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Study of Sowing Date on Some Morphological Traits of Spring Canola (*Brassica napus* L.) Cultivars

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Abstract: Due to the water deficit in West Meshkin, Ardabil Province for irrigating the autumn canola as well as the farmers' lack of inclination to the autumn cultivation, this field experiment was carried out in this region to evaluate the possibility of cultivating the spring canola and to study the effect of sowing date on the yield and on some morphological characteristics of canola cultivars, in 2009 at Agricultural Research Institute of western Meshkin, Ardabil, Iran. The 4 x 2 factorial experiment was laid out in randomized complete block design with three replications. The factors were 1) sowing dates including 30th March, 14th April, 29th April and 14th May and 2) genotypes including three cultivars of canola (Hayola410, RDF003 and Sarigol). The results showed that, straw yield, primary branch number, pod number per stem, pod number. per branch, plant height, distance between the first pod and the soil, percentage of hollow seeds, harvest index and branch number, were affected by different sowing date and by canola cultivars. The Highest seed yield, biological yield and other traits were obtained in the first sowing date. Also in interaction of sowing data and cultivar, the highest seed yield was obtained in Hayola410 × first sowing date. Lowest seed and biological yield were detected in sarigol × fourth sowing date. Therefore cultivar of Hayola410 has more potential for many traits. Thus, it can be suggested that use Hayola410 cultivar and first sowing date.

Key words: Canola varieties · Seed yield · Sowing date and Morphological traits

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].

Since in Iran canola is a relatively newly-introduced crop and there are such problems as seed falling, lack of the bred varieties resistant to falling, the farmers do not tend to cultivate this crop. However recently through the proper policy of Iran's Agricultural Jihad and the production of resistant varieties, the farmers have been increasingly cultivated this product. Therefore the country gives priority to the production of oil products. Planting date is critical since if canola is planted too early or late and the acceptable planting dates are based upon location and elevation [2, 3] stated that planting date is one of the most important production decisions. Timely sowing of canola has proven a key to maximize yield potential and by default reduce risk. With the delay in sowing date, all the investigated traits declined. Different researches indicate that through the delay in the sowing date, there occurs a decline in the pod number per plant [4], pod number per plant [5], plant height, pod number [6], stem number per plant [7] and finally seed yield and oil quality [8-10]. Christmas [12] observed that different canola genotypes do not respond so much to the weather conditions. Also Sun *et al*. [13] announced that, like

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different species, different genotypes adapt themselves to specific climatic conditions. Jasinska *et al.* [14] reported that seed yield decreased with delay in sowing date. Also Taylor and Smith [15] concluded that seed yield declined when sowing date is delayed. Johnson *et al*. [16] 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.* [17] in Pakistan evaluated ten canola varieties and reported that delaying sowing date significantly decreased plant growth and consequently low yield. Kirkland and Johnson [18] stated that seed yield was greater in the early sowing dates and smaller in the later sowing dates. Horton [19] found that highest yield of canola was observed from earlier sowings. Growth and yield are functions of a large number of metabolic processes, which are affected by environmental and genetic factors.

An experiment to study the Effects of sowing date on some morphological traits of spring canola cultivars was conducted at the Meshkin region, Ardabil, Iran. The purpose of this study was to understand morphological changes in different cultivars at planting dates.

MATERIALS AND METHODS

The field study was conducted the at Agriculture Research Station in western Meshkin (47°29´N and 38°22´E; 1244 elevation) Ardabil, Iran in 2009. Based on the soil test, pH was about 8.15, soil texture was Silt-loam and the depth of top soil was 60 cm (Table 1). Meteorological data for Meshkin Agricultural Resources Research during the growth period of canola in cropping seasons are presented in Table 2. This investigation was arranged as a factorial experiment based on the randomized complete block design with three replications. Factors were 1) sowing date including 30th March, 14th April, 29th April and 14th May and 2) genotypes including three cultivars of canola (Hayola410, RDF003 and Sarigol). The experimental unit included six ridges of 25 cm in width and 4 m in length, (i.e.6 m^2). The plant density was 150 plants per m^2. The seeds of three cultivars were sown at the depths of 3 to 4 cm. Other agronomy practices were done according to the soil test (Table 1). In order to measure the total dry matter, 40-50 days after planting and at intervals of 10 days, some plants were selected randomly from each row of the main plots and then were placed in the electric oven of 75°C until the constant weight was attained. Afterwards their dry weight was weighed.

