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Evaluation of Spring Rapeseed Cultivars Response to Spring and Autumn Planting Seasons

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ABSTRACT

In order to investigation of rapeseed cultivars reaction to spring and autumn plantings, 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 Pod per plant, 1000 seed weight, seed yield, and harvest index were significant (P<0.01). In autumn planting, Hyola 401 had the highest seed yield (4689 kg.ha^{-1}), whereas RG 405/03 had the maximum seed yield (2066 kg.ha^{-1}) in spring planting.

Keywords: Harvest Index, Planting season, Rapeseed, Seed yield and its Components.

INTRODUCTION

Canola (*Brassica napus* L.) is a valuable oil seed that has attracted the attention of many people in recent years. This plant has been given a great importance in the plan for "oil seed import reduction". The canola plant, on account of enjoying high percentage of oil and protein, was ranked third and second, respectively among the oil seeds [1]. 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) [2]. Date of planting is an important management factor in the production of all crops, especially in regions where the growing season is haft. The response of canola to planting date will be influenced by environmental conditions during the growing season. Evaluated three canola cultivars at four sowing dates and found that seed yield was the highest at the first two sowing dates. Shafique *et al.* [3] in Pakistan evaluated date significantly decreased plant growth and consequently low yield. Kirkland and Johnson [4] stated that seed yield was greater in the early sowing dates and smaller in the later sowing dates. Horton (2006), found that highest yield of canola was observed from earlier sowings [5]. Growth and yield are functions of a large number of metabolic processes, which are affected by environmental and genetic factors. Shivani and Kumar (2002) stated that sowing on 25th September and 5th October recorded significantly higher number of seeds per pod as compared to 15th October, 25th October and 4th November sowing [6]. Number of pod per plant recorded higher in 14 October sowing compared to 29th October, 13 November and 28 November sowing [7]. Panda *et al*. (2004) observed that delay in sowing beyond 16th October reduced 1000-seed weight [8]. Khan and Tak (2002) conducted a field experiment on a clay loam and suggested that the seed yield was higher with 20th October sowing than 5 October and 5 November sowing [9]. In addition, the seed yield was significantly higher in 20 October (2049.73 kg/ha) than 10 November (1437.3 kg/ha) and 30 November (915.08 kg/ha) sowing dates [10]. Seeding earlier than normal incorporates operational diversity into a cropping system that diversifies weed management systems [11]. Seeding canola into standing stubble in the fall or early spring can also improve crop yield and quality. For example, fall-seeded *B. napus* rapeseed yield was 22% higher than yield of spring-seeded rapeseed [12]. However, failure to adopt fall-seeded canola 25 yr ago was

attributed to thin stands in the spring, inadequate control of winter annual weeds [13] and ultimately low yield and yield stability. In this experiment we studied investigation of rapeseed cultivars reaction to spring and autumn plantings.

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 2004-2005 and 2005-2006 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).

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
2003-04		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

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 (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 (120 kg urea/ha) and the second was conducted at the time of reproductive organs appearance (120 kg urea /ha). 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. The number of pod per plant was estimated using the following relation:

Mean number of pod/main stem + Mean number of pod/lateral branches: Number of pod per plant. 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. Finally, eight samples of 100 seeds were taken from each seed lot of the experimental units and then weighed. Their average multiplied by 10 recorded 1000-seed weight (g). 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) at the probability level of 5%.

RESULTS AND DISCUSSION

Number of Pod in Plant:

In this review the simple effect of planting season and varieties , and also the interaction of planting season and varieties on the number of pods per plant was significant($P<0.01$)(Table 3). Autumn cultivation with an average 155.4, compared to spring planting with an average 77.9 had a significant advantage. The tested varieties of this trait in different groups were compared, so that ORS3150/3006 varieties with an average 151.8, more and Amica varieties with an average 91.5, produced the lowest number of Pod per plant (Table 4). Comparison of the effect of planting season and varieties showed that Syn-3 varieties, in the autumn planting and the spring planting season, varieties PP308 / 8 had the highest number of Pod per plant (Table 5). Number of Pods per plant, grain yield is a major component, because the capacity of a seed Pod provides and green shell pods with photosynthesis and the percentage of ingredients , provides for canola seed filling. Mendham *et al.*, have reported that in their study the pod number of fertile genotypes of canola, is more subordinate to weather conditions, sowing date and plant density than other such determinants [14]. Furthermore, Degenhart and Kondra reported that the "pod number per plant" decreases by a delay in sowing. Thus they observed that, as a result of the decrease in the number of pods pre plant, the number of pods per stem decreases [15]. Ozer too, during the first year of his studies reached similar conclusions. Moreover in examining the interaction effects of sowings date and genotypes, we observe that RDFG003 at the sowing date of 30 March enjoys the most extent of height. The genotypes of RDF003 at 30 march sowing date, Sarigol and Hayola at 30ht march sowing date and again RDF003 at 14 April sowing date are all statistically at the same level [16].

