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Yield And Yield Components Of Spring Canola Cultivars As Influence By Different Planting Seasons (*Brassica Napus* L.)

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ABSTRACT

The aim to research of yield and components yield of spring canola cultivars in different planting Seasons(autumn and spring), an experimental was carried out in a split plot design based on RCBD with four replications for two years (2004-2006) in Karaj. Treatments were included planting season in two levels as main plots such as common planting date, autumn planting (27 *September*) and spring planting (25 *March*) and spring rapeseed varieties as sub plots in 24 levels. The results indicated that simple effects of planting season and variety and also interaction effect on grain per pod, seed yield, oil yield and biological yield were significant($P<0.01$). In autumn planting, Hyola 401 had the highest seed yield (4689 $kg.ha^{-1}$) and Hyola 330 produced the maximum oil yield (2165 $kg.ha^{-1}$), whereas RG 405.03 had the maximum seed yield and oil yield (2066 and 713.6 $kg.ha^{-1}$, respectively) in spring planting.

Key words*: *Oil Yield , Planting season, Rapeseed, Seed yield and Biological Yield

Introduction

The increase in the planted area of oil seed crops is an indication of the success of plant breeders and agronomists in developing suitable cultivars and production methods in semi arid regions [21]. This plant grows annually in the favorable weather conditions. The meal and oil are two products extracted from this plant. The canola seed contains 40-50 percent oil. The production of oil seed in Iran is not high; about 80% of Iran's necessary oil is imported from foreign countries [1]. The average yield of oil crops in Iran is 245000 t (Area harvested 521000 ha), whereas the world average yield of oil crops is 261,099,000 t (Area harvested 157,382,000 ha) [3]. Sowing time is an important factor that determines the length of growing season and hence yields. 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. 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 [10]. Planting 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. Johnson *et al*. (1995), Karam (1998) and Tanveer *et al*. (1998) noted the significant effects of sowing date on the yield of canola Sarson [11,12,25]. 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 [2]. A number of studies have shown yield decline in canola with delay in sowing [6,13]. In addition, canola oil content has been found to de cline with later sowing [6]. Horton (2006), found that highest yield of canola was observed from earlier sowings [7]. Growth and yield are functions of a large number of metabolic processes, which are affected by environmental and genetic factors. Number of pod per plant recorded higher in 14 October sowing compared to 29th October, 13 November and 28 November sowing [24].In addition, the seed yield was significantly higher in 20 October (2049.73 $kg.ha^{-1}$) than 10 November (1437.3 $kg.ha^{-1}$) and 30 November (915.08 $kg.ha^{-1}$) sowing dates [28]. Seeding earlier than normal incorporates operational diversity into a cropping system that diversifies weed management systems [4]. The detrimental effects of insects and diseases on canola yields, as well as the effect of delayed s owing on production cost, have been reported [28]. Late sowings not only reduce seed yield, but also decrease oil levels in winter rapeseed [20,17] Given the above purpose of this study to evaluate the possibility of planting spring varieties of canola , a fall in the cool temperate

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regions (Karaj of Iran), In order to escape the drought in early and late stages of spring growth period and comparison with the cultivation of these varieties.

Materials And Methods

The present experiment was laid out with the purpose of evaluation of spring rapeseed cultivars response to spring and autumn planting seasons during the 2004-2006 cropping years in the Research Field of Seed and Plant Improvement Institute, Karaj, Iran. The site is situated at 35°59' E longitude and50°75' N latitude with semi-arid climate (warm and dry summers).The yearly average precipitation (30-years long term period) which is mostly concentrated during the autumn and winter months was 243 mm. Rainfall in the months of canola grown in the two years of experimental are presented in Table(1).

The experimental design was laid out in a Randomized Complete Block with a split plot arrangement of treatments in four replications. Treatments were included planting season in two levels as main plots such as common planting date, autumn planting (27 September) and spring planting (25 March) and spring rapeseed varieties as sub plots in 24 levels(Table 2).