RESULTS AND DISCUSSION

Branch Number: Based on the analysis of variances (Table 3), the main effect of the sowing date as well as the interaction effects between the sowing date and genotypes on the main stem number has been significant while the main effect of genotype on this trait has not been significant. The table of means comparison (Table 4) shows that the largest number of the stem (1.88) has been concerning the sowing date for 30th March but this number does not differ statistically with those of 14th May and 14th April sowing dates. These numbers are all classified in one single group. Moreover, in this respect, the sowing date of 29th April was located at the lowest level. Seemingly, the early spring is a suitable time for the increase in the number of stems of canola genotypes

Table 1: The analysis of Physico-chemical properties of the soil

Properties		Salinity (EC) ds/m	(pH)	(sp) %	Lime (TNV) %	(OC) %	(N) %	Available phosphorus (PaVa) PPM	Available potassium (KaVa) PPM	(C) %	(Si) %	(S) %	Soil texture	(Zn) PPM	(Fe) PPM	(Mn) PPM	(Cu) PPM
Sampling	0-30	0.5	8.15	48	14.35	1.31	0.1	6	340	18	50	32	Silty-loam	0.86	2	3.5	1.4
depth (cm)	30-60	0.42	8.15	45	22.5	1.2	0.1	7	224	18	45	37	loam	0.85	2	3.5	1.4

Table 2: Meteorological data for Meshkin Agricultural Resources Research during the growth period of canola in cropping seasons (2009)

	Temperature (°C)			Relative humidity (%)			Precipitation (mm)	
Months	Max. mean	Mean	Min. mean	Max. mean	Mean	Min. mean	Max	Sum
April	10.7	6.3	1.9	83.8	63.7	43.6	9.2	43.44
May	16.9	12.1	7.3	43.5	86.0	64.9	14.6	48.80
June	21.7	16.6	11.4	85.2	63.0	40.7	18.4	58.60
July	26.5	21.1	15.7	51.2	70.6	31.7	3.8	9.20
August	23.6	19.0	14.4	83.8	63.8	43.9	8.5	22.90
September	21.4	16.2	11.6	88.0	67.6	47.3	16.4	46.90
October	18.8	13.9	9.0	76	55.0	35.0	8.0	10.80

Table 3: Of the Effects of Different Sowing Dates on Physiological Traits of Canola Genotype

	MS										
S.O.V.	df	Seed yield	Branch number (no. plant_1)	Primary branch number	Pod No. per stem	Pod No. per branch	Plant height	Percentage of hollow seeds	Harvest index	Straw yield	Distance between the First Pod and the Soil
Block	2	140223*	0.0469	0.0711	7.6677	0.1233	176.57**	0.6300	3.87	541640	48.85*
Sowing date (SD)	3	11445905**	0.1499**	11.0766**	218.501**	1010.2**	8344.78**	41.0800**	734.14**	55873267**	2025.87**
Genotype (G)	2	451916**	0.02525	0.0577	2.257	25.5233	60.6336*	6.7900**	0.0608	1875644**	79.15**
SD × G	6	135937**	0.1037**	0.1244	2.1140	9.6981	88.359**	1.7455	6.775	4520290	34.53*
Error	22	29351	0.0196	0.1450	3.3114	11.537	21.3702	0.7366	31.396	279016.56	11.03
C.V. (%)	-	13.69	18.63	17.01	30.18	21.68	8.37	24.99	22.91	17.63	12.84

*, ** Significant at the 0.05 and 0.01 level, respectively

Table 4: Mean comparison for seed yield, biological yield and harvest index of canola genotypes at different sowing date