1000-Seed Weight

In this experimental the simple effects of Planting season and varieties, and also the interaction of effect of Planting season and varieties on 1000-seed weight were significantly($P<0.01$)(Table 3). Fall planting with an average 4.06 g, than the spring planting (25 March) , averaging 2.68 g had a significant advantage. Delay in planting season seed weight and seed yield is reduced [17]. Among the varieties tested, Hyola 401 hybrid of with the average 3.62 g , maximum and Hyola 308 hybrid with an average 3.17 g , were allocated to the lowest 1000-seed weight (Table 4). The mean comparison of the interaction effect of planting season and varieties also showed that RG4403 varieties in autumn planting and varieties RG405/02, were allocated to the highest 1000-seed weight (Table 5). Robertson *et al*. (2004) and Bhuiyan *et al*. (2008) stated that 1000-seed weight reduced with the delayed planting time[18,19].

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 percent of grain number and 34 percent 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 due by fewer pods per plant and lower 1000-vseed weight [20]. Different researches indicate that through the delay in the sowing date, there occurs a decline in the seed yield [21,22]. 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 Syn 3 varieties 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 [23]. 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 [24]. Also Taylor and Smith concluded that seed yield declined when sowing date is delayed [25]. 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 Syn 3, because of Produced the highest number of pods per plant and 1000-seed weight increased and Hyola 330 varieties due to the large number of seeds per pod of high yield and the same had in comparison with the varieties Hyola 401(Table 5). However, the treatment of spring plantig , 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 [26].

Oil Content

In this study of simple effects of planting season and varieties on oil content was significant at the one percent level (Table 3). The amount of oil content in the spring planting was 21 percent lower than the autumn planting. Among the varieties tested varieties and Option 500 with an average 42.39 %, the highest and varieties ORS3150/3006, with an averaging 39.55% , were allocated to the lowest oil content (Table 4). Interactions between planting seasons and varieties , no significant effect on this trait (Table 3). M. R. I. Mondal *et al*.(2011) reported oil percentages in seeds were higher in the seeds of early plantings but it was reduced due to delayed planting. The highest oil content in seed was recorded from November 01 planting and the lowest oil content in seed was recorded from November 30 planting [27].

Harvest Index

Harvest index of important physiological parameters that measure of photosynthetic efficiency of the transfer material is produced in plant seeds. Planting season and harvest index under the influence of different varieties, also the interaction effect of planting season and varieties were significant (P<0.01)(Table 3). Results are mean compared in Table 4 show that the rate of harvest index in the autumn planting was 16 percent higher than spring planting. Due to higher harvest index in the autumn planting date can to most of the grain yield and 1000 seed weight compared with that on the spring planting (Table 4). Positive and significant correlation of harvest index with grain yield , ($r_{=}$0.83) and 1000-seed weight ($r_{=}$0.44) this will confirm (Table 6). Varieties tested , the groups were statistically different , so that ORS3150/3008 varieties with an average 20.78 % ,the highest and varieties Sarigol, with an averaging 85/14 % , were allocated to the lowest harvest index (Table 4). The mean comparison of the interaction effect of planting season and varieties , also showed that ORS3150/3008 varieties in autumn planting with an average winter 23.88% the highest, and varieties of H-19, the cultivation of spring with an average 13.11%, the lowest harvest index were produced (Table 5). It seems that a high yield (4255 kg ha^{-1}) and low biological yield (17 830 kg ha^{-1}) in autumn cultivation due to the higher harvest index , in ORS3150/3008 varieties in compared with other varieties have been studied. While the varieties of 19-H, low grain yield (1101 kg ha^{-1}) with a mean biological yield (8709 kg ha^{-1}) , the lowest harvest index in spring planting , has resulted in among other varieties. Johnson *et al*., compared the various sowing dates of canola and reached the conclusion that the delay in sowing decreases the harvest index considerably [28]. Stapper & Fischer reported that late sowing date resulted in a shortening of the per-flowering period and decreases in seed yield, harvest index and yield component [29].