Table 1: Amount of Precipitation (mm) in 2003-2004 and 2005-2006 Cropping Seasons at Karaj Research Station, Iran

Year	Month	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	Total
2004-05		0	30.8	37.6	36	72.7	50.3	19.6	47.6	10.1	304.7
2005-06		1.8	28.5	5.6	49.3	85.2	3.1	42.4	6.7	2.5	225.1

Table 2: Type of Growth and Source of Canola Varieties Evaluated

Variety	Source	Cultivar	Hybrid
RGS 003	Germany	*	
Amica	Germany	*	
Sarigol	Iran	*	
Option 500	Germany	*	
Hyola 401	Canada		*
Hyola 42	Canada		*
Hyola 60	Canada		*
Hyola 420	Canada		*
Hyola 330	Canada		*
Hyola 308	Canada		*
Kimberly	Australia	*	
RGS 006	Germany	*	
19-H	Pakistan	*	
Syn-3	Iran		*
PR-401/16	Iran	*	
PP-401/15E	Iran	*	
PP 308/8	Iran	*	
PP 308/3	Iran	*	
ORS 3150-3006	Germany	*	
ORS 3150-3008	Germany	*	
RG 4403	Germany	*	
RG 405/03	Germany	*	
RGAS 0324	Germany	*	
RG 405/02	Germany	*	

Before the beginning of experiment, soil samples were taken in order to determine the physical and chemical properties. A composite soil sample was collected from depth of 0-30 and 30-60 cm. It was air dried, crushed, and tested for physical and chemical properties. The research field had a clay loam soil. The first top dressing distribution at 4-6 true leaf stage (125urea kg.ha^{-1}) and the second was conducted at the time of reproductive organs appearance. Hand weeding was done at 4-6 true leaf stage as well as mid- stem elongation stage. At the end of growing season and prior to crop harvest, 10 plants were chosen randomly from each experimental unit and were cut from the surface. Then traits consisted of number of pod per plant and number of seeds per pod, were measured.

At physiological maturity stage, for determining the seed yield, the crop was harvested from a 4.8 m2 area per each plot and was left in the field for drying until constant weight (up to 12% moisture). In order to separate seeds form pod, a trashing combine harvester was used. The harvested seeds from each experimental unit individually weighed with a precision scale and thereafter seed yield expressed as (kg\ha). In order to measure the seed oil percentage of each experimental plot, about 3 grams of seed was prepared and using an NMR apparatus, the oil percentage was measured. The said apparatus works based on the magnetic induction of hydrogen nucleus which is a spectrometry method. One of the advantages of this method is its being destructive which accelerates the speed and accuracy of measuring the seed oil content. processed by the combined analysis of variance using SAS statistical software. Means comparison of the data was done by Duncan's multi-range test (DMRT) (P<0.05).

Results And Discussion

Grain Yield:

The results variance analysis showed significant simple effects of planting season and varieties , and also the interaction effect of the planting season and variety on grain yield was at a level one percent (P<0.01)(Table 3). the results of mean compared grain yield in Table(4) show that treatment of spring planting date with a 50 percent reduction in the number of pods per plant , 35(%) of grain number and 34 (%) 1000-seed weight the reduced the grain yield of 3766.8(Kg.ha^{-1}) autumn planting treatment to 1402.9(Kg.ha^{-1}) was in the spring cultivation treatments. The yield reductions in rapeseed at later sowings can by fewer pods per plant and lower 1000-vseed weight [18]. Different researches indicate that through the delay in the sowing date, there occurs a decline in the seed yield [5,14]. Varieties studied in this experiment in terms of Grain yield the groups were statistically different, so that Syn-3 varieties with an average of 3114 (kg.ha^{-1}) , maximum and Sarigol varieties with an average 1931(kg.ha^{-1}) had the lowest grain yield (Table 4). It seems that varieties of Syn3 due to the large number of pods per plant and number of seeds in pod and high 1000-seed weight able to produce the highest grain yield, while Sarigol varieties of due to seeds per pod and low 1000-grain weight produced the lowest grain yield (Table 4). In the study of Morrison and Stewart as well as genetic differences among the four varieties of canola seed yield has been reported [15]. Study means compared the interaction effect of planting season and varieties showed that, Tested varieties, planted in different seasons, different responses have been shown to grain yield , So that the cultivation of hybrid Hyola 401 in Fall planting with an avrage 4689 (Kg.ha^{-1}), the highest and the spring planting season , RG405.03 varieties produced the highest grain yield (Table 5). Jasinska *et al*., reported that seed yield decreased with delay in sowing date [9]. Also Taylor and Smith concluded that seed yield declined when sowing date is delayed [8]. Varieties Hyola 401, despite the low number of pods per plant had the highest seed weight and seed number per pod and in the autumn crops produced the highest grain yield among the varieties experimental (Table 5). Also among the other varieties studied varieties Syn3, because of Produced the highest number of pods per plant and 1000-seed weight increased and Hyola330 varieties due to the large number of seeds per pod of high yield and the same had in comparison with the varieties Hyola401(Table 5). However, the treatment of spring planting , varieties RG405.03 despite the number of pods per plant And low number of seeds per pod had a lot of 1000-seed weight and able to produce the highest grain yield among the varieties studied (Table 5). In general, crop responses and evaluate them for optimal yield under various environmental conditions is dependent they have different abilities in the use of environmental conditions. This issue of the yield components and the interaction of genotype and environment when the conditions favorable and unfavorable is possible ,at each stage of plant growth [19].

Table 3: Mean squares of traits in the combined analysis of 24 varieties of spring rapeseed

		(MS)				
S.O.V	df	Grain yield	Plant height	Seed number in pod	Oil yield	Biological yield
Year	1	**	**	*	**	**
Error a	6	50832	155.6	12.41	57047	2156315
Planting Season	1	**	**	**	**	**
Year * Planting Season	1	ns	**	**	**	**
Error b	6	173500	170.1	13.53	131501	3334080
Variety	23	**	**	**	**	**
Year*Variety	23	**	**	**	**	**
Planting Season *Variety	23	**	**	**	**	**
Year* Planting Season*Variety	23	**	*	**	**	**
Error	276	39562	38.2	0.9	8776	730654
C.V. %	---	7.7	5.95	4.42	8.5	6.2

ns,*,** respectively: non- significant , significance in level of 5 and 1 %

Plant Height:

Fluctuations in plant height, the most striking characteristic of the condition is genetic and the environmental conditions in most plants. The simple effect of planting season, varieties, and also the interaction of season of sowing and varieties on plant height were significant (P<0.01) (Table 3). Cultivation of autumn (27 *Sep*.) with an average of 133.8 cm, compared to spring planting (25 *March*) with an average 85.5 cm, had a significant advantage. The tested varieties of these traits were in fact statistically different groups, So that, Amica variety with average 119.2 cm maximum, and hybrid of Hyola60 with an average 96.5 cm , Allocated to the lowest plant height (Table 4). The mean comparison of the interaction effect of planting season and varieties, Showed that the tested varieties planted in different seasons, different groups were compared in terms of the character. So that PP- 401.15E varieties in cultivation of autumn and Amica varieties in spring planted, allocated to the highest plant height (Table 5). Presumably, a longer growth period in autumn cultivation adequate opportunity to exploit the growth conditions including light, temperature and humidity provided, and increased photosynthetic materials, and finally vegetative growth and increased plant height has been, while on spring planting , due to the early stages of growth coinciding with the trend , and increase the temperature enough for the operation of the plant growth conditions has not been and therefore has reduced plant height. Hocking and Stapper [6] and Miralles *et al* [14] also shorten the period of vegetative growth canola planting date delay factor in reducing plant height in mind. Hoseiny Bay [8] has reported that the sowing dates noticeably affect the different canola traits such as the plant height. Potts and Gardiner [19] proved that a delay in sowing does not significantly affect the plant height. Taylor and Smith [26] have reported that the delayed sowing causes a decrease in canola height.