Treatment		Seed yield (kg ha^{-1})	Percentage of hollow seeds (%)	Straw yield (kg ha^{-1})	Harvest index (%)	Pod No. per stem	Pod No. per branch	Plant height (cm)	Branch number (no. plant^{-1})	Primary branch number	Distance between the First Pod and the Soil (cm)
Sowing date	30-March	2432.07a	2.43c	5573.0a	30.587 a	12.17a	24.48a	84.86a	1.88a	3.15a	40.94a
	14-April	1943.8b	3.80b	4488.5b	30.222a	8.15b	24.11a	75.61b	1.77a	2.77b	36.22b
	19-April	619.44c	6.51a	1819.3c	25.678a	2.93c	11.42b	40.77c	1.57b	2.37c	16.17c
	14-May	9.43d	1.05d	102.7d	11.322b	0.95d	2.20c	19.46d	1.76a	0.64d	10.15d
	Sarigol	1040.92b	4.17a	2585.7b	24.525a	6.71a	17.05a	53.95b	1.78a	2.18a	25.48b
Genotypes	Hayola410	1423.39a	2.64b	3374.5a	24.442a	5.48a	15.50a	53.81b	1.70a	2.21a	23.52b
	RDF003	1289.28a	3.53ab	3027.5ab	24.383a	5.96a	14.11a	57.77a	1.77a	2.31a	28.61a

*Means, in each column and for each factor, followed by similar letter (s) are not significantly different

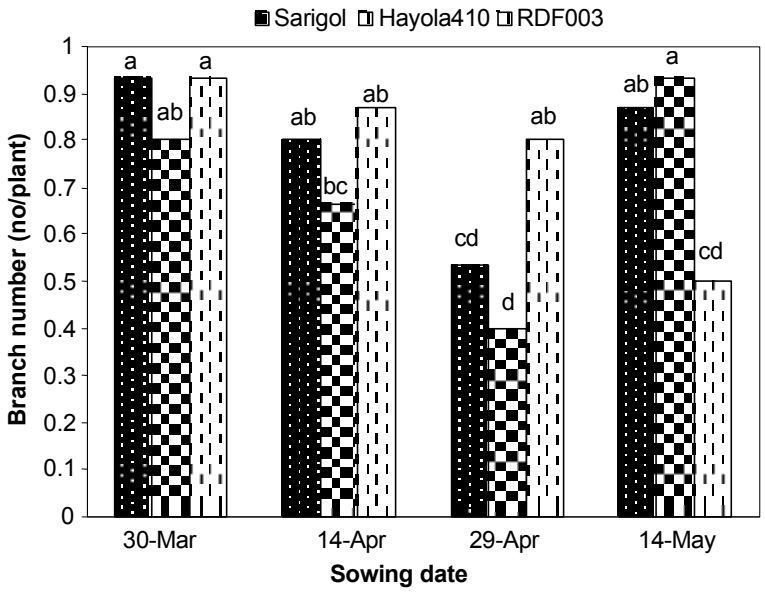

Fig. 1: Branch number changes as affected by interaction of sowing date and genotype

because, at this period, the plant has enough opportunity for increasing its foliage. Furthermore, in investigating the interaction effect of the sowing date on genotypes, it was proved that Sarigol and RDF003 at the sowing date of 30th March along with Hayola41 at the sowing date of 14th May were ranked the Highest. These two are classified in the same group as Hayola410 at the sowing date of 30th March, Sarigol and RDF003 both at the sowing date of 14th April, RDF003 at 29th April and Sarigol at 14th May (Figure 1).