Table (3). Mean squares of traits in the combined analysis of 24 varieties of spring rapeseed

		(MS)				
S.O.V	df	N. of Pod in Plant	1000-Seed Weight	Grain Yield	Oil Content	Harvest Index
Year	1	548002.2**	2.73**	6076075**	3574.6**	599.74**
Error a	6	128.4	0.325	50832	10.8	2.77
Planting Season	1	576159.6**	182.7**	50832**	8716.9**	964.59**
Year* Planting Season	1	564.1^{ns}	0.139ns	3509^{ns}	46.0ns	534.06**
Error b	6	120.4	0.37	173500	46.3	4.68
Variety	23	5080.5**	0.437**	1413118**	8.5**	33.39**
Year*Variety	23	2124.3**	0.321**	411381**	4.8**	13.38**
Planting Season* Variety	23	1666.7**	0.11**	1292110**	1.5ns	20.31**
Year* Planting Season* Variety	23	1214.2**	0.05*	414323**	2.8**	13.05**
Error	276	51.9	0.03	39562	1.4	2.63
C.V. %	---	6.18	5.18	7.7	2.9	8.9

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

Simple Correlation Between the Studied Traits :

Simple correlation between the traits test shows that the grain yield and harvest index had a significant positive correlation with 1000-grian weight. Also the between grain yield and harvest index, was a significant positive correlation (P<0.01). Gunasekera *et al.*, reported that canola seed yield is Strong correlation with shoot dry matter and harvest index[30]

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

Treatment	N. of Pod in Plant	1000-Seed Weight(g)	Grain Yield (Kg ha^{-1})	Oil Content(%)	Harvest Index(%)
Planting Season					
Autumn (27 *Sep*.)	155.45a	4.06a	3766.8a	4.39a	19.83a
Spring (25 *March*)	77.97b	2.68b	1402.9b	35.87b	16.66b
Cultivar					
RGS 003	133.4de	3.22hi	2489def	40.51d-k	18.39cde
Amica	91.6l	3.10ij	2291gh	40.62c-j	16.56fg
Sarigol	129.6e	3.20hij	1931i	39.90h-k	14.85h
Option 500	99.8j	3.22hi	2466def	42.39a	14.81def
Hyola 401	101.5j	3.62a	2854c	41.25b-e	19.47bc
Hyola 42	107.1i	3.18hij	2470def	40.17g-k	19.86ab
Hyola 60	117.1fg	3.37efg	2365e-h	41.50a-d	16.62fg
Hyola 420	98.5jk	3.40def	2583d	41.55abc	19.11bcd
Hyola 330	135.1de	3.44cde	2895c	41.68ab	18.84bcd
Hyola 308	113.7gh	3.07j	2236h	40.78b-h	18.06de
Kimberly	121.3f	3.19hij	2512de	39.67jk	18.37cde
RGS 006	94.1kl	3.26gh	2873c	40.68b-h	19.09bcd
19-H	115.2gh	3.41c-f	2500def	40.05j-k	16.39g
Syn-3	138.0cd	3.54a-d	3114a	40.72b-i	18.74bcd
PR-401.16	92.2l	3.50a-e	2443d-g	40.91b-j	17.32efg
PP-401.15E	96.8jkl	3.44cde	2909bc	40.29e-k	19.51bc
PP 308.8	130.2e	3.26gh	2423d-g	40.21f-k	16.70fg
PP 308.3	110.3hi	3.37efg	2945bc	41.20b-f	18.75b-e
ORS 3150-3006	151.8a	3.28fgh	2341fgh	39.55k	16.70fg
ORS 3150-3008	107.2i	3.55abc	3049ab	40.11g-k	20.78a
RG 4403	145.3b	3.59ab	2338fgh	40.94b-g	18.46cde
RG 405.03	115.4gh	3.47b-e	2822c	39.75ijk	19.01bcd
RGAS 0324	140.8bc	3.53a-d	2380e-h	40.92b-g	17.76def
RG 405.02	114.4gh	3.60ab	2807c	39.65jk	20.70a

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)