Seed number in pod:

Number of seeds per pod increased plant dry weight at flowering**,** If that is expressed in milligrams in each pod will increase**.** In this of Study, simple effects of planting season and varieties, and also the interaction effect of planting season and varieties on seed number per pod were significant (P<0.01)(Table 3)**.** Number of seed pods in autumn planting was 35 % higher than spring planting . Among the varieties of Amica varieties with an average 24.56 , maximum and RG405.03 varieties with an average 17.48 , allocated to the lowest number of seeds per pod (Table 4). Mean comparison of the interaction effect of planting season and varieties , showed that the cultivated varieties Amica in the autumn planting with a mean 30, the highest and were produced lowest number of seeds per pod Kimberly varieties (Table 5). In this regard, Rao *et al*, (1991) reported that the ability of different cultivars of rapeseed seeds inside the pod is different and number of seeds per pod, the risk factors and determinants of seed yield in canola [21].

Oil yield:

Simple effects of planting season and varieties, and also the interaction of planting season and varieties on oil yield were significant(P<0.01)(Table 3). Autumn cultivation with an average 1707.3 (kg.ha^{-1}), compared to spring planting with an average 499.7(kg.ha^{-1}), was significantly superior. Because of this, possibly coinciding with the higher temperature during grain filling in spring cultivation is compared with autumn cultivation the results of Robertson *et al* (2004) also is consistent. Among the environmental factors that affect the oil temperature is the most important factor that with the increase of Reduced oil content [22,16]. The results showed that oil yield , compared with oil content has been more affected by planting date (Table 5). It seems that the issue of greater control of oil content by genetic factors and the impact of high oil yield of changes in seed yield compared to the percentage of oil. In this review, Syn-3 varieties with an averaging 1337 (kg.ha^{-1}), the highest and varieties Sarigol with mean 819.1 (kg.ha^{-1}), allocated to the lowest oil yield (Table 4). The mean comparison of the interaction effect of planting season and varieties also showed that tested varieties planted in different seasons of the characters were statistically different groups, so that the hybrid Hyola330, Hyola401 and Syn-3 in the planting autumn and RG405.03 varieties in planting spring most of the oil yield production. In this review the superior varieties of oil yield, also had the highest grain yield (Table 5). Therefore, due to higher oil yield in these varieties can be respectively, due to the high yield and high oil yield content was expressed. Study, the results of correlation between oil yield and seed yield in (Table 6) shows that oil yield with seed yield ($r_=0.99$) very high correlation , in comparison with the oil content ($r_=0.35$). Jasinka *et al*., (1989) reported that seed and oil yields decreased with delay in sowing date [24].

Biological yield:

Simple effects of planting season and varieties, and also the interaction effect of planting season and varieties on biological yield were significant (P<0.01)(Table 3). Fall planting with an average 18984 (kg.ha^{-1}), compared to spring planting with an average 8625.5 (kg.ha^{-1}), significantly superior and loss of biological function on spring planting the autumn sowing date, was 54% (Table 4). In this experiment, autumn planting date due to having the highest plant height , number of seeds per pod, and seed yield, had the highest dry matter in comparison with spring sowing date (Table 4).That is, delayed planting dates lead to a reduction in seed yield by decreasing assimilate transition efficiency to economical sinks (grains) [23]. As delayed planting dates cause more reduction in biomass than seed yield, HI was higher than biomass. Among the varieties, most of biological functions belonging to the variety of PP308.3 was with an average 15660 (kg.ha^{-1}) and to attention the high yield , this result seems natural. mean comparison of the interaction effect of planting season and varieties showed that in the autumn planting season ,varieties Syn-3 and the spring planting season, varieties RG405.03, allocated to the most biological yield, the seed yield results were quite similar (Table 5). The reason could be due to the significant positive correlation is between biological yield and grain yield, which has been reported by Robertson *et al* [22] Study the correlation coefficients (Table 6) in this experiment also shows that positive and significant relationship is between the biological yield and grain yield (r =0.81). It seems that in the planting autumn ,canola varieties with longer growth period and favorable environmental conditions than spring planting, have produced more dry matter. While on spring planting conditions due to the shorter growth period, heat and drought of last season and less favorable environmental factors varieties studied different reactions the photosynthetic build materials and thus have shown that dry matter production.