Primary Branch Number: The main effect of sowing date on the primary branch number has been significant at 1% probability but neither the main effect of genotype nor

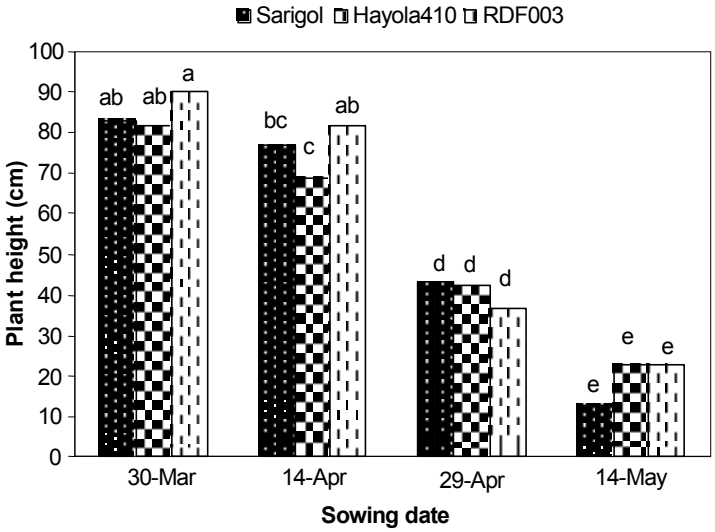

Fig. 2: Plant height changes as affected by interaction of sowing date and genotype

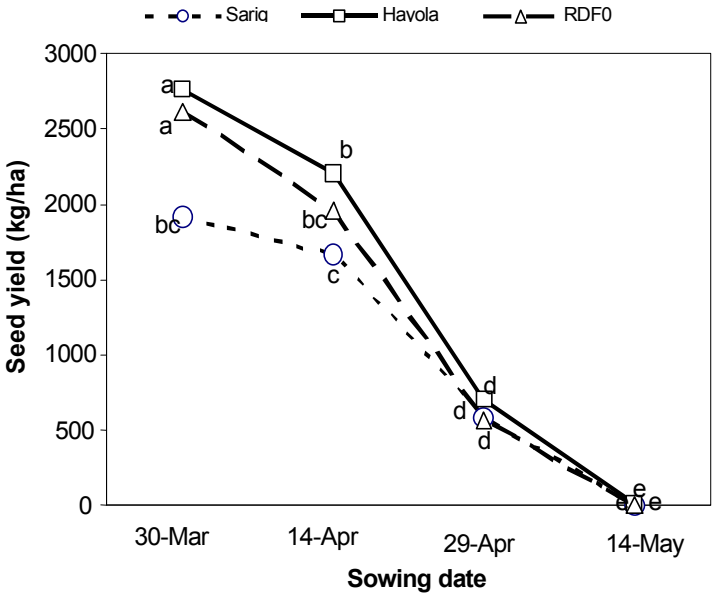

Fig. 3: Seed yield changes as affected by interaction of sowing date and genotype

the interaction effect of sowing date on genotype, has been significant (Table 3). According to the table of means comparison, the sowing date of 30th March with (15.3 primary branches) is ranked above all and differs statistically with other sowing dates (14th April, 29th April and 14th May). The next sowing dates are ranked in their sowing date order; as the fewest number of branches is observed at the last sowing date, namely 14th May (Table 4). Johnson *et al*. [20] and Ozer [7], in resembling reports announce that "branch number pre plant" decreases by a delay in the sowing date. Jenkins and Leich [21] reported that the number of side-branches decreases by a delay in the sowing; this can by justified by the fact that, because of unfavorable weather conditions, the growth period of the plant is ephemeral. If the sowing takes place in time, the plant grows naturally and has enough opportunity for branching. On the other hand if the sowing occurs late, the plant would rather pass the different growth stages and produce seeds than produce the branches.

Pod No. Per Stem: According to the analysis of variances (Table 3), the main effect of the sowing date on the pod number of the stem, is significant at 1% probability but the main effect of genotypes and the interaction effect between the sowing date and genotypes on the pod

number of the stem are not significant. At 30th March sowing date the pod number pre stem, like other morphological traits, had the largest quantity (12.7 pod pre stem) and was ranked in the highest group. In this respect, the other sowing dates (14th April, 29 th April, 14thMay ranked) the next ones respectively (Table 4). Mendham *et al.* [22] 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. Furthermore Degenhart and Kondra [23] 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. Ozer and Oral [24] believe that the "pod number per plant" is, besides genotypes, related to the sowing date. In this experiment, too, with a delay in sowing the number of pods has decreased both on the stem and on the branch. This can be resulted from the brevity of the different phonological stages at delayed sowings, since in this case the plant has little opportunity for producing larger number of pods.