	No. of Pod in Plant		1000-Seed Weight(g)		Grain Yield (Kg ha^{-1})		Oil Content(%)		Harvest Index(%)	
Cultivar	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring
RGS 003	165.5ef	101.2no	4.0d-g	2.43f	3725d-h	1253pq	45.1b-e	35.9g-l	19.5d-i	17.2l-p
Amica	118.9jk	64.27t-w	3.75ij	2.46st	2966j	1615mn	45.2b-e	36.01g-l	17.06m-p	16.06opq
Sarigol	175.1cd	84.81p	3.91f-i	2.49rst	2941j	921s	34.9j-n	34.9j-n	16.5nop	13.1s
Option 500	123.8j	75.85qr	4.0d-g	2.43t	3597f-i	1336op	37.5f	37.5f	18.9f-m	16.6nop
Hyola 401	133.2i	69.82r-u	4.40a	2.83klm	4689a	1020rs	36.6f-i	36.6f-i	22.3ab	16.6nop
Hyola 42	141.5h	72.66qrs	3.84ghi	2.52rst	3647e-h	1293opq	34.7lmn	34.7lmn	21.4bcd	18.3g-n
Hyola 60	169.7de	64.44t-w	4.19bcd	2.55p-t	3712d-h	1017rs	36.8fgh	36.8fgh	19.01e-m	14.2rs
Hyola 420	139.3hi	57.72wx	4.08c-f	2.72k-q	3410i	1755lm	37.4f	37.4f	18.5g-n	19.7d-i
Hyola 330	175.1cd	95.03o	4.08c-f	2.80klm	4660a	1130p-s	37.03fg	37.03fg	22.2b	15.5pqr
Hyola 308	152.4g	75.14qr	3.6j	2.54q-t	2979j	1493no	36.1f-l	36.1f-l	17.8i-o	18.2g-n
Kimberly	162.4ef	80.2pq	3.80hi	2.58o-t	3821def	1203pqr	34.8k-n	34.8k-n	19.6d-i	17.2l-n
RGS 006	132.4i	55.86xy	3.80hi	2.72k-q	4054bc	1691lmn	36.3f-j	36.3f-j	20.2c-g	18.0h-o
19-H	144.1h	86.18p	4.17bc	2.65m-s	3900cd	1101qrs	35.4h-n	35.5h-n	19.7d-i	13.1s
Syn-3	213.3a	62.67u-x	4.21bc	2.85kl	4649a	1580mn	35.8g-m	35.8g-m	20.6b-f	16.8nop
PR-401.16	112.6klm	71.89rst	4.21bc	2.78k-n	3790d-g	1095qrs	36.2f-k	36.2f-k	19.9c-h	14.7qrs
PP-401.15E	133.6i	59.93vwx	4.08c-f	2.79k-n	4078bc	1741lm	35.3i-n	35.3i-n	21.6bc	17.4k-p
PP 308.8	143.8h	116.4jkl	3.84g-i	2.67l-r	3657e-h	1189pqr	35.4h-n	35.4h-n	19.1e-l	14.3rs
PP 308.3	160.7f	59.95vwx	3.99d-g	2.73k-q	4040c	1851 l	36.2f-l	36.1f-l	19.7d-i	17.45k-o
ORS 3150-3006	187.3b	116.4jkl	3.96e-h	2.60n-t	3511hi	1170pqr	34.2n	34.2n	19.4e-i	13.9rs
ORS 3150-3008	164.6ef	49.84y	4.21bc	2.88k	4255b	1844 l	35.01j-n	35.01j-n	23.8a	17.7i-o
RG 4403	180.6bc	110.0lm	4.21a	2.77k-o	3377i	1300opq	36.4f-j	36.3f-j	19.5d-i	17.4k-p
RG 405.03	165.4ef	65.44s-w	4.16b-e	2.78k-n	3578ghi	2066k	35.2i-n	35.2i-n	19.23e-k	18.8f-m
RGAS 0324	174.2cd	107.4mn	4.31ab	2.74k-p	3537hi	1222pqr	36.6f-i	36.6f-i	19.28e-k	16.2opq
RG 405.02	160.9f	67.85r-v	4.32ab	2.89k	3829de	1786lm	34.5mn	34.4mn	20.6b-f	20.9b-e

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	No. of Pod in Plant	1000-Seed Weight(g)	Grain Yield (Kg ha^{-1})	Oil Content(%)	Harvest Index(%)
No. of Pod in Plant	1	0.248^{ns}	0.162ns	-0.182^{ns}	0.06^{ns}
1000-Seed Weight(g)		1	0.445*	0.088^{ns}	0.439*
Grain Yield (Kg ha^{-1})			1	0.252^{ns}	0.831**
Oil Content(%)				1	0.139^{ns}
Harvest Index(%)					1

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

CONCLUSION

In conclusion this study, spring hybrid of Hyola401 in autumn planting having the highest 1000- grain weight and a 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 Hyola401) due to the high yield potential can be planted in early autumn.

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