Conclusion:

In conclusion this study, spring hybrid of Hyola401 in autumn planting having the highest relatively large number of seeds per pod , produced the highest grain yield 4689 (kg.ha^{-1}). So in cold temperate regions of Iran (Example of Karaj),Cold tolerant varieties of spring rapeseed (Hybrids Hyola 401) due to the high yield potential can be planted in early autumn.

Table 4: Main Comparison of Studied Traits in Spring Rapeseed Cultivars (2004-206 years)

Treatment	Grain yield (Kg.ha^{-1})	Plant height (cm)	Seed number in pod	Oil yield (Kg.ha^{-1})	Biological yield (Kg.ha^{-1})
Planting Season					
Autumn (27 *Sep*.)	3766.8a	133.8a	25.5a	1707.3a	18984a
Spring (25 *March*)	1402.9b	85.5b	17.3b	499.7b	8625b
Cultivar					
RGS 003	2489def	101.7ghi	22.1d-g	1070ef	13200fgh
Amica	2291gh	119.2a	24.6a	954h	13750ef
Sarigol	1931i	107.3ef	19.6i	819i	12660hij
Option 500	2466def	116.1abc	21.5e-i	1093de	13430fg
Hyola 401	2854c	96.8ij	23.5bc	1262b	13630efg
Hyola 42	2470def	104.7fg	23.2bc	1049efg	12190g
Hyola 60	2365e-h	96.5j	18.1kl	1046efg	13420fg
Hyola 420	2583d	115.3a-d	21.4ghi	1097de	13800ef
Hyola 330	2895c	110.5de	23.6b	1288ab	14200de
Hyola 308	2236h	99.7hij	22.0e-h	943h	12430ij
Kimberly	2512de	114.8a-d	23.7b	1059efg	13340fg
RGS 006	2873c	99.0hij	20.2j	1220bc	14800cd
19-H	2500def	119.7a	22.2def	1066efg	14270de
Syn-3	3114a	115.7a-d	21.7e-i	1337a	16230a
PR-401.16	2443d-g	117.2ab	22.8cd	1062efg	13400fg
PP-401.15E	2909bc	115.1a-d	21.3hi	1226bc	14770cd
PP 308.8	2423d-g	117.8ab	22.3de	1035efg	13840ef
PP 308.3	2945bc	110.9cde	21.5f-i	1259b	15660ab
ORS 3150-3006	2341fgh	115.0ad	21.6e-i	989gh	13300fg
ORS 3150-3008	3049ab	107.5ef	18.2k	1270ab	14150de
RG 4403	2338fgh	110.7de	21.0i	1004fgh	12520ij
RG 405.03	2822c	106.4efg	17.5l	1147d	15240bc
RGAS 0324	2380e-h	112.9bcd	23.1bc	1025efg	13040ghi
RG 405.02	2807c	102.7fgh	18.5k	1163cd	14140de

For a given means within each column of each section followed by the same letter are not significantly different ($p < 0.05$).

Table 5: The means Comparison of Interaction Effects of Planting Date and Cultivars(2004-206 years)