Pod No. Per Branch: If you notice the variances analysis (Table 3), you observe that the main effect of the sowing date on the pod number per branch is significant; however the main effect of genotypes and the interaction effect between the sowing date and genotypes on the pod number per branch" is not significant. The sowing dates of 30th March and 14th April, that jointly have the most amount of effect (24.48 pods per branch) and are placed in the first group, differ statistically a lot with the sowing dates of 14th May and 29th April. The last sowing date (14th may) is ranked the last with the average of 2.20 pod per branch (Table 4). Here, again, the in-time sowing dates have had the largest number of produced pods because they had had enough time. This finding corresponds with the findings of many researchers including Debenhart and Kondra [23], Ozer and Oral [24] and Mendham, *et al*. [22].

Plant Height: According to the analysis of variances (Table 3), the morphological trait of "plant height" is noticeably influenced by the main effect of sowing dates at 1% probability, by the main effect of genotypes at 5% probability and the interaction effect between sowing dates and genotypes at 1% probability. The table of Means Comparison shows that the sowing of 30th march has the most effect on the "plant height" as it has the highest size (84.86 cm). Other sowing dates (14th April, 29th April and 14th May) are respectively ranked in the lower groups; as the sowing of 14th may is in the lowest place having the smallest plant height (19.46cm). There is a difference of 336 percent between the first and the last sowing dates (Table 4). At in-time sowings in the spring, the plant has enough opportunity to grow appropriately so that it will enter the reproduction stage later. On the other hand, at late sowings the plant naturally has a lesser growth and its height shortens because the temperature goes up and the environmental conditions become unfavorable. Hoseiny Bay [25] has reported that the sowing dates noticeably affect the different canola traits such as the plant height. Potts and Gardiner [26] proved that a delay in sowing does not significantly affect the plant height. Taylor and Smith [27] have reported that the delayed sowing causes a decrease in canola height. According to the Table of Means Comparison, the genotype of RDF003 with 57.77cm height has more quantity of height than other two genotypes (Hayola410, Sarigol) and is placed in group A. The genotypes of Sarigol and Rdf003 do not differ with each other and are both classified in group B (Table 4). In this respect, the genetic difference between the genotypes has brought about the different heights of the plant. In an investigation by Vaezy *et al.* [28], it was proved that various experimental lines differ considerably with each other in terms of some such agricultural properties as the Plant Height at 1% probability. These differences have indicated the genetic differences in the studied properties between these lines. Ozer [7], 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 30th march enjoys the most extent of height. The genotypes of RDF003 at 30th march sowing date, Sarigol and Hayola at 30ht march sowing date and again RDF003 at 14th April sowing date are all statistically at the same level. Sarigol genotype at 14th May sowing date, placed at the lowest level, is ranked the same with two other genotypes at this sowing date (Figure 2).

Distance Between the First Pod and the Soil: Taking into account the table of the variances analysis, we see that the main effect of the sowing date and the genotype on the trait of the distance between the first pod and the soil, is significant at 1% probability. Also the interaction effect between the sowing date and the genotype on this trait is significant at 5% probability (Table 3). It is noticeable from the Means Comparison table that the biggest number concerns the first sowing date with an average of

40.94cm; the pods of this sowing date are in the appropriate height to be harvested mechanically. The next sowing dates (14th April, 29th April and 14th May) are respectively ranked in the next classes such that the lowest pod is formed at the last sowing date (14th May) in a distance of 10.45cm from the soil (Table 4). Possibly at the earlier sowing dates, due to more height of the plant, the pods are formed on a more appropriate height. In examining the main effect of genotypes, too, RDF003 is ranked higher than other two genotypes. This genotype, furthermore, in terms of "plant height" is higher than other two, so its pods are formed on higher places. The genotypes of do not differ statistically with each other (Table 4). In examining the interaction effect between the sowing date and the genotype on the "distance between the first pod and soil", at 30th March sowing RDF003 and Sarigol are jointly ranked the first. At the sowing dates of 29th April and 14th May, all three genotypes are placed at the lowest level. RDF003 is a high-footed genotype whose pods are, consequently, formed on higher places. The sowing of 30th March influences the "plant height" and so influences the "distance between the first pod and the soil".

