900 cd	1101 qrs	1738 c	394 opq	44.63 de	35.47 hn
SYN3	4649 a	1580 mn	2116 a	557 jm	45.62 be	35.83 gm
PR401.16	3790 dg	1095 qrs	1722 c	402 opq	45.56 be	36.26 fk
PP401.15E	4078 bc	1741 lm	1837 b	613 ijk	45.21 be	35.36 in
PP308.8	3657 eh	1189 pqr	1643 cf	427 opq	45 be	35.41 hn
PP308.3	4040 c	1851 l	1860 b	658 ij	46.21 abc	36.19 fl
ORS 31503006	3511 hi	1170 pqr	1575 efg	404 opq	44.9 be	34.21 n
ORS 31503008	4255 b	1844 l	1920 b	620 ijk	45.21 be	35.01 jn
RG 4403	3377 i	1300 opq	1532 g	475l p	45.5 be	36.37 fj
RG 405.03	3578 ghi	2066 k	1580 efg	713 i	44.26 e	35.25 in
RGAS 0324	3537 hi	1222 pqr	1599 dg	451 nop	45.22 be	36.61 fi
RG 405.02	3829 de	1786 lm	1713 c	613 ijk	44.83 cde	34.46 mn

Means in each column followed by similar letter(s) are not significantly different at 5% probability level using Duncan's Multiple Rang Test

3.4 percent in a week. The studies by Hocking and Stapper, (2001), Robertson *et al.* (2004) and Walton *et al.* (1999) shows that a delay in planting reduces the weight of one thousand seeds and grain yield. Unusual reduction of the size of canopy and shortening of the growth period are among the most important causes of the reduction of grain yield in delayed planting (Dipenbrock 2000) and (Hocking and Stapper 2001).

The simple effects of planting season and cultivar on the oil content were significant at 1% level, however, the interaction of the planting season and cultivar on this trait was not significant (Table 2).

Fall planting was significantly superior with an average of 45.39%, compared to spring planting with an average of 35.87%. The tested cultivars were placed in different statistical groups in terms of this trait in such a way that Option 500 cultivar with an average of 42.39% had the maximum and ORS3150.3006 cultivar with an average of 39.55 had the minimum oil content (Fig 3).

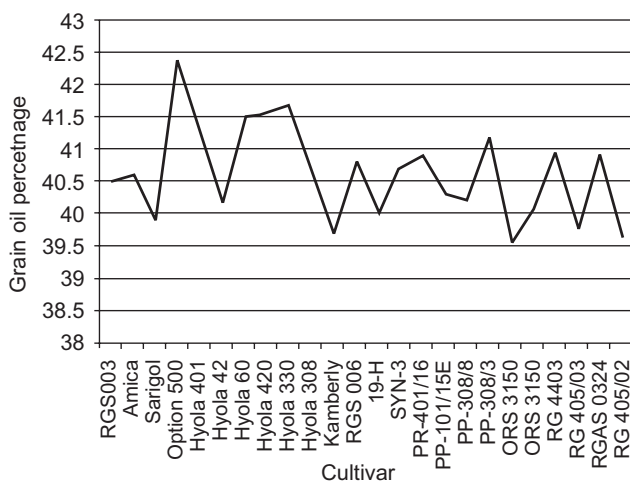


Fig 3 Mean comparison of the simple effect of cultivar on oil content

The simple effects of planting season and cultivar, as well as the interaction of planting season and cultivar on the oil yield, were significant at the 1% level. Fall planting was significantly superior with an average of 1 707.3 kg/ha, compared to spring planting with an average of 499.7 kg/ha. This is probably because the seed filling period in winter planting coincides with the higher temperature. Among the environmental factors that affect the oil amount, temperature is the most important factor. When it increases, the oil percentage will be reduced. Hocking and Stapper (2001), Robertson *et al.* (2004) and Walton *et al.* (1999) reported similar results regarding the reduction of oil percentage (7.1%) by each degree increase in temperature during flowering and seed filling. The tested cultivars were placed in different statistical groups in terms of this trait in such a way that Syn-3 cultivar with an average of 1 337 kg/ha had the maximum while Sarigol cultivar with an average of 819.1 kg/ha had the minimum oil yield (Fig 4). A comparison of the average of the interaction of the planting

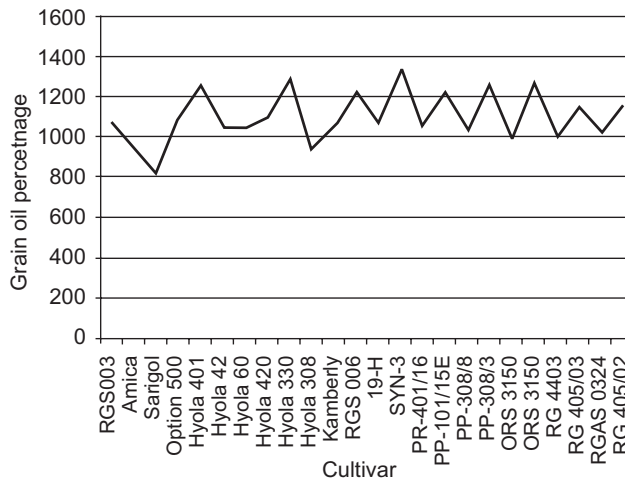


Fig 4 Mean comparison of the simple effect of cultivar on oil yield

season and cultivar showed that the tested cultivars at different planting seasons were placed in statistically different groups in terms of this trait (Table 3). Hyola 330 hybrid cultivar planted during fall showed the highest oil yield (2 165 kg/ha) whereas the lowest oil yield (321 kg/ha) was recorded from Sarigol cultivar that was planted during Spring (Fig 5).