Cultivar	Grain yield (Kg.ha^{-1})		Plant height (cm)		Seed number in pod		Oil yield (Kg.ha^{-1})		Biological yield (Kg.ha^{-1})	
	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring
RGS 003	3725d-h	1253pq	125.6fg	77.8opq	26.0ef	18.2pqr	1677cde	463.1m-p	19040e-h	7355vw
Amica	2966j	1615mn	142.9abc	95.5j	30.0a	19.1l-q	1339h	568.8jkl	17460i-m	10030opq
Sarigol	2941j	921s	119.6gh	95.04j	22.9g	16.2s	1317h	321.0q	17850i-l	7458vw
Option 500	3597f-i	1336op	145.2ab	87.1k-n	24.7g	18.3o-r	1695cd	490.0l-q	18980e-h	7883t-w
Hyola 401	4689a	1020rs	116.3hi	77.3opq	27.6bcd	19.28l-o	2146a	378.1pq	21030b	6236x
Hyola 42	3647e-h	1293opq	136.7cde	72.6q	27.7bc	18.6n-q	1659c-f	438.8nop	17060lm	7324vw
Hyola 60	3712d-h	1017rs	111.2i	81.8no	20.8k	15.32st	1712c	378.0opq	19580def	7257vw
Hyola 420	3410i	1755lm	141.0a-d	89.7j-m	25.3fgh	17.5r	1555fg	639.3ijk	18450ghi	9150qrs
Hyola 330	4660a	1130p-s	138.9bcd	82.2no	27.8b	19.4lmn	2165a	420.9opq	21030b	7370vw
Hyola 308	2979j	1493no	127.0f	72.4q	26.6de	17.3r	1351h	535.3k-n	16660m	8206tuv
Kimberly	3821def	1203pqr	145.7ab	83.8mno	27.4bcd	19.9kl	1698cd	419.8opq	19570def	7117w
RGS 006	4054bc	1691lmn	118.0h	80.0nop	25.5fg	14.9t	1833b	606.0ik	20100cd	9496qr
19-H	3900cd	1101qrs	146.1ab	92.5jkl	25.4fgh	19.1l-p	1738c	394.6opq	19840cde	8709rst
Syn-3	4649a	1580mn	141.1a-d	90.3j-m	24.5gh	18.8m-p	2116a	557.3i-m	22540a	9915opq

PR-401.16	3790d-g	1095qrs	142.9abc	91.5jkl	26.1ef	19.4lmn	1722c	402.5opq	19040e-h	7762t-w
PP-401.15E	4078bc	1741lm	147.9a	82.36no	26.3ef	16.2s	1837b	613.7ijk	18890e-h	10640o
PP 308.8	3657e-h	1189pqr	141.0a-d	94.5j	26.7cde	17.8qr	1643c-f	427.6opq	1980d-g	8495stu
PP 308.3	4040c	1851 l	140.9a-d	80.9nop	26.7cde	16.2s	1860b	658.0ij	20500bc	10820o
ORS 3150-3006	3511hi	1170pqr	136.4cde	93.6jk	25.8ef	17.4r	1575efg	404.5opq	18050h-k	8552stu
ORS 3150-3008	4255b	1844 l	134.3de	80.6nop	22.7ij	13.7u	1920b	620.2ijk	17830i-l	10460op
RG 4403	3377i	1300opq	126.2gh	95.1j	24.4h	17.6qr	1532g	475.0l-p	17320klm	7714uvw
RG 405.03	3578ghi	2066k	126.8f	85.9lmn	21.9j	12.9u	1580efg	713.6i	18740f-i	11730n
RGAS 0324	3537hi	1222pqr	130.5ef	95.2j	26.3ef	19.8lm	1599d-g	451.6nop	18380g-i	7706uvw
RG 405.02	3829de	1786lm	131.0ef	74.3pq	23.4i	13.6u	1713c	613.2ijk	18650f-i	9627pq

For a given means within each column of each section followed by the same letter are not significantly different ($p < 0.05$).

Table 6: Simple Correlation Coefficients Between the Studied Traits (2004-2006 years)

Traits	Grain yield (Kg.ha^{-1})	Plant height (cm)	Seed number in pod	Oil yield (Kg.ha^{-1})	Biological yield (Kg.ha^{-1})
Grain yield(Kg.ha^{-1})	1	0.079^{ns}	0.036^{ns}	0.99**	0.81**
Plant height(cm)		1	0.44*	0.076^{ns}	0.061^{ns}
Seed number in pod			1	0.047^{ns}	0.013^{ns}
Oil yield(Kg.ha^{-1})				1	0.81**
Biological yield (Kg.ha^{-1})					1

ns,*,** respectively: non- significant , significance in level of 5 and 1 %

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