Agricultural Traits Relating the Yield Improvement

Percentage of Hollow Seeds: The analysis of variances (Table 3) shows that the main effect of the sowing date and that of the genotype on the percentage of hollow seeds is significant at 1% probability while their interaction effect on this percentage is not significant. According to the table of Means Comparison, the largest percentage of the hollow seeds (6.51%) is observed at the third sowing date (29th April) while the smallest percentage (1.05 %) is observed at the last sowing (Table 4). Christensen *et al.* [29] state that with a delay in sowing, due to the disorder in substance transport, an increase happens in the percentage of hollow seeds. The studies have indicated that high and low temperatures, during the flowering period, make the pollens unproductive and so are the main causes of the decrease in grain crops [30]. Vaezi *et al*. [28] quoting from Lunn [31] state that the pollination period up to a week is a critical, determinant factor in the formation of the seeds in the pod. If the environmental conditions are favorable in this period, there occurs appropriate pollination, floret inoculation and seed formation into the pod. Through the pollination in unfavorable environmental conditions, some of the flowers either become unproductive or fall down. The brevity of the reproduction growth stage along with the high temperature, during the flowering and other periods, causes a decrease in the number of productive pods and distorts the transport of stored substances to the seeds; consequently decreases the weight of 1000-seed, makes the seeds hollow and finally decrease the yield [28]. Sarigol has had the largest percentage (4.17) of hollow seeds and has been classified in the same group as RDF003. The least percentage of hollow seeds (2.64) is observed in Hayola410 genotype (Table 4). The higher yield of Hayola410 as compared to other genotypes, apart from its other positive properties, may be specially attributed to its low percentage of hollow seeds.

Harvest Index: If we notice the table of the variances analysis (Table 3), we observe that exclusively the main effect of sowing date on Harvest Index is significant while the interaction between the sowing dates and genotypes does not affect this index significantly. The sowing of 30th March has the highest (30.587 percent) Harvest Index; however this number does not differ statistically with those of 14th April and 29th April sowings and they all are placed in the same group- group A. The smallest harvest index (11.322 percent) was observed at 14th May sowing date- the last one (Table 4). Johnson *et al.* [20] compared the various sowing dates of canola and reached the conclusion that the delay in sowing decreases the harvest index considerably. These findings are identical to the findings of Sung *et al.* [32] and Mac Key *et al.* [33].

Straw Yield: The Straw Yield and stubble yield have been affected by the sowing date and the genotype while these have not been affected by the interaction effect between the sowing date and genotypes (Table 3). The Means Comparison Table shows that the most quantities of straw and stubble yield (5573kg/hs) have been obtained at 30th March sowing. At the last sowing date, namely 14th May, the least quantities of straw and stubble yield (102.7kg/ha) were observed (Table 4). In fact the straw and stubble yield, is subordinate to the biological yield of the plant. As we saw on the subject of "biological yield", the delayed sowing decrease the biological yield; consequently the straw and stubble yield decrease. According to the table of Means Comparison, Hayo410 has had the least straw and stubble yields with an average of 4kg/ha.This genotype and RDF003 are both placed in one group. Sarigol genotype, having 8525.7 kg/ha yield, is placed in the lowest group.

CONCLUSION

The results showed that early sowing in spring had the optimum yield. At the first sowing (30th March) the following traits revealed the largest quantities: "main stem number, primary branch number, pod number per stem, pod number per branch, plant height, distance of the first pod from soil, pod number pre plant, seed yield, pod length, pod diameter, biological yield, straw and stubble yield". Hayola410 genotype has been on an appropriate level in terms of some traits including pod length, low percentage of hollow seeds, biological yield" and more importantly "seed yield"- this genotype has had the most acceptable yields.

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