Hyola 330 hybrid cultivar and RG405.03 cultivar recorded the highest oil yield during fall and spring season respectively (Fig 5).

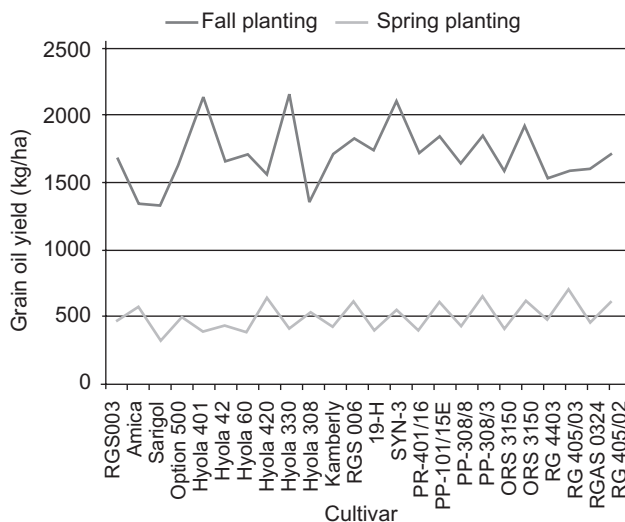


Fig 5 Mean comparison of the interaction effect of planting season by cultivar on oil yield

General conclusion

Season of planting was significantly influencing all measured traits. The results obtained from combined analysis showed that the simple effects of planting season and cultivar, as well as the interaction of planting season and cultivar on grain yield and oil yield, were different at P<0.01. Generally, for the fall planting season, Hyola 401 hybrid had the highest grain yield and Hyola 330 hybrid

had the highest oil yield. However, for the spring planting season, RG 405.03 cultivar had both highest grain and oil yields. The study indicated that it is possible to cultivate the spring cultivars of the plant during fall in cool temperate regions. By cultivating Hyola 401 and Hyola 330, desirable yields can be achieved due to early ripening of these cultivars.

REFERENCES

- Bitarafan Z and Shirani Rad A H.2012. Water stress effect on spring rapeseed cultivars yield and yield components in winter planting. *International Journal of Physical Sciences* 7(19): 2755–67.
- Dipenbrock W.2000. Yield analysis of winter oilseed rape (*Brassica napus* L.). *Field Crops Research* 67: 35–49.
- Fanaei H R, Galvi M, Ghanbari Bonjar A, Soluki M and Narouyinejad M R.2008. The effect of sowing date and seed rate on yield and yield components of two rapeseed cultivars in Sistan region. *Iranian Journal of Agriculture Sciences* 10(1): 15–30.
- Faraji A, Latifi N, Soltani A and Rad A H S. 2009. Grain yield and water use efficiency of canola (*Brassica napus* L.) as affected by high temperature stress and supplemental irrigation. *Agricultural Water Management* 96(1): 132–40. DOI: 10.1016/j.agwat.2008.07.014.
- Farre I M, Robertson J, Walton G H and Asseng S. 2002. Simulating phenology and yield response of canola to sowing date in western Australia. *Australian Journal of Agricultural Research* 53: 399–409.
- Hocking P J and Stapper M. 2001. Effects of sowing time and nitrogen fertilizer on canola and wheat and nitrogen fertilizer on Indian mustard dry matter production, grain yield and yield components. *Australian Journal of Agricultural Research* 52: 623–34.
- Robertson M J, Holland J F and Bambach R.2004. Response of canola and Indian mustard to sowing date in the grain belt of north-eastern Australia. *Australian Journal of Experimental Agriculture* 44: 43–52.
- Shirani Rad A H, Naimi V and Esfahani S N. 2010. Evaluation of terminal drought tolerance in spring and autumn cultivars of rapeseed. *Iranian Journal of Agricultural Sciences* 12(2): 122–32.
- Shirani Rad A H, Shahsavari N and Jais H M.2012. Effect of water shortage in late season on agronomic traits of rapeseed (*Brassica napus* L.). *African Journal of Agricultural Research* 7(25): 3677–84.
- Sinaki J M, Heravan E M, Rad A H S, Noormohammadi G G and Zarei G.2007. The effects of water deficit during growth stages of oilseed rape (*Brassica napus* L.). *American-Eurasian Journal of Agricultural & Environmental Sciences* 2(4): 417–22.
- Walton G, Si P and Bowden B. 1999. Environmental impact on canola yield and oil. *Proceeding of 10th International Rapeseed Congress* 1999, Canberra, Australia.